IAGA Bulletin N° 15

INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS

ASSOCIATION OF GEOMAGNETISM AND AERONOMY

(Formerly Association of Terrestrial Magnetism and Electricity)

Transactions
of the
Rome Meeting

SEPTEMBER 14-25, 1954

of the
Association of Terrestrial Magnetism
and Electricity

Edited by
V. LAURSEN

COPENHAGEN
HØRSHOLM BOGTRYKKERI · HØRSHOLM
1957

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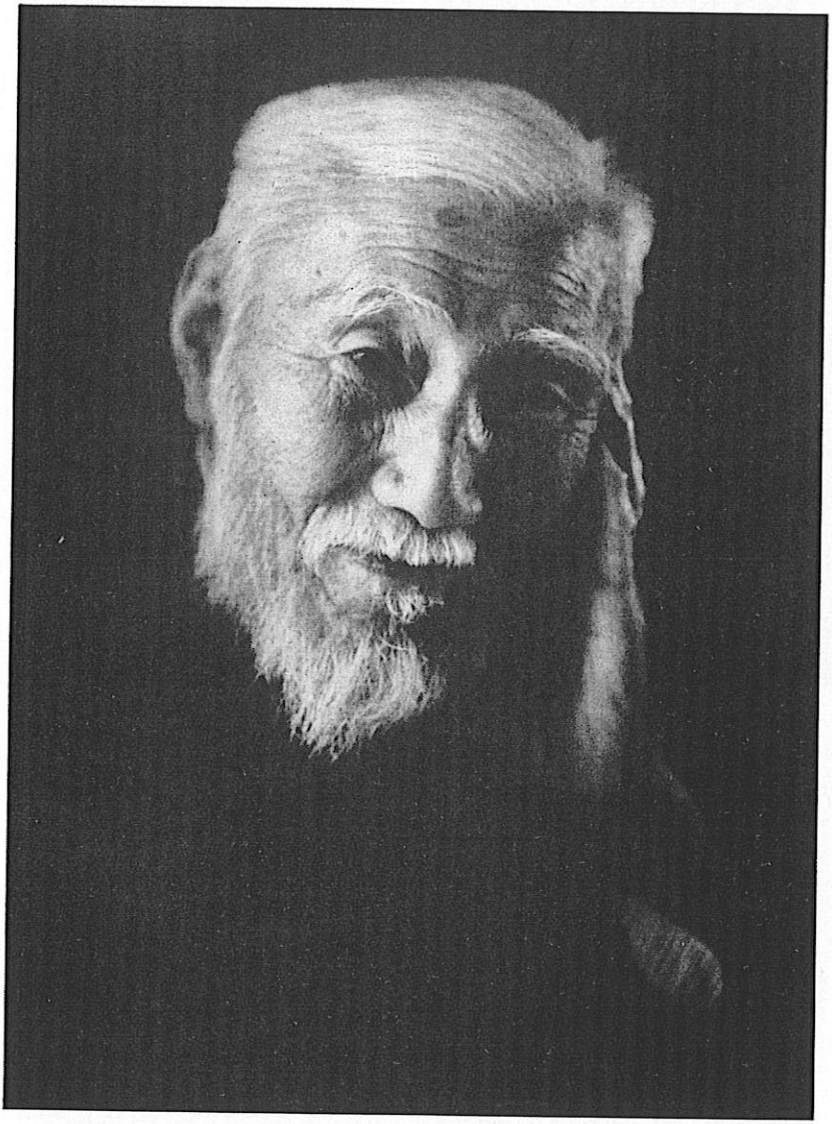
Aeronomy is the science of the upper atmospheric regions where dissociation and ionization are important.

S. Chapman.



Ai Tanakadate

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CORRIGENDA

p. 19, l. 12 f. b.: leur propriétés radioélectriques
read: leurs propriétés radioélectriques
p. 24, l. 1 f. a.: *K. Kato, A. Takayi and I. Kato*
read: *Y. Kato, A. Takagi and I. Kato*
p. 29, l. 19 f. a.: *C. J. Johnson and E. B. Meadows*
read: *C. Y. Johnson and E. B. Meadows*
p. 37, l. 5 f. a.: *J. C. Seddon and U. E. Jackson*
read: *J. C. Seddon and J. E. Jackson*
p. 70, l. 12 f. a.: *P. S. Nolan*
read: *P. J. Nolan*

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PART VI — RESOLUTIONS AND COMMITTEES

Introduction

Statement summarizing the proceedings of the Rome meeting

by J. COULOMB

(Presented at the final plenary session of the International Union of Geodesy and Geophysics, September 25, 1954)

La dixième Assemblée de notre Union restera marquée pour les Géomagnéticiens par la mort de l'Association Internationale de Magnétisme et Electricité Terrestres et par sa résurrection sous le nom d'Association Internationale de Géomagnétisme et d'Aéronomie. C'est l'aboutissement d'une longue négociation avec les Unions Scientifiques représentant des disciplines apparentées au magnétisme terrestre, notamment l'Union Radio-Scientifique Internationale, ainsi qu'avec l'Association Internationale de Météorologie. Je veux ici remercier de leur compréhension nos collègues appartenant à ces organismes si directement intéressés par cette transformation.

La liaison intime entre les perturbations géomagnétiques et certains phénomènes de la haute atmosphère ne faisait certes aucun doute pour personne; il était difficile de limiter au départ notre action dans ce domaine, mais il fallait éviter de heurter des traditions légitimes. La solution a été trouvée d'une part dans une convention de travail conclue avec nos collègues météorologistes, d'autre part dans l'adoption de ce terme d'Aéronomie, dû au Professeur Chapman, terme nouveau et encore imparfaitement défini, mais dont chacun de nous, en apportant le résultat de ses recherches aux prochaines Assemblées, contribuera à polir les contours.

Dès cette année, le comité mixte de la Haute Atmosphère que nous avons élu à Bruxelles a fait preuve, sous l'impulsion de son Président le Prof. Kaplan et de son Secrétaire le Dr. Nicolet, d'une activité exemplaire. Les séances qu'il a organisées ont soulevé un énorme intérêt. Citons parmi les sujets qui lui ont été confiés les aurores polaires, les marées de l'atmosphère, et les relations entre le rayonnement cosmique et les phénomènes géomagnétiques; sur ce dernier point des résultats extrêmement importants et nouveaux nous ont été communiqués.

L'électricité terrestre disparaît de notre titre, déjà assez long. Cependant l'électricité tellurique est évidemment liée au géomagnétisme. Quant à l'électricité atmosphérique, une de nos activités traditionnelles, elle est influencée par la météorologie, à laquelle je concevrais personnellement qu'elle pût être rattachée. Elle est pour l'instant étudiée par un second comité mixte entre nos deux Associations.

Outre ces questions, on peut citer parmi les sujets traités dans nos séances les perturbations magnétiques rapides, le paléomagnétisme et la variation séculaire. Une séance commune avec l'Association de Séismologie a été consacrée aux mouvements dans le noyau terrestre et à sa conductibilité; elle fut présidée de façon inoubliable par le Professeur Bullard. Enfin un très gros effort a été fait pour définir les conditions scientifiques des études géomagnétiques au cours de la prochaine Année Géophysique Internationale.

Le rôle joué dans la préparation des séances par les comités spécialisés de notre Association a été plus grand qu'aux assemblées précédentes, et j'espère qu'il s'accroîtra encore. Notre Association a reconsidéré leurs buts et regroupé certains d'entre eux pour augmenter leur efficacité. Mais cette réforme ne diminuera pas, et même augmentera probablement la lourde charge qui pèse sur les épaules de notre parfait Secrétaire Général le Dr. Laursen; il a bien voulu néanmoins en accepter le renouvellement, aux applaudissements de tous. Nous avons élu comme Président le Professeur Bartels, l'éminent Directeur de l'Institut de Géophysique de l'Université de Göttingen, et comme Vice-présidents le Professeur Kaplan et le Dr. Rayner.

Part I

Agenda and Minutes

Final agenda for the meeting

The following agenda is based on the provisional agenda issued on July 15, 1954, but will include all later modifications and amendments, in order to cover as exactly as possible the actual programme for the individual meetings. It should be noted that on certain days two parallel meetings were held, one indicated as a meeting of »Group G« and one as a meeting af »Group UA«. In such cases the »G«-meeting will be on special geomagnetic topics, whereas the programme of the »UA«-meeting will have relation to special problems in upper atmospheric physics. The »UA«-meetings and also several plenary sessions of the Association were arranged by the President and the Secretary of the Joint Committee on Upper Atmosphere.

Tuesday, 14 September

14^h00: IATME, opening session (Minutes see p. 9).
Presidential address presented by Prof. *J. Coulomb.*

Wednesday, 15 September

9^h00: IATME, plenary session (Minutes see p. 9).
1. Secretary's report.
2. Modification of statutes.
3. Nomination of Temporary Committees for the Rome meeting.
4. Special Committees for the next three-year period.
5. National reports.

14^h30: IATME, plenary session (Minutes see p. 12).
1. National reports (continued).
2. Report of Committee No 5 (Giant Pulsations).

Thursday, 16 September

9^h00: IATME, group meeting. Group G (Minutes see p. 13).
1. Report of Committee No 1 (Sites of New Observatories).
2. Report of Committee No 3 (Secular Variation).

3. Report of Committee No 4 (Magnetic Charts).
4. Communications on secular variation.
5. Communications on magnetic charts.

9h00: IATME, group meeting. Group UA (Minutes see p. 14).
1. Communications on the thermosphere.
2. Rocket observations during the International Geophysical Year.

14h30: IATME, plenary session (Minutes see p. 15).
1. Nominations of Chairmen for Special Committees.
2. Communications on magnetic perturbations.

Friday, 17 September

9h00: IATME, plenary session (Minutes see p. 17).
1. Election of Executive Committee for the next three-year period.
2. Magnetic observations during the International Geophysical Year.
3. Report of Committee No 11 (Equatorial Observations).
4. Communications on the equatorial jet current and allied phenomena.

14h30: IATME, plenary session (Minutes see p. 18).
1. Report of Committee No 9 (Characterization).
2. Communications on instruments and observatory technique.
3. Communications on earth currents.
4. Communications on magnetic activity.

Saturday, 18 September

9h00: Joint meeting. Group G + Association of Meteorology. (Arranged by the Joint Committee on Atmospheric Electricity. Minutes see p. 19).

Problems in atmospheric electricity.

9h00: IATME, group meeting, Group UA (Minutes see p. 20).
1. Report of Committee No 2 (Aurora).
2. Communications on the auroral spectrum.

Monday, 20 September

9h00: IATME, group meeting. Group G (Minutes see p. 21).
1. Communications on the electrical conductivity of rocks.
2. Special Report on palaeomagnetism (Prepared by *T. Nagata*, Special Reporter on Palaeomagnetism).
3. Communications on palaeomagnetism.

9h00: IATME, group meeting. Group UA (Minutes see p. 24).
1. Communications on the airglow spectrum.

2. Auroral and airglow observations during the International Geophysical Year.

14h30: Joint meeting. Group G + Association of Seismology (Minutes see p. 25).

Movements in the earth's core and electrical conductivity (Discussion arranged by *Sir Edward Bullard).*

14h30: IATME, group meeting. Group UA (Minutes see p. 29).
1. Communications on atmospheric spectra (cont.).

Tuesday, 21 September

9h00: IATME, plenary session (Minutes see p. 29).
1. Administrative matters
   a) Statutes (Name of the Association).
   b) Other administrative matters.
2. Communications on magnetism and aurora.

14h30: IATME, plenary session (Arranged by the UA Group. Minutes see p. 34).
1. Report of Committee No 13 (Lunar Variations).
2. Communications on atmospheric tides and allied phenomena.

Wednesday, 22 September

9h00: Joint meeting with Association of Meteorology. (Arranged by the Joint Committee on Upper Atmosphere. Minutes see p. 34).

Problems of the mesosphere.

14h30: IATME, group meeting. Group G (Minutes see p. 35).
1. Report of Committee No 6 (Observatory Publications).
2. Report of Committee No 8 (Observational Technique).
3. Instrumental equipment for the registration of rapid magnetic variations (Special report prepared by *E. Thellier* on behalf of Committee No 8).
4. Communications on instruments and observatory technique (cont.).

14h30: IATME, group meeting. Group UA (Minutes see p. 36).
1. Communications on ultraviolet radiation and X-rays.

Thursday, 23 September

9h00: IATME, group meeting. Group G (Minutes see p. 37).
1. Communications on instruments and observatory technique (cont.).
2. Report of Committee No 7 (Comparisons).
3. Report of Committee No 12 (Airborne Surveys).
4. Communications on field observations.

9^h00: IATME, group meeting. Group UA (Minutes see p. 39).
1. Communications on the Geophysical aspects of cosmic rays.
2. Cosmic ray observations during the International Geophysical Year.

14^h30: IATME, plenary session (Minutes see p. 40).
1. Special report on the equatorial jet current (Prepared by *D. F. Martyn* on behalf of Committee No 11).
2. Nomination of members of Special Committees.
3. Budget.
4. Resolutions.

List of Delegates attending the meeting

The following list gives the names of Delegates who attended the Rome meeting of the Association of Terrestrial Magnetism and Electricity (with the omission of Delegates attending only the Presidential Address on the 14th September).

Name	Country	Name	Country
Adkins, J. N.	U.S.A.	Brockamp, B.	Germany
Ambolt, N.	Sweden	Bucher, W. H.	U.S.A.
Ashour, A.	Egypt	Bullard, Sir Ed-	
Balsley, J. R.	U.S.A.	ward	Great Britain
Barbier, D.	France	Bullen, K. E.	Australia
Barnett, M. A. F.	New Zealand	Bullerwell, W.	Great Britain
Bartels, J.	Germany	Bureau, J.-L.	France
Bates, D. R.	Great Britain	Bureau, R.	France
Båth, M.	Sweden	Cagniard, L.	France
Beals, C. S.	Canada	Carder, D. S.	U.S.A.
Beloussov, V.	USSR	Cardús, J. O.	Spain
Benkendorff, R.	Germany	Chapman, S.	Great Britain
Berkner, L. V.	U.S.A.	Cortesi, C.	Italy
Bernard, R.	France	Coulomb, J.	France
Bidault, G.	Morocco	Courvoisier, P.	Switzerland
Bider, M.	Switzerland	Craddock, J. M.	Great Britain
Birch, F.	U.S.A.	Curtis, A. R.	Great Britain
Boato, G.	Italy	Danusaputro, S.	Indonesia
Bock, R.	Germany	Davies, Frank T.	Canada
Bollo, R.	France	Denisse, J. F.	France
Boni, A.	Italy	Dessens, H.	France
Bossolasco, M.	Italy	Deutsh, E.	Great Britain
Bouska, J.	Czechoslovakia	Devik, O. M.	Norway
Bricard, J.	France	Deij, L. J. L.	Holland

Name	Country	Name	Country
Dias, M. Affonso	Portugal	Jobert, N.	France
Diegesi, D.	Italy	Kaiser, T. R.	Great Britain
Dieminger, W.	Germany	Kalashnikov, A. G.	USSR
Di Martino, G.	Italy	Kántás, K.	Hungary
Doporto, M.	Ireland	Kaplan, J.	U.S.A.
Du Bois, P. M.	Great Britain	Kaplan, L. D.	U.S.A.
Duclaux, F.	France	Karapiperis, P.	Greece
Egedal, J.	Denmark	Khalek, A.	Afghanistan
Ehmert, A.	Germany	Kjær, R.	Norway
Elliot, H.	Great Britain	Knudsen, J.	Norway
Elst, N. Van der	Belgian Congo	Koenigsfeld, L.	Belgium
Elvey, C. T.	U.S.A.	Kunetz, G.	France
Emery, K. O.	U.S.A.	Lahaye, E.	Belgium
Errulat, F.	Germany	Laursen, V.	Denmark
Fea, G.	Italy	Longuet-Higgins, M. S.	Great Britain
Fedele, D.	Italy	Lowes, F. J.	Great Britain
Ferraro, V. C. A.	Great Britain	Madill, R. Glenn	Canada
Festa, C.	Italy	Maeda, K.	Japan
Finch, H. F.	Great Britain	Mange, P.	U.S.A.
Flohn, H.	Germany	Martino, G. Di	Italy
Friedman, H.	U.S.A.	Mason, B. J.	Great Britain
Gandolfo, S.	Italy	Matsushita, S.	Japan
Gaskell, T. F.	Great Britain	Maurizid, G.	Italy
Geneslay, R.	France	Maxwell, A.	Great Britain
Gerson, N. C.	U.S.A.	Mayaud, P.-N.	France
Giorgi, M.	Italy	McFarlane, P. B.	Great Britain
Glasenapp, M. v.	Germany	Medi, E.	Italy
Gold, T.	Great Britain	Meisser, O.	Germany
Goody, R. M.	Great Britain	Migaux, L.	France
Gornoung, M.	USSR	Miley, H. A.	U.S.A.
Gorshkov, P. G.	USSR	Misener, A. D.	Canada
Grenet, G.	France	Molina, F.	Italy
Griffiths, D. H.	Great Britain	Monine, A.	USSR
Gutenberg, B.	U.S.A.	Moore, A. F.	Great Britain
Hall, S. H.	Great Britain	Montalbetti, R.	Canada
Hales, A. L.	South Africa	Murphy, T.	Ireland
Harang, L.	Norway	Mühleisen, R.	Germany
Hecht, F.	Austria	Nagata, T.	Japan
Hée, A.	France	Nelson, J. H.	U.S.A.
Herlofson, N.	Sweden	Newell Jr., H. E.	U.S.A.
Herrinck, P.	Belgian Congo	Niblett, E. R.	Canada
Hide, R.	Great Britain	Nicolet, M.	Belgium
Hill, M. N.	Great Britain	Noetzlin, J.	France
Hoge, Edm.	Belgium	Odishaw, H.	U.S.A.
Houghton, J. T.	Great Britain	Olsen, J.	Denmark
Hulburt, E. O.	U.S.A.	Orlin, J. J.	Norway
Imbert, B.	France	Paetzold, H. K.	Germany
Irving, E.	Great Britain	Parry, J. H.	Great Britain
Ising, G.	Sweden	Pekeris, C. L.	Israel
Israël, H.	Germany	Peoples, J. A.	U.S.A.
Jacobs, J. A.	Canada	Perlat, A.	France
Jager, C. de	Holland	Pettit, H. B.	U.S.A.
Jarman, C. A.	Great Britain	Pierce, E. T.	Great Britain
Jeffreys, Sir Harold	Great Britain	Plassard, J.	France
Jobert, G.	France	Poncet, I.	France

Name	Country	Name	Country
Pramanik, S. K.	India	Sousa Nazareth, F. M. de	Portugal
Price, A. T.	Great Britain	Spencer Jones, Sir Harold	Great Britain
Ramsey, W. H.	Great Britain	St. Amand, P.	U.S.A.
Ranzi, I.	Italy	Stoneley, R.	Great Britain
Ramachandra Rao, M. B.	India	Stoyko, N.	France
Ramanathan, K. R.	India	Sucksdorff, E.	Finland
Rayner, J. M.	Australia	Thellier, E.	France
Revelle, R.	U.S.A.	Thellier, O.	France
Rigby, M.	U.S.A.	Thomson, Andrew	Canada
Rivault, R.	France	Thorarinsson, S.	Iceland
Rikitake, T.	Japan	Toperczer, M.	Austria
Rittmann, A.	Switzerland	Tozer, D. C.	Great Britain
Roach, F. E.	U.S.A.	Tönsberg, E.	Norway
Roberts, E. B.	U.S.A.	Uffen, R. J.	Canada
Roberts, P. H.	Great Britain	Urey, H. C.	U.S.A.
Robertson, E. J.	New Zealand	Vacquier, V.	U.S.A.
Rodriguez-Navarro De Fuentes, J.	Spain	Vassy, A.	France
Romañá, A.	Spain	Vassy, E.	France
Roquet, J.	France	Vegard, L.	Norway
Rosini, E.	Italy	Veldkamp, J.	Holland
Runcorn, S. K.	Great Britain	Vlodavez, V.	USSR
Schielderup Paulsen, H.	Norway	Vodusek, R.	Yugoslavia
Scholte, J. G.	Holland	Voogt, A. H. de	Holland
Seaton, M. J.	Great Britain	Walton, G. F.	Great Britain
Sestoft, I.	Denmark	Weelden, A. van	Holland
Shapley, A. H.	U.S.A.	Wells, H. W.	U.S.A.
Sheppard, P. A.	Great Britain	Wexler, H.	U.S.A.
Siksna, R.	Sweden	Wilkes, M. V.	Great Britain
Silleni, S.	Italy	Wilson, C. D. V.	Great Britain
Simpson, J. A.	U.S.A.	Wilson, J. T.	Canada
Singer, S. F.	U.S.A.	Wolbach, J. G.	U.S.A.
Slaucitajs, L.	Argentina	Wormell, T. W.	Great Britain
Smyth, E. T. W.	Great Britain	Yriberry, A. J.	Argentina
		Özdogan, I.	Turkey

Minutes of the meeting

Session of September 14, 1954

Opening session

The meeting was called to order by the President, Professor *J. Coulomb,* at $14^{h}00$ in one of the rooms of the Palace of Congresses of the Organization »E. U. R.«, World Fair of Rome.

Professor *Coulomb* then presented his Presidential Address (see Appendix 1, p. 42).

Morning session of September 15, 1954

Plenary session

The President called the meeting to order at $9^{h}05$, and requested the audience to rise in honour of those Magneticians whose deaths had been reported since the Brussels Assembly, and whose names were read by the President (see Appendix 2, p. 55).

The Secretary presented his report which was approved by the meeting (see Appendix 3, p. 56).

The discussion was then opened on the provisional agreement which had been established between the Association of Terrestrial Magnetism and Electricity and that of Meteorology on the position within the IUGG of Upper Atmospheric Physics (see Appendix 5, I, p. 63).

In reply to a question raised by Sir *Harold Spencer Jones* the President underlined that there would be no overlapping of work between IATME and URSI because all questions relating to radio transmission are left entirely to URSI.

The meeting approved in principle the agreement as submitted. The question of a new name will be discussed in a later meeting, when the agreement has been discussed in the Meteorological Association.

The meeting also approved the purely formal change of statutes, which had been proposed by the Bureau of the Association, and which concerns the right to invite guests to General Assemblies (see Appendix 5, II, p. 67).

The following temporary Committees were established for the duration of the Rome meeting:

Nominations Committee:

Prof. *Lahaye*, Convener
Dr. *Rayner*
Prof. *V. Vacquier*
Prof. *Nagata*
Dr. *Ambolt*

Resolutions Committee:

Prof. *Thellier*, Convener
Prof. *Kaplan*,
Father *Romañá* or Father *Cardús*

Budget Committee:

Dr. *Koenigsfeld*, Convener
Dr. *Olsen*
Prof. *Elvey*
Dr. *Veldkamp*

The meeting approved a suggestion by the Executive Committee that the following be appointed representatives of the IATME on the Mixed Commissions of the ICSU:

Mixed Commission on Ionosphere:

Prof. *Chapman*
Prof. *Bartels*
Prof. *Bates*
Prof. *Nicolet*

Mixed Commission on Solar and Terrestrial Relationship:

Prof. *Vassy*
Prof. *Hasegawa*
Prof. *Bartels*

The discussion was then opened on the establishing of Special Committees for the next three-year period. The Executive Committee presented the following proposal:

1. (comprising the previous Committees 1 + 11 + 6 + 15) Committee on Observatories.
2. (2) Aurora.
3. (14) Upper Atmosphere.
4. (3) Secular Variation (Palaeomagnetism).
5. (4 + 12) Magnetic Charts.
6. (13) Lunar Variations.
7. (7) Intercomparisons.
8. (8) Magnetic Instruments.
9. (9 + 5) Characterization.
10. (10) Atmospheric Electricity (Joint Committee with Meteorology).

Dr. *Egedal* asked why it was considered desirable to reduce the number of Committees.

Prof. *Bock* recommended the establishing of a Special Committee on earth currents. The proposal was supported by Father *Romañá*. Prof. *Thellier* proposed a Committee on pulsations and was supported by Prof. *Grenet*. Prof. *Bartels* said that all aspects of geomagnetism could not be covered by Special Committees.

Prof. *Vacquier* underlined the importance of secular variation for the construction of magnetic charts, and after further remarks by Dr. *Roberts*, Dr. *Herrinck*, Prof. *Thellier*, Father *Cardús* and Dr. *Egedal* the meeting decided by vote that the following Committees should be established:

1. Committee on Observatories
2. » » Aurora and Airglow
3. » » High Atmosphere
4. » » Secular Variation and Palaeomagnetism
5. » » Magnetic Charts
6. » » Lunar Variations
7. » » Comparisons
8. » » Magnetic Instruments
9. » » Characterization

It was further recommended that subject to the approval of the Association of Meteorology the two Joint Committees with this Association be continued, namely:

the Committee on Atmospheric Electricity
» » » Upper Atmosphere.

Father *Romañá* was requested to prepare for the afternoon meeting a brief statement concerning the proposals made by Prof. *Bock* and by Prof. *Thellier* (Earth currents, pulsations).

National reports were then presented as follows:

Spain by Dr. Rodriguez *Navarro*
France by Prof. *Thellier*
Denmark by Dr. *Egedal* and Dr. *Olsen*
Belgium by Prof. *Lahaye*
Belgian Congo by Dr. *Herrinck*
Argentina by Father *Yriberry*
Germany by Prof. *Errulat* and Prof. *Dieminger*
Australia by Dr. *Rayner*
Canada by Dr. *Madill* and Dr. *Davies*
Norway by Prof. *Vegard*
Japan by Prof. *Nagata*
Finland by Dr. *Sucksdorff*
Sweden by Dr. *Ambolt*
India by Dr. *Pramanik*.

Presenting the Danish National Report Dr. *Egedal* pointed out that it should be more valuable if observatories, instead of publishing monthly or 3-monthly mean values, would publish a yearbook as soon as possible after the end of the year. It should not be necessary for observatories to publish their character figures as this is done very quickly by the Association.

It was decided that the afternoon meetings should begin at 14^h30 and not, as provisionally fixed, at 14^h00.

The meeting adjourned at 11^h45.

Afternoon session of September 15, 1954

Plenary session

The meeting was called to order by the President at 14^h30, and the presentation of National Reports was continued as follows:

Ireland by Dr. *Doporto*
New Zealand by Dr. *Robertson*
Great Britain by Dr. *Ferraro*
Italy by Prof. *Medi*
U.S.A. by Prof. *Vacquier*, Prof. *Kaplan* and Dr. *Singer*
Czechoslovakia by Dr. *Bouska*.

In connection with the U.S.A. report Dr. *Roberts* gave some additional information concerning the new observatory at Fredericksburg which is going to replace Cheltenham.

Father *Romañá* then presented his statement concerning the establishing of Special Committees for earth currents and pulsations. He felt that international cooperation was badly needed for an adequate study of these two subjects, but at the present stage he would not insist on the creation of new Special Committees, since the work might very well be referred to smaller working groups within already existing Committees. In this connection he suggested that the nomination of members for Special Committees should be deferred to one of the last meetings of the Assembly, in order to be able to include scientists who during the Assembly might have shown a particular interest in the subjects concerned.

Prof. *Cagniard* would prefer the formation of a Special Committee on earth currents, and the opinion of Prof. *Cagniard* was supported by Dr. *Rodriguez Navarro* and by Father *Cardús*, who remarked that when parallel variations occurred in magnetism and in earth currents the latter were frequently the most clear.

Also Prof. *Grenet* and Father *Romañá* were in favour of Prof. *Cagniard's* proposal and the meeting finally decided that in addition to the 9 Committees proposed during the morning meeting there should be a Committee No 10:

Committee on Rapid Variations and Earth Currents

A proposal by Dr. *Egedal* that the Committee should be divided up in two Committees was not accepted.

Dr. *Olsen,* Chairman of Committee No 5 (Giant Pulsations), then presented the report of his Committee. This report was discussed by Dr. *Herrinck.* Dr. *Ambolt* drew attention to some recent investigations carried out in Stockholm by Prof. *Alfvén* and his collaborators.

It was decided that the programme of Committee No 5 should form part of the programme of the new Committee No 10.

The meeting adjourned at $16^{h}30$.

Morning session of September 16, 1954

A. Group meeting, Group G

The meeting was called to order at $9^{h}10$ by the President.

Prof. *Lahaye,* Chairman of Committee No 1 (Sites of New Observatories), presented the report of his Committee. Dr. *Roberts* made a few comments on the report, stating that

1) The proposed station Jarvis Island is a definite part of the U.S. Geophysical Year programme.
2) The Florida observatory (temporary) is now operating (near Cape Canavarat).
3) The Fuquene observatory (Colombia) is now operating.
4) The Tatuoca observatory (Brazil) will probably operate in about one year.

The meeting approved the proposals made by Committee No 1 that the Association should approach the authorities in Hong Kong and in Brazil, urging that the observatories of Hong Kong and Tatuoca be put in operation as soon as possible. The proposals were referred to the Resolutions Committee (see Part VI, Resolution No 1).

In the absence of Dr. *Vestine,* Chairman of Committee No 3 (Secular Variation), Dr. *Pramanik* presented the report of the Committee. The Committee will meet during the General Assembly in order to see whether the general recommendations made in the report can be brought into a more definite form so as to form a suitable base for a resolution.

Dr. *Ambolt,* Chairman of Committee No 4 (Magnetic Charts), presented the report of his Committee.

The meeting approved recommendation No 1 of the Committee that in the future the epoch .0 (January 1) shall be used as reference date for magnetic charts. Dr. *Ambolt* stated that the values used should be mean values for 12 months, centred on January 1. The proposal was referred to the Resolutions Committee (see Part VI, Resolution No 3).

Recommendation No 2 was discussed by Dr. *Roberts,* Sir *Harold Spencer Jones,* Dr. *Madill* and Dr. *Ambolt,* but will not form the base for a resolution.

Recommendation No 3 was withdrawn, and following some discussion by Sir *Harold Spencer Jones,* Prof. *Thellier,* Dr. *Robertson,* Prof. *Coulomb* and Prof. *Nagata* the recommendation No 4 concerning the desirability of obtaining declination observations from weather ships was referred to the Resolutions Committee. At the same time and in accordance with a proposal made by Dr. *Robertson* the Committee No 4 was requested to prepare a similar recommendation concerning naval ships and to submit also this recommendation to the Resolutions Committee (see Part VI, Resolution No 2).

Prof. *Slaucitajs* then presented his communication: "On the movement of geomagnetic intensities' isoporic foci near the South American Continent".

The communication by Dr. *Mendonça Dias:* "Analysis and interpretation of a transient geomagnetic anomaly in secular variation in "Peninsula Iberica" and North Atlantic" was presented by title, reference being made to the distributed abstract.

Father *Romañá* presented the communication by himself and by *Gaibar Puertas:* "Etude d'un siècle de variation séculaire de F et G, et de D et I dans l'ensemble des observatoires magnétiques du Globe". For further details on the subject Father *Romañá* referred to Memoria No 11 de l'Observatoire de l'Ebre: "Variacion secular del campo geomagnético" of which publication the observatory would be glad to send copies to scientists interested in the problem. The paper was discussed by Prof. *Thellier,* Sir *Edward Bullard,* Dr. *Ambolt* and the President.

Dr. *Lowes* presented his communication: "The geomagnetic secular variation and induction in the earth's core", which was discussed by Prof. *Coulomb.*

Finally Prof. *Bock* presented his "Map of the disturbances of the geomagnetic vertical intensity of Europe". Copies of the map were distributed and Prof. *Bock*'s proposal as to a continuation of the work was referred to the Committee on Magnetic Charts.

The meeting adjourned at 11^h30.

Morning session of September 16, 1954

B. Group meeting, Group UA

The meeting was called to order at 9^h00 by Prof. *M. Nicolet.*

Technical communications were presented as follows:

H. E. Newell: Rocket data in the thermosphere.
P. Mange: Diffusion processes in the thermosphere.
H. W. Wells: Travelling disturbances in the upper ionosphere.

A. Maxwell: Investigations of the upper ionosphere by observations of radio stars.

These papers were discussed by *H. E. Newell, P. Mange, A. Maxwell, H. W. Wells, T. R. Kaiser, L. V. Berkner, C. T. Elvey, L. Harang, D. Barbier, M. V. Wilkes, M. Nicolet* and others.

The following papers were presented by title:

P. Dominici: Ionospheric recordings in Rome during the solar eclipse of June 30, 1954.

F. Mariani: On some physical interpretations of h'(f) curves of ionospheric virtual heights.

F. Mariani: An extension of Chapman's photoionization theory to a non-isotherm atmosphere.

The meeting continued by discussing rocket observations during the International Geophysical Year. The subject was referred to a working group, which was appointed at the end of the meeting with the following membership:

H. E. Newell, Chairman
A. Boni
A. Ehmert
T. Gold
N. Herlofson
R. Montalbetti
J. M. Rayner
S. F. Singer
E. Vassy.

The working group met several times during the General Assembly, and a report was submitted to the Special Committee for the International Geophysical Year (CSAGI).

Afternoon session of September 16, 1954

Plenary session

The President called the meeting to order at 14^h30, and requested Prof. *Lahaye* to present, on behalf of the Nominations Committee, the list of suggested Chairmen for the 10 Special Committees of the Association. The list was adopted with some few modifications and the Chairmen elected as follows:

Committee	*Chairman*
1. Observatories	Prof. *Lahaye*
2. Aurora and Airglow	Prof. *Elvey*
3. High Atmosphere	Prof. *Kaplan*
4. Secular Variation and Palaeomagnetism	Prof. *Nagata*

5.	Magnetic Charts	Dr. *Ambolt**)
6.	Lunar Variation	Prof. *Chapman*
7.	Comparisons	Mr. *Laursen*
8.	Magnetic Instruments	Dr. *Madill**)
9.	Characterization	Prof. *Bartels*
10.	Rapid Variations and Earth Currents	Father *Romañá*
	Joint Committee on Atsmospheric Electricity (subject to the approval of the Association of Meteorology)	Dr. *Koenigsfeld.*

It was underlined that the Chairmen have the right to establish within their Committees smaller working groups on special problems.

There followed a presentation of communications on magnetic perturbations.

Prof. *Coulomb* first presented his paper: "Pulsations enregistrées à l'Observatoire de Chambon-la-Forêt", which was illustrated by copies of records obtained at Chambon-la-Forêt.

Dr. *Veldkamp* then presented a paper on "Geomagnetic and geoelectric pulsations", which paper was discussed by Prof. *Nagata* and Dr. *Rikitake.*

Prof. *Thellier* presented a paper by himself and by Mme *Thellier:* "Sur la variation D_{st} des orages à début brusque et des orages à début progressif". Father *Cardús,* Prof. *Ferraro* and Prof. *Chapman* took part in the discussion.

The communication by *E. H. Vestine:* "Magnetic storms as an atmospheric phenomenon" was presented by Dr. *Wells.*

Prof. *Nagata* presented the paper by himself and by Dr. *Fukushima:* "Characteristics of polar magnetic storms".

Dr. *Rikitake* presented two papers, first the paper by *Rikitake* and *Yokoyama:* "Anomalous relations between H and Z components of transient geomagnetic variations" and then the paper by *Rikitake:* "Regionality of the sudden commencement of magnetic storms". The two papers were discussed by Prof. *Bartels,* Prof. *Coulomb* and Dr. *Price.*

The paper by *Grenet, Kato, Ossaka* and *Okuda:* "Pulsations in the terrestrial magnetic field at the time of bay disturbance" was presented by Prof. *Grenet* and discussed by Prof. *Coulomb* and Dr. *Veldkamp.*

The meeting adjourned at 16^h45.

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*) Dr. Ambolt has later requested to be relieved of his duty as Chairman of Committee No 5, and in accordance with a suggestion by the Executive Committee of the Association Dr. Madill has assumed the chairmanship of the Committee on Magnetic Charts, while Dr. J. H. Nelson has taken over the chairmanship of the Committee on Magnetic Instruments.

Morning session of September 17, 1954

Plenary session

The meeting was opened at 9^h10 by the President, who called at once on Prof. *Lahaye,* Chairman of the Nominations Committee, to present the Committee's list of suggested names for the new Executive Committee. The names proposed by the Committee were all accepted, and the Executive Committee for the period 1954—1957 will be composed as follows:

President: Prof. *Bartels*
Vice-Presidents: Prof. *Kaplan* and Dr. *Rayner*
Secretary and Director of the Central Bureau:
Mr. *Laursen*
Members: Prof. *Chapman*
Capt. *Roberts*
Prof. *Nicolet*
Prof. *Hasegawa*
Prof. *Slaucitajs*
Prof. *Coulomb* (Retiring President).

Since the discussion on statutes had been deferred to the plenary session of Tuesday 21 at 9^h00 the meeting went on to the discussion of magnetic observations during the International Geophysical Year. It was decided to appoint a special working group to consider the question and to prepare a report, not later than Monday the 20th Sept., for submission to the IUGG Committee on the AGI. The working group was established as follows:

Prof. *Coulomb*
Mr. *Laursen*
Dr. *Madill*
Dr. *Egedal*
Dr. *Rayner*
Prof. *Bartels*

and the group was convened to hold its first meeting in direct continuation of the full session.

Dr. *Egedal,* Chairman of Committee No 11 (Equatorial Observations), then presented the report of his Committee. In connection with the report Dr. *Rodriguez Navarro* gave additional information concerning recent observations carried out in Spanish Guinea and Fernando Poo.

The five resolutions, proposed by the Committee and expressing the gratitude of the Association for special magnetic observations carried out by

Observatorio del Ebro
Dr. *M. R. Madwar,* Helwan
The Sudan Meteorological Service
Observatorio Nacional, Rio de Janeiro
The Geophysical Institute of Huancayo

were referred to the Resolutions Committee (see Part VI, Resolution No 4).

The President regretted that Dr. *D. F. Martyn,* who was to present a special report on the equatorial jet current, in connection with the report of Committee No 11, had had to return unexpectedly from Great Britain to Australia and that the text of Dr. *Martyn*'s report had not yet been received.

Dr. *Pramanik* then presented the following two papers: *S. K. Pramanik* and *S. Yegnanarayanan:* "Diurnal magnetic variation in equatorial regions"; *S. K. Pramanik* and *P. S. Hariharan:* "Diurnal magnetic variations near the magnetic equator".

Father *Cardús* presented the paper by Father *Romañá* and himself: "The range of the diurnal magnetic variation in Spanish Guinea near the equator".

S. Matsushita presented his paper: "On the Es near the magnetic equator".

In connection with the above communications Dr. *Herrinck* reported briefly on "La variation diurne de la composante horisontale et de la déclinaison magnétique le long du 30^{me} méridien du Congo Belge".

The meeting adjourned at 10^{h}45.

Afternoon session of September 17, 1954

Plenary session

The meeting was called to order at 14^{h}30 by the President, who asked Prof. *Bartels,* Chairman of Committee No 9 (Characterization), to present the report of the Committee.

Following the presentation of the report Dr. *Veldkamp,* Secretary of the Committee, gave some additional information concerning the latest volume, Bulletin 12 h, which had just been issued in the series of magnetic activity indices publications. Dr. *Veldkamp* wished to express the gratitude of the Committee towards all observatories which had contributed so promptly to the volume.

On behalf of the Association the President expressed his appreciation of the work done by the Characterization Committee and quite especially of the remarkable effort which had made it possible to have the Bulletin 12 h issued before the Rome meeting.

Dr. *Veldkamp* announced that he had brought with him a number of copies of Bull. 12 h, which he would be glad to distribute to delegates particularly interested.

The report of Committee No 9 includes a series of recommendations as to the future work of the Committee. It was decided by the meeting:

a) To instruct the Characterization Committee to continue the current schemes of K, Kp, Ap and Ci, and to entrust to Committee No 10 the study of ssc, psc, si and sfe, it being understood that the occurrence of these phenomena will also in the future be published in the Bull. 12.
b) To instruct the Characterization Committee to provide for further correlation studies of K...Kp, to be used in conversion tables (K into Ks) and for discussions on the geographical and time distribution of geomagnetic activity.
c) To encourage by an appropriate resolution the scaling of K-indices for years before 1937 by stations with long series of magnetograms.
d) To instruct the Characterization Committee to make further studies on current measures of solar wave radiation, W, and the equatorial H-level (ERC).

The recommendations a) to c) were referred to the Resolutions Committee (see Part VI, Resolutions No 5 and 6).

Professor *Kalashnikov* presented his paper: "Investigation of terrestrial magnetism by means of a fluxmeter". The paper was commented upon by Prof. *Vacquier*. In connection with the presentation of the paper Dr. *Ambolt* expressed the general wish that scientific papers published in Russian should, whenever possible, be accompanied by an abstract in some Western European language.

The President thanked Prof. *Kalashnikov* for his interesting communication and then called on Dr. *Kunetz* to present his paper: "Enregistrements des courants telluriques à l'occasion de l'éclipse de soleil du 25 février 1952". The paper was discussed by Dr. *Veldkamp*.

Dr. *J. F. Denisse* presented a communication on "Contrôle de l'activité géomagnétique par les centres d'activité solaires, distingués suivant leur propriétés radioélectriques".

The President suggested, that a resolution should be passed, expressing the congratulations of the Association on occasion of the 50 years jubilee of the Alibag observatory. This suggestion was approved by the meeting and referred to the Resolutions Committee (see Part VI, Resolution No 7).

The meeting adjourned at 16h30.

Morning session of September 18, 1954

A. Joint meeting. Group G + Association of Meteorology

(Arranged by the Joint Committee on Atmospheric Electricity, IATME and IAM) on *Problems in atmospheric electricity*.

The meeting was called to order at 9h05 by Prof. *J. Coulomb*, President of the IATME, and then Dr. *T. W. Wormell* took over the chairmanship with Dr. *L. Koenigsfeld* acting as Secretary. Owing to illness the Chairman of the Joint Committee, Prof. *H. Norinder,* was prevented from attending the meeting.

Dr. *Wormell* presented his communication: "Recent tendencies in research in atmospheric electricity", and continued by submitting two recommendations made by the Joint Committee on Atmospheric Electricity. These recommendations were referred to the Resolutions Committee (see Part VI, Resolution No 12).

The following communications were then presented and discussed:

L. Koenigsfeld: Le gradient de potentiel en altitude (mesures obtenues par radiosondes).

H. Norinder: Magnetic field variations caused by lightning in vicinity (presented by Dr. *Ambolt*).

M. Giorgi and *F. Molina:* Electric field and air masses at Rocca di Papa's Observatory.

M. Bossolasco: Recherches d'électricité atmosphérique en montagne.

M. Bossolasco: Die Zeitdauer des Blitzes.

M. Kawamo: The local anomaly in the atmospheric electric field in a large city.

R. Mühleisen: Untersuchung der Abweichungen des Ganges der luftelektrischen Elemente über dem Kontinent vom weltweiten Verlauf.

E. Medi: On the electric charges of the atmosphere.

E. Medi: Researches on the behaviour of the earth's magnetic field during the solar eclipse of June 30, 1954.

H. Israël: Zur Trennung von Leitungsstrom und Maxwell'schem Verschiebungsstrom bei Messung des luftelektrischen Vertikalstromes.

E. T. Pierce and *M. Large:* The fine structure of natural point discharge currents.

D. Fedele e *Vittori Atisari:* Sonda dinamica per la misura del campo elettrico terrestre.

B. Mason: The generation of charge in thunderstorms.

Prof. *H. Israël,* Father *Yriberry* and Dr. *L. Koenigsfeld* took part in the discussion.

The meeting adjourned at 12^{h}30.

Morning session of September 18, 1954

B. Group meeting. Group UA

The meeting was called to order at 9^{h}00 by the acting Chairman, Dr. *D. Barbier.*

In the absence of Prof. *C. Störmer,* Chairman of Committee

No 2 (Aurora), the report of the Committee was presented by Prof. *L. Vegard.*

Dr. *R. Montalbetti* presented his paper: "Interpretation of the auroral spectrum" reviewing auroral and airglow investigations in Canada.

D. R. Bates then presented his paper: "Theory of the auroral spectrum".

A paper by Dr. *W. N. Abbott:* "Observations of low-latitude aurorae in Greece" was presented by title.

The papers were discussed by *R. Montalbetti, D. R. Bates, L. Vegard, S. Chapman, L. Harang, M. Nicolet, H. E. Newell, M. J. Seaton, A. Maxwell, C. T. Elvey, J. Kaplan,* and *V. C. A. Ferraro.*

Morning meeting of September 20, 1954

A. Group meeting. Group G

The meeting was called to order at 9h00 by the President. Mme *O. Thellier* acted as Secretary.

The first item on the agenda was the presentation of the paper by *S. K. Runcorn* and *D. C. Tozer:* "The electrical properties of olivine and related substances at high pressures and temperatures". The paper was discussed by Dr. *Uffen* and Dr. *Vacquier* and also by Prof. *Price* who made the following remark:

It is of great interest to find that the conclusions arrived at by Dr. *Lahiri* and myself about the increase of electrical conductivity with increasing depth within the earth, based on analysis of the geomagnetic variations, are finding support from experimental and theoretical investigations of the temperature effects on semi-conductors. I should emphasize that our results only gave a lower limit (of about 10^{-11} e.m.u.) for the conductivity below 1000 km., but we found that in the region 400—600 km. the conductivity cannot be higher than about 10^{-13} e.m.u. If I understand Dr. *Runcorn* rightly, any increase of ionic conductivity will be inhibited by the high pressure, but there will be a considerable increase of electronic conductivity. I am not quite clear, however, whether Dr. *Runcorn* also considers that there is in addition some change of composition or of state of the earth minerals in the region between 400—1000 km. depth.

Prof. *T. Nagata* then presented his Special Report on Palaeomagnetism, prepared for the Rome meeting at the request of the Association. Prof. *Nagata* further outlined a probable international scheme for palaeomagnetic research.

The communication by *K. M. Creer, E. Irving* and *S. K. Runcorn:* "The direction of the earth's magnetic field in remote epochs" was discussed first by Dr. *Deutsch,* who said:

I think it is necessary here to separate the problem concerning the complete reversal of magnetization in rock formations (of the order of 180°) from that of the rotation of the magnetic azimuth through intermediate angles.

Dr. *Runcorn*'s conclusion to the effect that the earth's magnetic field has been reversed in the past is supported by evidence from several other sources, in particular the detailed work carried out under Prof. *Bruckshaw* at the Imperial College, London, on Tertiary dykes and lava flows of Great Britain.

As far as the second problem is concerned, I wonder whether the occurrence of obliquely directed magnetization vectors, observed only over the small area of Great Britain, is alone sufficient to support the theory of pole wandering.

In this connection, I would like to mention some of the results obtained by Prof. *Blackett*'s group at Imperial College from their work on Keuper marls: As outlined in a recent paper by Clegg, Almond and Stubbs, the marls from 9 sites across Great Britain all showed declinations roughly along a northeast-southwest axis. About half of all the specimens had normal polarizations (i.e. declinations towards the north-east and downward dips) and the other half were reversed. Most of the magnetic dips, however, were considerably smaller than the present dips at the same localities. It is suggested in this paper that the whole land mass which now constitutes England has rotated clockwise through 34° relative to the earth's geographic axis.

Finally, if pole wandering has occurred, as Dr. *Runcorn* suggests, does this not imply that at the times concerned the rocks outside the British Isles should also have been magnetized in directions differing considerably from that of the present geomagnetic field? *Graham,* on the other hand, has suggested that the direction of the magnetic azimuths of rocks from certain parts of the United States has remained roughly northward for 200 million years. This seems to me to contradict the pole wandering theory.

Dr. *Gold* then made the following statement:

The discussion concerning the origin of the large angles of magnetization from the present geographic pole is now concerned with the two hypotheses of large scale continental drift and polar wandering. I should like to make clear what is implied by polar wanderings. The simplest theory, and the one requiring least movement, is that the earth does not possess permanent rigidity of its geoidal shape. The absence of such permanent rigidity is in any case implied by the general close approximation to isostacy. Such an earth would then, when a small unbalance has occurred, turn over slowly relative to its axis of rotation, and adjust all the time its shape appropriately to the axis of rotation. Stability would only occur when the equator runs through the excess unbalancing mass.

Of course the investigations will be able to settle the controversy in the end. But it is important to realize that the condition of polar wandering has almost to be expected, while that of large scale continental drift requires assumptions of adequate mobility of the crust.

It must also be mentioned that the magnetic consequences of polar drift are small along a meridian containing the path of the pole. Such a condition applies to some of the American data.

The discussion continued by the following comment by Dr. *Lowes*:

The positioning of the geomagnetic pole from the direction of magnetization of rocks depends not only on the horizontal direction of magnetization (declination), which is probably very close to the direction of the original field, but also on the vertical direction (dip). For the lava flows this latter direction is also reliable, but there have been arguments put forward that this is not necessarily so with sedimentary rocks. If the magnetization of these is depositioned it is possible that the grain directions might be flattened, and the dip reduced. However, the study by *Irving* of the slump fold in the Tarridonian (which took place shortly after deposition) shows that for some time after deposition the magnetization was unstable, but the SE direction of the slump bed and the sandwiching beds shows that the magnetization has remained stable for most of their life. This can only indicate that, in this case at least, the magnetization is by some process, as yet unknown, which occurs after deposition. With a fast-depositioned magnetization process it is much more likely that the observed dips are those of the original field.

Also Dr. *Irving* took part in the discussion.

Prof. *Thellier* presented the following papers:

A. Roche: "Exposé sommaire des études relative à l'aimantation de matériaux volcaniques".

Mlle *J. Roquet:* "Sur les aimantations rémanente isotherme et thermorémanente du sesquioxyde de fer α et de la magnétite".

E. Thellier et Mme *O. Thellier:* "Nouveaux résultats sur la direction et l'intensité du champ magnétique terrestre dans le passé historique".

Then followed the presentation of the following communications:

J. R. Balsley and *A. F. Buddington:* "Correlation of reverse remanent magnetism and negative anomalies with certain minerals".

J. Parry: "Interpretation of reversed magnetization in igneous rocks".

T. Nagata, S. Akimoto, S. Uyeda, K. Momose and *E. Asami:* "Reverse magnetization of rocks and its connexion with the geomagnetic field".

N. Kawai: "Instability of natural remanent magnetism of rocks".

K. Kato, A. Takayi and *I. Kato:* "Reverse natural remanent magnetism of dyke of basaltic andesite".
D. H. Griffiths: "The remanent magnetism of varved clay from Sweden".

The last mentioned paper was commented upon by Prof. *Ising.*
The papers by *J. Hospers:* "Summary of studies on rock magnetism", and by *J. W. Graham:* "Tracing the earth's magnetic field in geologic time", were read by title.
The meeting adjourned at 11h30.

Morning session of September 20, 1954

B. Group meeting. Group UA

The meeting was called to order at 9h00 by the acting Chairman, Prof. *E. Vassy.*
Communications on the airglow spectrum were presented as follows:

D. Barbier: Interpretation of the airglow spectrum.
M. Dufay and *J. Dufay:* Contribution to the study of the violet and ultraviolet airglow spectrum, (presented by *D. Barbier*).
P. Berthier: Nouvelle évaluation de l'altitude de l'émission des bandes du proche infrarouge des molécules OH et O_2 durant la nuit, (presented by *D. Barbier*).
J. Dufay et *P. Berthier:* Dispositif pour l'enregistrement continu des variations d'intensité des spectres nocturne et crépusculaire, (presented by *D. Barbier*).
F. E. Roach: Variations in the airglow spectrum.
P. St. Amand: Observations on the red line of oxygen.

The papers were discussed by *D. Barbier, F. E. Roach, D. R. Bates, L. Vegard, M. Nicolet, H. E. Newell, M. J. Seaton, C. T. Elvey,* Mme *A. Vassy, A. H. Shapley, T. R. Kaiser, P. St. Amand.*
D. Barbier presented a preliminary report on planned airglow observations during the International Geophysical Year. This report had been prepared by a special working group with Prof., *Barbier* as Chairman and with the following members:

J. Bricard
C. T. Elvey
J. Kaplan
Father *Mayaud*
T. Nagata
M. Nicolet
F. E. Roach
M. J. Seaton
Mme *Vassy.*

Another working group on auroral observations during the IGY was set up with the following membership:

C. T. Elvey, Chairman
D. R. Bates
S. Chapman
L. Harang
T. R. Kaiser
Father *Mayaud*
R. Montalbetti
F. E. Roach
E. Tönsberg
L. Vegard.

The final reports of the two working groups were later submitted to the Special Committee for the International Geophysical Year.

Afternoon session of September 20, 1954

A. Joint meeting. Group G + Association of Seismology

Discussion on *Movements in the earth's core and electrical conductivity.*

(Arranged by Sir *Edward Bullard*).

The meeting was called to order at 14h30 by the Chairman, Sir *Edward Bullard*. Dr. *M. N. Hill* acted as Secretary.

The discussion was opened by *E. C. Bullard* and other papers read were by:

K. E. Bullen: Physical properties of the earth's core.
H. C. Urey: Energy sources in the core.
S. K. Runcorn: Motions in the earth's core and geomagnetism.
J. Coulomb: The magnetic secular variation.
T. Rikitake: Electrical conductivity of the core.
E. H. Vestine: Relation between fluctuations in the earth's rotation, the variation of latitude, and geomagnetism.
R. Revelle and *W. Munk:* Causes of irregularities in the rotation of the earth.
D. G. Knapp: The synthesis of external magnetic fields by means of radial internal dipoles (read by title).

In his introductory paper *Bullard* noted that it is only recently that anything became known about movements in the earth's core; the knowledge is still slight but there are probably several observable phenomena which are connected with such motions and there are good prospect of discovering their important features. The first suggestion of an observable effect due to motions in the core came from the time scale of the magnetic secular variation. Large changes, with their origin within the earth, occur in times of the order of a hundred years which is about a factor of 10^5 times less than the usual time scale for events in the solid part of the earth. For this reason it appears impossible that the secular variation, or any other rapidly changing phenomenon, can have its origin in the earth's mantle. The simplest method of accounting for the secular variation is to suppose that it is attributable to motions in the fluid core although there is, so far, no direct evidence of their existence.

The hypothesis of fluid motion raises many questions concerning the mechanical, thermal and electrical properties of the material of the core, and allows electrodynamical theories to be developed to explain not only the secular variations but also the origin of the earth's main magnetic field. A number of papers have been published by *Bullard, W. M. Elsasser* and others about these theories of the main field. These were not considered in detail at this discussion. *Bullard* pointed out, however, that the dynamo theory of the origin of the main field provides a strong field within the core which does not normally reach to the surface. On the other hand the secular variations are produced by fluid motions which must be near the surface since otherwise the screening effect caused by the high electrical conductivity of the material of the core would prevent their being observed at the surface of the earth. Calculations have shown that eddies at the core surface cannot produce the observed effects unless the initial field is considerably greater than the main dipole field. *Bullard* suggested that this might occur where the strong field associated with the dynamo theory is brought to the surface of the core at those places where the material rises from within the core. This process is analogous to a theory of the magnetic field of sunspots and appeared more plausible than the model suggested by *Coulomb* later in the meeting.

Bullen's paper concerned the density, the pressure and the elastic constants in the lower mantle and in the inner and outer cores. At the surface of the outer core *Bullen* estimated that the density lies between 9.4 and 11.5 g/cm^3 and increases to between 9.8 and 12.0 g/cm^3 at the base of the outer core. The comparable figures for the incompressibility are between 6.2 and 12.6×10^{12} dynes/cm^2 increasing to between 6.4 and 13.1×10^{12} dynes/cm^2, and for the pressure 1.35×10^6 kg/cm^2 increasing to 3.20×10^6 kg/cm^2. The rigidity is probably less than 10^{10} dynes/cm^2. At the base of the mantle the density appears to be 5.6 g/cm^3. At the centre of the earth *Bullen* estimated that the density is between 14.5 and 18.0 g/cm^3, the rigidity between 1.5 and 3.6×10^{12} dynes/cm^2, and the incompressibility about 17×10^{12} dynes/cm^2. The pressure at the centre probably lies between 3.6 and 4.0×10^6 kg/cm^2.

Bullen suggested that the most probable composition of the outer core is a mixture of iron and ultrabasic rock perhaps in the form of a high pressure modification. The inner core consists of material whose atomic number is at least equal to that of iron with the possibility of an accumulation of elements of higher atomic number.

Urey's paper concerned the distribution of radioactivity which for thermochemical reasons might be present in an iron core, and a consideration as to whether it might be adequate in quantity to maintain the adiabatic gradient which is the primary condition for convection. He concluded that Uranium and Thorium are not present in the core but that it was not inconceivable that the heating is caused by the presence of radioactive Potassium. He also suggested that it was incorrect to expect, as in earlier work, a similarity between the concentration of the radioactive elements U, Th and K in iron meteorites and in the earth's core. Finally *Urey* expressed extreme uncertainty concerning the presence of the radioactive elements in the core and suggested, as in an earlier paper, that a more likely source of energy for maintaining convection currents would come from a reduction in the gravitational potential energy of the earth as a result of progressive differentiation from a more uniform to a less uniform chemical composition.

In the discussion following *Urey*'s paper *Runcorn* asked whether there was any evidence for the present transference of iron from the mantle to the core. This might provide, through the loss of gravitational potential energy, the heat required to maintain the fluid motions. *Urey* replied that this process might exist but that there was no evidence for it.

Runcorn's paper opened with a discussion of the electrical conductivity of the lower part of the mantle. He explained that the value could not exceed about 1 ohm^{-1} cm^{-1} since otherwise the sudden changes in rate of the secular variations would be obscured from the surface by electromagnetic induction. *Runcorn* also suggested that the irregular changes in the length of the day are caused by varying electric currents in the lower part of the mantle and their associated torques. These changes occur in times comparable with the changes in the rate of the secular variation, and this confirms that the conductivity cannot exceed a similar value. Further, if the conductivity were much less than 1 ohm^{-1} cm^{-1} then excessively high E.M.F.'s would be required to produce the variable currents.

Finally, *Runcorn* gave details of calculations from which he concluded that reversals of the earth's main dipole field could be produced by changes of distribution of fluid motions in the toroidal field. It would not be necessary to reverse the direction of the toroidal field.

Coulomb considered a non-rotating earth model whereby the secular variation and the non-dipole fields are produced by steady motions in the core of the form of a "champignon". Because of the high electrical conductivity of the core the fields must be produced from the surface layer of such motions which would in effect crowd the dipole field into regions of convergence of the flow and disperse it in regions of divergence. The velocity of vertical motion in a column of cross section 100 km^2 which would be required to produce dipole fields of the order of magnitude of those observed would be 5 m/s. This is considerably greater than velocities previously postulated but on the other hand *Coulomb* pointed out that *Elsasser* admits the existence of horizontal velocities at least of the order of 0.1 cm/s, which is the value which would be obtained for a layer 50 km thick at a distance of 1600 km from the ascending column. In the discussion following *Coulomb*'s paper doubt was expressed as to whether vertical velocities of the suggested magnitude could exist.

Revelle and *Munk* discussed the irregular fluctuations in the rotation of the earth. They deducted that the annual variations in the length of the day and in the position of the axis of the earth's rotation relative to the earth's crust could not be associated with motions in the earth's core but rather with atmospheric changes. On the other hand they believed that the atmosphere could not account for all the variations taking place in the order of ten years, and by a process of elimination they concluded that the observed fluctuations in the length of the day were probably due to the transference of angular momentum from the core to the mantle. The variations in relative angular momentum agree in sign and magnitude with those inferred from the westward drift of the magnetic field discussed in *Vestine*'s paper. The combined evidence indicates a differential velocity between the core and the mantle of 10—12 km/yr near the boundary at the equator. The slippage zone cannot be thick since otherwise the detailed features of the non-dipole field could not be observed at the surface. This places a useful upper limit to the viscosity of the core material and supports *Bullard*'s conclusion that the viscous coupling between the core and the mantle is less than the electromagnetic coupling.

In the discussion following this paper *Bullard* said that the various estimates of the kinematic viscosity of the core covered the range 10^{-3} to 10^{7} $cm^2 \cdot s^{-1}$. He favoured a value of 10^{-3} $cm^2 \cdot s^{-1}$ and considered there was no necessity to exceed a value 1 $cm^2 \cdot s^{-1}$. Sir *Harold Jeffreys* replied that the nutation changes give an indication of a much higher value which might be adequate for viscous coupling between the core and mantle. *T. Gold* questioned the validity of *Jeffrey*'s method of obtaining this higher value.

Rikitake's paper was concerned with the determination of the electrical conductivity of the core supposing that the currents which produce the secular variations are no greater than those required by a dynamo theory to produce the main field. If an upper limit to the electrical currents is set then for an observable magnetic effect at the surface of the earth, there is an upper limit to the conductivity of the core. This is because of the cancelling effect of the field of the primary current which will result from the induced secondary currents producing the fields which become more nearly equal to that of the primary current as the conductivity increases. *Rikitake* estimates that from these considerations the conductivity must be less than 10^4 ohm^{-1} cm^{-1}, a figure compatible with the result required by the physics of metallic iron under high temperature and pressure. In this paper *Rikitake* did not consider the magneto-hydrodynamic effect.

Afternoon session of September 20, 1954

B. Group meeting. Group UA

The meeting was called to order at 14h30 by the acting Chairman, Prof. *D. R. Bates,* and the discussion on atmospheric spectra which had been opened in the morning session of the UA-group was continued by the presentation of the following papers:

M. J. Seaton: Theory of the airglow spectrum.
C. J. Johnson and *E. B. Meadows:* Mass spectrometric determination of atmospheric ions (presented by *H. E. Newell*).
P. St. Amand: Instrumentation for nightglow research.
L. Vegard: The intensity distribution of the sodium D-line emission in the atmosphere.
L. Vegard: Intensity variations of auroral hydrogen lines and the influence of the solar proton radiation on the auroral luminescence.

M. J. Seaton, F. E. Roach, P. St. Amand, M. Nicolet, S. F. Singer, C. T. Elvey, T. R. Kaiser and *E. Vassy* took part in the discussion.

Morning session of September 21, 1954

Plenary session

The meeting was called to order by the President at 9h05, and the discussion was opened on the question as to whether the Association was to change its name. The President suggested, that the discussion should be limited to the following three possibilities:

1) That the Association retains its old name.
2) That the name is changed as suggested in the agreement between the Association of Terrestrial Magnetism and Electricity and that of Meteorology, the new name being
   International Association of Geomagnetism and Ionospheric Physics
   Association Internationale de Géomagnétisme et de Physique de l'Ionosphère.
3) That the name is changed as suggested by Prof. *Chapman* into
   International Association of Geomagnetism and Aeronomy
   Association Internationale de Géomagnétisme et d'Aéronomie.

Dr. *Ambolt* opened the discussion by expressing the hope that a change of name, leaving out the word "electricity", would mean no change in the position of the atmospheric electricity within the domain of the Association.

Prof. *Ferraro:* The term "Ionospheric Physics" suggests that only the ionized layers of the atmosphere are being considered, whereas in fact many other aspects of the physics of the atmosphere are being included in our Association. It is clear that the second name proposed is thus not sufficiently comprehensive.

Prof. *Nicolet:* Je pense qu'il faut éviter toute confusion dans l'utilisation du mot ionosphère. Nous avons, en effet, la Commission Mixte de l'Ionosphère qui peut s'occuper de tous les aspects des recherches ionosphèriques. De plus il faut utiliser un nom ayant un sens beaucoup plus large.

Dr. *Berkner* made the following comments: May I speak in favour of the title Geomagnetism and Aeronomy as the name of the Association. There is real need for a new word to express the scientific interests of the Association in the outer atmosphere. The word, aeronomy, suggested by Prof. *Chapman,* is the science connecting astrophysics and our interests in the outer atmosphere. It is always difficult to become familiar with a new word. Twenty-five years ago there was much objection to introduction of the word "ionosphere", yet this word has become very useful. In fact, the development of our science has depended on it. The word "aeronomy" expresses, similarly, ideas that are very important for which we need such a single word. The word aeronomy properly expresses our interests in the high atmosphere and astrophysical effects upon it. Therefore I would urge adoption of the name Geomagnetism and Aeronomy as the title of this Association.

Captain *Roberts* supported the view expressed by Dr. *Berkner,* and so did Prof. *Chapman,* who said: It occurs to me that there is advantage in having a brief title for an Association. Proposals

2 and 3 shorten Terrestrial Magnetism to Geomagnetism. Proposal 3 also simplifies the second part of the proposed title, and I hope the new word aeronomy will in time become a familiar name for the not yet (and perhaps never to be) precisely defined subject of the physics of the high atmosphere.

The meeting was adjourned for 5 minutes and when it was called to order again by the President the new name of the Association was put to the vote. Since a change of name would involve a modification of the statutes the vote was taken by countries, and the delegates of 14 member countries, represented at the meeting, decided by 12 votes for proposal 3, 2 for proposal 1 and no abstinents that the new name of the Association should be

The International Association of Geomagnetism and Aeronomy
L'Association Internationale de Géomagnétisme et d'Aéronomie*).

On behalf of the Resolutions Committee Prof. *Thellier* submitted a draft resolution expressing the congratulations of the Association on the occasion of the Golden Jubilee of the Alibag Observatory. This resolution (Res. No 7) was finally adopted and immediately conveyed to the Director General of Observatories, New Delhi.

On behalf of the Committee on Magnetic Charts Dr. *Ambolt* made the following statement concerning the proposal by Prof. *Bock* on the construction of a vertical intensity map for Europe:

Regarding the proposal from Prof. *Bock* to entrust to the "Amt für Bodenforschung", Hannover, to design a new map of geomagnetic vertical intensity for Europe, the Committee is of the opinion:

1) That the time is not yet ripe for such an action.
2) That if an action of the kind mentioned should be taken, it ought to be made on a world-wide scale and entrusted to a special sub-committee of the IAGA Committee on Magnetic Charts.

The meeting then considered the preliminary report of the working group on geomagnetism, International Geophysical Year. The report was adopted with some minor corrections and amendments.

The meeting continued, with Dr. *T. Gold* in the chair, as a discussion on magnetism and aurora. Communications were presented as follows:

*) The Executive Committee of the Association decided at a later meeting that subject to the consent of the Union the new name should become effective from the closure of the Rome Assembly.

V. C. A. Ferraro: The origin of magnetic storms and aurora.
T. R. Kaiser: Radioecho from aurora.

The latter paper was followed by a presentation of Prof. *Rydbeck*'s film showing records obtained by radar observation of aurorae at Kiruna, Sweden.

E. O. Hulburt: Solar proton aurora theory.
N. Herlofson: Outline of Alfvén's latest work on auroral theory.

In discussing these papers it was stated by Dr. *Sucksdorff:* According to my experience there are three essentially different forms of aurora: 1) the homogeneous arcs, 2) the moving forms with rays, corona, etc. (the auroral disturbance), and 3) the flaming aurora. These three forms of the aurora are in their appearance so different, that it seems to me to be almost impossible to explain them all through a *common* physical theory.

Dr. *Sucksdorff*'s opinion was supported by Dr. *Ambolt.*

Prof. *Vegard* made the following comment: These papers deal with fundamental problems in connection with auroral theories, and there will be no time for a profound discussion. All three theories differ in essential points from my own, and I may also mention that the reference of *Ferraro* to the Doppler displacement of auroral Hydrogen lines is incomplete and liable to give a wrong impression of historical facts. These facts, as well as my own auroral theory, have been given in previous publications and briefly also in one of the papers read at this congress. According to my view the essential features of aurorae and magnetic storms are explained by assuming that the solar ray bundles are composed of electron rays electrostatically neutralized by positive ions (mainly protons).

The theory of *Chapman* and *Ferraro,* however, as well as that of *Alfvén* does not explain the typical distribution and features of aurorae and magnetic storms, e. g. the facts that they mainly appear in the auroral zone and are concentrated near magnetic midnight. It remains to be found out if these theories can be further developed or whether they are based on essentially wrong assumptions.

The theory suggested by *Hulburt* may in a way be regarded as an extreme specification of the neutralized bundle, on which my theory is founded. He assumes however, that the bundle consists of protons, and that it is neutralized by slow electrons, which are picked up by the bundle on its way through space from the sun to the earth. Such a bundle, however, cannot explain the observed facts, e. g. the great variability of the relative intensity of the hydrogen lines, and other properties of the auroral spectrum, some of which were mentioned in the paper on aurorae read at this general assembly of U.G.G.I.

Prof. *Chapman:* I agree with Prof. *Vegard* that the theories of magnetic storms are very far from giving any satisfactory explanation of the aurora at present. This is because of the great mathematical difficulty of developing the theory; we are just at the beginning of a long story. It would be very desirable if laboratory experiments could solve some of these difficulties for us, but experiments can have no demonstrative force, whatever their qualitative merits, unless there is a sound theoretical linkage between the experiment and the conditions in nature. I do not think that this has yet been supplied for the interesting experiments by Dr. *Malmfors*. As regards Dr. *Alfvén*'s theory, so well expounded by Dr. *Herlofson* I am unconvinced that the events occurring when the solar stream approaches the earth can be treated in the way he adopts. I think that the theory must at all stages take account of the simultaneous presence of both the positive and negative charges, and it is not satisfactory to consider either set alone and merely say that any space charges developed according to this manner of treatment will rapidly be dispersed.

Dr. *Singer* expressed the opinion that theories of aurora and magnetic storms must take account of the fact that there are also cosmic ray effects. These C.R. effects are more likely to give us information about the solar beam itself *before* it interacts with the earth's dipole field, and it is on the nature of the beam that all theories disagree with each other. C.R. can thus investigate electromagnetic conditions far from the earth (it is mainly for historical reasons that aurora and magnetic storms receive most attention). Theories should therefore try to explain some of the C.R. phenomena, e. g. 1) how to produce C.R. decreases, 2) why during some storms there are no C.R. decreases, 3) why C.R. decreases are sometimes observed at the geomagnetic pole (this points to a mechanism far from the earth).

Prof. *Ferraro* made the following remark: There have been several attempts made to revive the Störmerian hypothesis recently, and we have just heard one such hypothesis from Dr. *Hulburt*. The advocates of the solar electric current hypothesis, however, overlook one important fact, namely that during the growth of an electric current there is an associated electric field which tends to accelerate interplanetary electrons to the speeds of the ions. I have recently shown that the maximum current a solar stream can carry is of the order of 50 ampères. This is much too small to be of any geomagnetic interest. Further the differential velocity is such that the streams could not be appreciably bent in the earth's magnetic field. I am afraid therefore that all such attempts to revive the solar electric current hypothesis are bound to be fundamentally incorrect.

The papers were further discussed by *T. Gold, T. R. Kaiser, E. O. Hulburt, N. Herlofson* and *H. Elliot*.

The meeting adjourned at 12h00.

Afternoon session of September 21, 1954

Plenary session

The meeting was called to order at 14h30 by Prof. *S. Chapman* as acting Chairman.

In his capacity of Chairman of Committee No 13 (Lunar variations), Prof. *Chapman* referred to the distributed report of the Committee and then called on the following experts to present their communications on atmospheric tides and allied phenomena:

M. V. Wilkes: General aspects of atmospheric oscillations.
B. Haurwitz: The lunar air tide (read by title).
A. Romañá, S.J.: Influence de la lune sur la composante horizontale à Moka (Fernando Poo).
J. O. Cardús, S.J.: L-effect on D in Tortosa.
S. Matsushita: Lunar tidal variations in the sporadic E-region.
J. Bartels: A new reduction of S and L at Huancayo, 1922—1946.
J. Bartels: Atmospheric tides at Zürich and Säntis, 1894—1949.

The papers were discussed by *J. Bartels, S. Chapman, P. Herrinck, K. R. Ramanathan* and *M. V. Wilkes.*

In discussing Dr. *Wilkes'* paper Prof. *Ramanathan* said: We know that in addition to the input of energy near the ground an appreciable quantity of solar radiation is absorbed in the atmosphere near the top of the ozone layer between 30 and 50 km, and it is estimated that there is a temperature range of the order of 10°C near 50 km. What is the effect of the input of energy at these levels on the distribution of velocities of oscillation between the ground and 80 km?

With reference to the paper by Father *Cardús* Prof. *Chapman* pointed out that the different ratio S_N/L_N and S_D/L_D may be due to the fact that there is a reversal of the north component at middle latitudes for S, and so it is possible to get very different values for the ratio at different stations; for D there is not such a reversal.

In discussing Prof. *Bartels'* papers Dr. *Herrinck* pointed out that an analysis of the lunar variation at Elisabethville (1938—1953) gives practically the same results as those found by Prof. *Bartels* for Huancayo.

Dr. *Wilkes* asked in what circumstances it would be useful to give curves for the variation of a quantity under discussion as a function of lunar time, and in what circumstances resolution in harmonic components would be more useful.

Morning session of September 22, 1954

Joint meeting with Association of Meteorology

(Arranged by the Joint Committee on Upper Atmosphere, IATME and IAM) on *Problems of the mesosphere*

The meeting was called to order at 9h00 by Prof. *J. Kaplan,* Chairman of the Joint Committee.

There followed presentation of the following communications:

H. E. Newell: Rocket data on atmospheric pressure, temperature, density, and winds.

T. R. Kaiser: Atmospheric data from meteors.

W. Dieminger: Remarks about the distribution of electron density at mesospheric levels.

F. J. Scrase: Variations of temperature in the stratosphere up to 30 km over the British Isles, (presented by *J. M. Craddock*).

P. A. Sheppard: The meteorological point of view on observational data in the mesosphere.

Afternoon session of September 22, 1954

A. Group meeting. Group G

The meeting was called to order by the President at 14^h30, and Capt. *Roberts,* Chairman of Committee No 6, Committee on Observatory Publication, was called upon to present the report of his Committee. The report was adopted with some modifications of the proposed resolution on a "standard schedule of magnetic observatory publications". The discussion on this resolution was partly concerned with the general desirability of some of the data suggested for publication, and partly with the degree of priority to be given to each cathegory of data.

Dr. *A. F. Moore* stressed the importance of publishing daily means. Some observatories do not publish such means, but publish the average value of each hour for each month only, which makes the analysis of the mean daily values impossible.

Prof. *Coulomb* questioned the real use of giving daily maxima and minima and Dr. *Finch* said in this connection, that if maxima and minima *are* required it may not be desirable to suppress publication of these values at observatories at which a decision has been made to publish magnetograms.

Father *Cardús* expressed the opinion, supported by Prof. *Coulomb,* that descriptions of magnetic activity need not to be given in the yearbooks in so far as such descriptions have already been published in the Association Bulletin 12.

Also Dr. *Ambolt,* Prof. *Bartels,* Dr. *Lowes* and Capt. *Roberts* took part in the discussion before the proposed resolution was referred to the Resolutions Committee (see Part VI, Resolution No 14).

Prof. *Thellier,* Chairman of Committee No 8, Committee on Observational Technique, then presented the report of his Committee.

The report was adopted after a brief discussion as to whether horizontal variometers in high latitude ought to be orientated in the astronomical X Y directions or in the geomagnetic X' Y' directions. The meeting seemed to be in favour of the astronomical orientation.

In connection with the report Dr. *Olsen* gave some information concerning an improved observational technique developed in Denmark for the determination of D by means of QHM.

Prof. *Thellier* went on to the presentation of the special report on instrumental equipment for the registration of rapid magnetic variations, which report has been prepared by Prof. *Thellier* on behalf of Committee No 8, and at the request of the Special Committee for the International Geophysical Year 1957—58.

The report gave rise to a thorough discussion of several aspects of the subject.

Father *Yriberry* mentioned the disadvantages connected with the disturbing magnetic effect of the core in core instruments.

Prof. *Bartels* and Dr. *Nelson* discussed the considerable variation with ordinate of the scale value of a sensitive H-variometer. This variation must be taken into account when evaluating the records.

Prof. *Cagniard* drew attention to the possibility of recording magnetic variations on sound tracks.

Prof. *Grenet* saw a clear interest in the recording of dH/dt which quantity is proportional to the energy.

Dr. *Veldkamp* underlined the importance of reliable time marks on the magnetic records and recommended to produce such time marks by short-circuiting a resistance in the recorder-lamp circuit.

Further technical details were discussed by Prof. *Coulomb,* Prof. *Grenet* and Prof. *Thellier.*

Dr. *Pramanik* then presented the paper by *V. V. Sohoni, S. K. Pramanik, S. L. Malurkar* and *S. P. Venkiteshwaran:* "Effect of electric current on the magnetic instruments at Alibag Observatory".

Dr. *Nelson* presented his "Preliminary report on a differential magnetograph", which report was discussed by Prof. *Coulomb,* who drew attention to the device developed by *Dürschner,* by Dr. *Lowes* who commented upon the use of electronic amplifying, and by Dr. *Herrinck.* Dr. *Nelson* and Dr. *Lowes* will keep the Instrument Committee of the Association informed about further development of the equipments described.

The two communications: *J. Castet* et *G. Grenet:* "Variomètre électromagnétique Type B", and *J.-L. Bureau:* "Etude des P.S.C. enregistrées au moyen du variomètre électromagnétique. Comparaison avec les enregistrements classiques", were presented by Prof. *Grenet* and Dr. *Bureau* and discussed by Prof. *Thellier* and Prof. *Cagniard.*

The meeting adjourned at 17^h00.

Afternoon session of September 22, 1954

B. Group meeting. Group UA

The meeting was called to order at 14^h30 by the acting Chairman, Dr. *E. O. Hulburt.*

The following communications on ultraviolet radiation and X-rays were presented:

H. Friedman: Rocket results on ultraviolet radiation and X-rays.
C. de Jager: Theories of the ultraviolet emission from the sun.
J. C. Seddon and *U. E. Jackson:* L'application des fusées à l'étude de l'ionosphère (presented by *H. E. Newell*).
S. F. Singer: An artificial satellite for observing ultraviolet radiation.
D. H. Menzel and *J. G. Wolbach:* Variations at the E-layer (presented by title).

The papers were discussed by *H. Friedman, C. de Jager, E. O. Hulburt, S. F. Singer, M. Nicolet, W. Dieminger, L. Vegard, H. E. Newell, M. J. Seaton, A. H. Shapley, L. V. Berkner, P. Mange, N. C. Gerson.*

Morning session of September 23, 1954

A. Group meeting. Group G

The meeting was called to order at 9^h00 by the President, and continued the discussion on instruments and observatory technique.

Dr. Nelson first presented the paper by *L. Hurwitz, Patrick L. O'Dea* and *J. H. Nelson:* "Machine processing of magnetic data".

The paper was discussed by Dr. *Wilkes,* who gave some details concerning the procedures used in Cambridge, and also by Prof. *Coulomb* and Dr. *Pramanik.*

The Secretary, in his capacity of Chairman of Committee No 7, Committee on Comparisons, presented the report of the Committee. The report was discussed by Dr. *Nelson,* Dr. *Ambolt,* Dr. *Pramanik* and Sir *Harold Spencer Jones.*

Since Dr. *J. W. Joyce,* Chairman of Committee No 12, Committee on Magnetic Airborne Surveys, had been unable to attend the meeting, reference was made to his written report, which had been distributed, and which was adopted without discussion.

From Mr. *H. F. Johnston,* Chairman of Committee No 15, Committee on a Thesaurus of Annual Observatory Values, no report had been received.

Dr. *E. Hoge* presented the report by *E. Hoge* and *J. M. van Gils:* "Anomalies magnétiques et séismicité en Belgique".

The meeting then continued the discussion on the recommendation to be made concerning the registration of rapid magnetic variations, with special reference to the International Geophysical Year. The meeting was in favour of the proposal that quick-run records of the variations of X, Y (H, D), and Z should be obtained by means of very sensitive variometers, scale values

1 γ/mm for X and Y, $\frac{1}{10}$ γ/mm for Z, and with a paper speed of 6 mm/min. For X and Y (H and D) appropriately damped magnet variometers may be used, for Z it seems necessary to use a coil instrument with fluxmeter.

Father Mayaud made the following remark: "Pourquoi ne pas faire travailler le *déclinomètre* en X-mètre, c'est-à-dire, avec un *fil de torsion,* en sorte qu'un aimant compensateur ne soit pas nécessaire pour avoir la sensibilité suffisante de 1γ/mm? D'autre part, il semblerait préférable d'enregistrer sur H et D (en X-mètre) si les enregistrements lents sont sur H et D, ceci pour les régions *non-polaires.*"

It was agreed that a registration of dH/dt with a scale value of abt. 0.05 γ/sec/mm would be highly desirable. Prof. *Coulomb,* supported by Father *Romañá,* stressed the interest of a registration also of dZ/dt. The meeting was in favour of the registration of the derivatives of two horizontal rectangular components dX/dt and dY/dt. If only one derivate could be recorded, then preferably dX/dt (dH/dt).

The meeting charged Prof *Thellier* with the preparation of a resolution which should afterwards be passed on to the CSAGI.

Dr. *R. Kjær* presented his report: "The Norwegian Hydrographic Office and the magnetic survey of Norway".

The communication by Dr. *A. Maxwell:* "Electronic recording of the transient variations in the geomagnetic field" was presented by the author.

Prof. *Bartels* thanked Dr. *Maxwell* for his interesting communication, and Dr. *Vacquier* opened a discussion on the costs of operating an electronic equipment and the qualifications of the personnel required.

Dr. *J. R. Balsley* stated that it had been the experience of the U.S. Geological Survey during the last ten years that the maintenance of electronic magnetometers could be easily accomplished by radio and television maintenance personnel who had had a limited training in the particular technique involved.

Dr. *Maxwell* expressed the opinion that mechanical recording equipment would gradually be replaced by electronic equipment, and Father *Yriberry* suggested that for the AGI there be set up one or two electronic sets which could be compared directly with corresponding mechanical equipments.

Prof. *Bartels* was in favour of utilizing the experience of the electronic specialists, but warned against throwing away the classical types of instruments. Usually a photographic recorder gives more than a pen recorder owing to the thickness of the trace of the pen-record.

Further details were discussed by Sir *Harold Spencer Jones* and by Dr. *Nelson* who expressed the need for a higher accuracy. In this connection Dr. *Balsley* reported briefly on a new development in electronic magnetometers using the gyromagnetic resonance of water to give a drift-free absolute value of magnetism accurate to 0.1γ according to recent reports. The measurements employs only the standards of frequency which are the most accurately and easily obtained. This development should be closely followed by the IATME because of its obvious applications to magnetic observations.

Dr. *Jarman* mentioned an absolute instrument which had been used in airborne surveys for over 15 months with an accuracy of 1/20000.

Prof. *Coulomb* and Dr. *Maxwell* finally discussed the possibility of manufacturing the electronic equipment in mass-production. Dr. *Maxwell* was requested to contact appropriate firms and to report to the Instrument Committee and to the CSAGI concerning delivery conditions and price.

Dr. *Molina* was then called upon to present the report by *M. Giorgi, E. Medi* and *F. Molina:* "A magnetic survey in Northern Sicily".

Dr. *Egedal* gave a brief report on the magnetic effect of the solar eclipse of June 30, 1954. The D-record from Rude Skov showed a distinct depression near the maximum of the eclipse, and Dr. *Egedal* and Dr. *Ambolt* had initiated an inquiry among other observatories in or near the total zone in order to throw more light on this interesting question.

The meeting adjourned at 12^{h}00.

Morning session of September 23, 1954

B. Group meeting, Group UA

The meeting was called to order at 9^{h}00 by the acting Chairman, Dr. *H. Elliot,* who opened a discussion on the geophysical aspects of cosmic rays. The following communications were presented:

S. F. Singer: Geophysical aspect of cosmic rays — present problems.

J. A. Simpson: The cosmic radiation and solar-terrestrial relationships.

S. E. Forbush: World-wide variations of cosmic-ray intensity and terrestrial magnetic activity, (abstract read by *H. Elliot*).

Working Association of Primary Cosmic Ray Research, Japan: On the morphology of the cosmic ray storms, (presented by *T. Nagata*).

S. F. Singer: Remarks concerning a particular geomagnetic storm.

A. Ehmert: Cosmic rays and magnetic disturbances.

F. Bachelet and *A. M. Conforto:* Variations with time of cosmic ray intensity.

The papers were discussed by *H. Elliot, S. F. Singer, J. A. Simpson, T. Nagata, A. Ehmert, L. V. Berkner* and *F. E. Roach.*

A special working group with the following constitution:

T. Gold, Chairman
H. Elliot
A. Ehmert
N. Herlofson
S. F. Singer
T. Nagata
J. A. Simpson

had been charged with the preparation of a report on cosmic ray observations during the International Geophysical Year. This report was submitted by Dr. *Gold* and passed on to the Special Committee for the International Geophysical Year.

Afternoon session of September 23, 1954

Plenary session

The meeting was called to order at $14^{h}30$ by the President.

The minutes for the meetings on Sept. 15, 16 and 17 (morning) had been distributed and were submitted for approval. The meeting approved the minutes in principle; amendments are to be sent to the Central Bureau.

Prof. *Chapman* presented the special report on the equatorial jet current, which Dr. *D. F. Martyn* had prepared on behalf of the IATME Committee No 11. The report was accepted with thanks, and it was regretted that the author had been unable to attend the meeting and to participate in a further discussion on some of the conclusions drawn.

Prof. *Lahaye,* on behalf of the Nominations Committee, presented the suggestions of the Committee as to the membership of the Special Committees of the Association for the coming three year period. The proposed list of members for each Committee was adopted with only few amendments, and the meeting further approved the following suggestions put forward by the Nominations Committee:

1) That Dr. *I. A. Fleming* be nominated Honorary Chairman of Committee No 1, Committee on Observatories.
2) That Prof *C. Störmer* be nominated Honorary Chairman of Committee No 2, Committee on Aurora and Airglow.
3) That Prof. *J. Keränen* be nominated Honorary Chairman of Committee No 5, Committee on Magnetic Charts.
4) That the Executive Committee consider the possibility of adding to each of the Special Committees an additional member from the USSR.

For membership of the Committees, see Part VI, Resolutions and Committees.

Dr. *Egedal* recommended that the creation within a Committee of smaller working groups for the treatment of special problems should be announced in an appropriate way, so that those interested in the problems in question would know about the existence of the group.

In a report, presented by Dr. *Koenigsfeld* on behalf of the Budget Committee, the Committee summarized the result of its examination of the financial statement for the period 1st January 1951 to 21st December 1953, as prepared by the Secretary (see p. 62). In accordance with the recommendation of the Committee the meeting approved the statement as submitted.

The budget for the period 1st January 1954 to 31st December 1956 was then submitted in the form recommended by the Executive Committee, and approved without amendments (see p. 62). Following a proposal by Prof. *Chapman* it was decided that if additional resources should become available during the period, such resources should preferably be used for purposes relating to the International Geophysical Year.

The Resolutions Committee now presented the final text of the resolutions which had been adopted in principle during the meeting. All the resolutions were carried unanimously with only minor amendments (see Part VI, Resolutions and Committees).

This was the last item on the agenda for the General Assembly 1954, but before the meeting was closed the President-elect, Prof. *Bartels,* rose to express, on behalf of the audience, the thanks and appreciation of the Association, for the splendid work done by the Chairman and the Secretary of the Upper Atmosphere Group, Prof. *Kaplan* and Prof. *Nicolet,* in organizing and conducting the special meetings on upper atmospheric physics. Finally Prof. *Bartels* addressed the retiring President, Prof. *Coulomb* in words of gratitude and recognition for the outstanding way in which he had conducted the work of the Association during the past three years, and for his excellent leadership during the Rome meeting.

The meeting adjourned at 16^h15.

Appendices to the minutes

APPENDIX 1

Adresse Présidentielle

Présentée par le Professeur

J. COULOMB

Mesdames, Messieurs,

La clôture de l'Assemblée de Bruxelles laissait aux soins de votre Président deux questions importantes. Il lui fallait tout d'abord essayer de sauver le "Research", le navire non magnétique construit avant la guerre par l'Amirauté britannique ; celle-ci ne jugeait plus possible d'en achever l'équipement et d'en assurer l'entretien. La mission que vous m'aviez ainsi confiée, j'ai fait les plus grands efforts pour la remplir. Il a été envisagé successivement de faire du "Research" un Laboratoire International des Nations Unies, de le faire prendre en charge par le Conseil Océanographique que l'U.N.E.S.C.O. avait projet de créer, enfin de lui consacrer les premières sommes qui pourraient être recueillies auprès de grandes fondations privées au titre de l'Année Géophysique Internationale. Chacun de ces buts a été poursuivi par les voies les plus diverses : en faisant appel aux Comités Nationaux pour l'U.N.E.S.C.O., au Conseil Economique et Social des Nations Unies, à la voie diplomatique. Le Secrétaire Général de l'Union, ainsi que nos anciens Présidents, le Professeur *Chapman* et le Dr. *Fleming,* ont eux-mêmes fait des démarches pressantes, auxquelles répondaient celles des hommes de science anglais et en particulier celles de notre collègue l'Astronome Royal Sir *Harold Spencer Jones.* Nous avons trouvé partout un accueil compréhensif, on ne nous a nulle part opposé de refus catégorique. Mais des années sont nécessaires pour mettre en mouvement les grands organismes internationaux, des années pendant lesquelles il eût fallu entretenir le "Research" sans être sûr de pouvoir l'utiliser ensuite. Durant ces délais, la décision de démolir le navire a été prise fin Mars 1952. Cette perte douloureusement ressentie par tous les géomagnéticiens nous a rendu manifeste, une fois de plus, la grandeur des services rendus à notre science par l'Institution Carnegie.

Mais elle ne nous dispense pas de songer à l'avenir. On a pu, de divers côtés, pallier à l'absence de grand navire spécialisé. Je citerai seulement deux de ces entreprises. D'abord l'expédition de la Galathea qui comportait des mesures en mer profonde faites par nos collègues danois. D'autre part j'ai appris par hasard il y a quelques mois que le Dr. *B. M. Cwilong,* professeur de physique à l'Université de Colombie Britannique, avait entrepris avec un petit bâtiment de 48 tonnes, la "Princess Waimai", une croisière d'observations magnétiques dans l'Océan Pacifique, et qu'un autre navire non magnétique, de 10 mètres de long, le Non-magnetic III, en achèvement à Vancouver, devait le rejoindre aux îles Hawaï. Le Canada nous donne ici une précieuse leçon : Que les grands pays maritimes, seuls ou par groupes, acceptent d'armer pour faire des mesures des bâtiments de faible tonnage, par exemple des dragueurs de mines qui sont extrêmement peu magnétiques, et les expéditions plus importantes, dont vous savez comme moi l'absolue nécessité pour la science, ne tarderont pas à s'imposer d'elles-mêmes. Peut-être, après en avoir discuté, pourrons nous émettre des voeux précis que notre futur Président essayera à son tour de faire aboutir ; j'espère qu'il aura plus de succès que je n'en ai eu moi-même.

Le second des grands problèmes qui s'étaient posés à l'Association au cours de l'Assemblée de Bruxelles, c'était de trouver, pour nos collègues engagés dans les recherches concernant la Haute Atmosphère, la place où ils puissent discuter le plus utilement des questions que les intéressent et des actions internationales qui pourraient en faciliter la solution. Beaucoup d'entre eux souhaitaient que notre Association leur fournisse une telle place ; les accueillir nous paraissait à tous un enrichissement certain. Un projet accordant à la Haute Atmosphère une très grande liberté d'action tout en évitant l'éclatement de notre Association avait été établi à Bruxelles par le Professeur *Chapman* et soumis à l'Association de Météorologie. Mais il intéressait beaucoup d'autres organismes, en particulier l'Union Radio-Scientifique Internationale. Votre Bureau a procédé avec eux à un très large échange de vues. Puis, au cours d'une réunion du Comité Exécutif de l'Union tenue à Paris en Avril 1953, le Bureau de l'Association de Météorologie en a de nouveau discuté avec notre Bureau, sous la présidence du Professeur *Chapman.* Nous sommes arrivés à un accord qui délimite autant qu'il est possible les domaines d'action de nos deux Associations. Cet accord ne pourra évidemment être considéré comme définitif qu'à l'issue de cette Assemblée, mais il a déjà permis de donner une forme nouvelle au programme de nos travaux. Comme vous avez pu le constater à la lecture de l'ordre du jour, nous aurons cette année deux sortes de séances : D'une part des séances plénières sur des questions administratives ou sur des questions scientifiques intéressant l'ensemble de nos membres ; d'autre part des séances jumelées où se discuteront dans des salles séparées les problémes de la Haute Atmosphère et les problèmes du Géomagnétisme interne ou superficiel. Les réunions concernant la Haute Atmosphère sont organisées par le Comité actif que nous avons élu à Bruxelles conjointement avec l'Association de Météorologie, et l'une des réunions prévues est commune avec cette Association. Ce sera à vous de dire si vous approuvez la nouvelle organisation, ou sinon de suggérer à notre dévoué Secrétaire Général comment il faudrait la perfectionner pour la préparation de la prochaine Assemblée.

Une question étroitement liée à la précédente est celle du titre même de notre Association. Tout le monde est d'accord pour maintenir dans ce titre le Magnétisme terrestre, et même pour l'abréger en Géomagnétisme. Mais les Météorologistes répugneraient à nous voir ajouter quoi que ce soit qui rappelle le mot d'Atmosphère, même "haute" ou "supérieure". Ils suggèrent que notre but est la physique de l'Ionosphère, tandis que le Professeur *Chapman* nous conceille d'adopter le mot neuf d'Aéronomie. Je vous en parle surtout pour vous laisser le temps de vous accoutumer à ce mot, mais il ne serait pas souhaitable d'ouvrir une discussion sur le titre de notre Association tant que l'accord ne serait pas complet sur le domaine qu'elle doit couvrir ; en effet cette question de titre, qui paraît a priori secondaire, soulève les plus grandes passions et risque, si on la pose d'emblée, de faire échouer toute la réforme.

Pour répondre à l'accroissement de ses responsabilités, notre Association devra examiner, dès la présente Assemblée, si elle n'estimerait pas souhaitable d'améliorer son organisation interne, en particulier la répartition des tâches entre ses divers Comités. Notre rôle statutaire consiste à étudier les questions qui concernent le Magnétisme et l'Electricité terrestres en tant que ces questions exigent une coopération internationale. Ainsi nous avons d'abord à stimuler et à coordonner les efforts nationaux. C'est pourquoi nos Comités ont été créés en vue de tâches précises : obtenir des résultats mieux répartis ou plus comparables, recueillir et élaborer des données éparses. Quelques uns ont accompli dans cet ordre d'idée un travail énorme ; ils peuvent être considérés (et sont même considérés par l'U.N.E.S.C.O.) comme de véritables services internationaux. Je pense surtout à notre Comité pour la comparaison internationale des étalons géomagnétiques et à notre Comité des caractères magnétiques. Par contre, certains de nos Comités remplissent surtout un rôle d'information sur les progrès réalisés dans les divers pays, rôle dévolu souvent à leur seul Président. Or ces informations devraient déjà figurer dans les rapports nationaux, et ceci enlève un peu d'intérêt à une récapitulation par sujets de travail.

Peut-être serait-il possible de distribuer plus largement la besogne entre les divers Comités Spéciaux et, au sein de chacun d'eux, entre les membres qui les composent. Du même coup, il semblerait possible de réduire un peu le nombre de nos Comités, qui était de 5 à la première Assemblée de Rome en 1922, qui est maintenant de 15. Un questionnaire en ce sens a été adressé aux Présidents des Comités eux-mêmes, et nous aurons à discuter leurs propositions. Cette réduction permettrait éventuellement, sans alourdir la tâche de notre Secrétaire Général, de donner satisfaction aux demandes de créations nouvelles, qui vous paraîtraient justifiées. Vous aurez, ici encore, des décisions à prendre. C'est ainsi qu'on nous a proposé la création d'un Comité Spécial du Magnétisme fossile. Pour que vous soyez complètement éclairés, le Comité Exécutif a désigné le Professeur *Nagata* comme rapporteur de cette question. Vous pourrez ainsi juger dans quelle mesure elle est susceptible d'une action internationale.

Si j'ai cru devoir mettre l'accent sur notre rôle de coopération matérielle, il est évident que toute organisation serait vaine si elle ne considérait simultanément l'aspect purement scientifique des problèmes à résoudre. C'est à ce titre que, dans l'ordre du jour de nos Assemblées, une part de plus en plus importante est consacrée à l'exposé de travaux scientifiques personnels. Je me demande si, dans cette voie, nous n'avons pas atteint à Bruxelles une limite qu'il serait raisonnable de ne pas dépasser. En effet, nous ne pouvons espérer intéresser l'ensemble de nos membres à des discussions de détail ; nous ne pouvons non plus fragmenter notre Assemblée en un grand nombre de colloques fermés dont chacun réunirait un petit nombre de spécialistes. De tels colloques sont bien entendu de la plus grande utilité. Notre Association se doit d'aider, ou de faire aider par l'U.N.E.S.C.O., ceux dont nos collègues pourraient prendre l'initiative en dehors de nos Assemblées triennales, ou à leur occasion, immédiatement avant ou après. A l'Assemblée même il me semble que certaines restrictions sont inévitables dans la présentation des communications. Une telle discipline est déjà exercée, dans une mesure en général assez faible, par les Comités Nationaux. Il me semble qu'elle serait mieux assurée encore si l'organisation de chacune de nos séances était confiée à l'un de nos Comités Spéciaux, ou à défaut de Comité compétent, confiée à une personnalité particulièrement qualifiée. Il ne s'agirait d'ailleurs pas nécessairement de limiter le temps de parole. Au contraire il serait parfoit nécessaire de provoquer des exposés d'ensemble sur des points insuffisamment couverts. Un tel rôle est dès maintenant assuré par le Comité Spécial de la Haute Atmosphère dans son propre domaine, qui est pourtant très vaste, mais il me semble que la formule pourrait être généralisée.

La difficulté évidente d'une telle organisation est qu'elle doit être envisagée longtemps à l'avance. Cette difficulté ne semble pas insurmontable. Nous avons tenté un premier pas dans cette voie dès la présente session, en groupant, le mieux possible, les communications prévues et en les rapprochant du rapport présenté par le Comité Spécial qui traite du sujet le plus voisin. J'en donnerai seulement quelques exemples : — 1°) — Les communications sur le spectre auroral suivront le rapport du Comité n°2 — 2°) — Nous avons demandé au Dr. *Martyn* de bien vouloir présenter, après le rapport du Dr. *Egedal* concernant les observations équatoriales organisées par notre Comité n°11, une discussion scientifique des résultats obtenus — 3°) — D'accord avec l'Association de Séismologie, le Professeur *Bullard* présidera une séance entièrement consacrée aux recherches théoriques sur les mouvements dans le noyau terrestre, qui ont commencé il y a 15 ans à peine par le travail d' *Elsasser* et qui semblent devoir résoudre définitivement les questions posées par l'origine du champ et sa variation séculaire ; les communications sur ce sujet qui nous ont été adressées directement ont été transmises au Professeur *Bullard* et il en a lui-même provoqué d'autres. — 4°) — Enfin le Comité n°8 sur la technique des observations a confié au Professeur *Thellier* un rapport sur les modes d'enregistrement à adopter au cours de l'Année Géophysique Internationale pour l'étude des variations rapides, en particulier des pulsations. J'espère que la lecture de ce rapport amènera de fructueux échanges de vue, et que des rapports analogues seront consacrés, lors de prochaines Assemblées, aux perfectionnements instrumentaux les plus désirables, par exemple aux étalons primaires qui nous font si cruellement défaut. Bien entendu, la tâche du Comité n°8 ne s'arrêterait pas là, mais il devrait stimuler, entre les Assemblées l'exécution du programme envisagé.

On voit par ces essais encore très imparfaits ce que pourrait être l'organisation de nos séances par les Comités eux-mêmes. J'ai tenu à présenter de telles suggestions, car je les crois de nature à développer leur activité et à orienter favorablement la vie même de notre Association, mais je pense que vous attendez aussi de moi quelques considérations plus scientifiques. Je me garderai cependant d'aborder, malgré leur importance, les questions pour lesquelles nous avons prévu des séances spéciales, en particulier la question de la variation séculaire, bien que son intérêt soit pleinement reconnu en France, puisque ses principaux aspects seront évoqués par le Professeur *Nagata* d'une part, par le Professeur *Bullard* de l'autre. La question des pulsations qui sera traitée par le Professeur *Thellier* du seul point de vue instrumental, m'a paru au contraire mériter quelques mots précédant la discussion sur les appareils qui serviront à les enregistrer.

Les travaux sur les pulsations pourraient être médités par l'historien des sciences. Car les géophysiciens se sont intéressés à elles à plusieurs reprises ; des auteurs très connus ont bien décrit leurs propriétés essentielles dans des périodiques répandus. Et pourtant la curiosité soulevée par ces publications s'est chaque fois rapidement émoussée. Lorsque survenait une nouvelle crise, peu de chercheurs avaient le courage de fouiller les vieux textes, et beaucoup retrouvaient des phénomènes observés depuis longtemps. Parmi les pionniers dont les observations sont à relire, il faut rendre hommage à *Van Bemmelen, Ebert, Birkeland, Angenheister,* pour ne citer qu'eux parmi bien d'autres. (La mémoire d'*Eschenhagen* a été mieux gardée parce que son nom était souvent associé aux pulsations elles-mêmes). Ce devoir dûment rempli, je me permettrai de ne plus trop me soucier des priorités ; j'essayerai plutôt de voir dans son ensemble la situation actuelle, et de me tourner un peu vers l'avenir.

Il faudrait définir d'abord ce que nous appellerons des pulsations. Ce nom, qui n'est pas le seul à avoir été adopté, mais qui semble aujourd'hui généralement admis, a été employé dans des sens très divers. Dans son sens le plus général, il qualifierait les variations plus ou moins oscillatoires du champ magnétique terrestre comportant des composantes spectrales de période comprises entre 1/10ème de seconde et 10 minutes par exemple. Bien entendu des composantes de période plus courte ou plus longue sont présentes dans n'importe quel phénomène magnétique. Mais un même enregistrement ne peut les mettre en évidence. En ce sens, notre définition des pulsations est en réalité instrumentale. Bien plus, la bande de fréquences indiquée est encore trop large pour la plupart des appareils. On trie en général plus finement dans leur spectre. C'est l'origine de quelques contradictions entre les résultats publiés et c'est pourquoi nous devrons faire un effort pour unifier simultanément nos instruments et notre vocabulaire.

Au dessus de 10 minutes de période, on se trouve dans le domaine des enregistreurs classiques ; les variations qui sont ainsi enregistrées, et que vous connaissez bien, n'ont pas de caractère oscillatoire marqué. Par contre, la limite inférieure des périodes semble moins tranchée. Nos collègues *Harang* d'une part, *Sucksdorff* de l'autre, ont décrit des pulsations de période trop courte pour être séparées par les enregistreurs ordinaires. Ces "vibrations" comme les appelle *Harang* présentent un caractère très local. Mais elles se montrent quelques fois aux latitudes moyennes ; on les a vues par exemple lors de la tempête magnétique du 28 Mars 1946 inscrite à Chambon-la-Forêt sur l'enregistreur La Cour rapide. Cependant il faut être prudent dans l'interprétation des données correspondant aux variomètres non amortis. Ici j'empiète un peu, mais très peu, sur le domaine du Professeur *Thellier* : Lors de coups de foudre proches enregistrés sur le même appareil en 1953, les oscillations propres des aimants ont donné à l'enregistrement un aspect analogue au précédent. Or un variomètre amorti, qui n'était pas en service au moment de la tempête magnétique précédente, a donné seulement des impulsions insignifiantes. Ainsi, pour l'observation des pulsations, l'amortissement est une condition presque aussi importante que l'accroissement de sensibilité.

Si on veut descendre à des périodes encore plus basses, il faut admettre un changement complet dans les méthodes de mesure, et c'est à cause de cette modification instrumentale que j'ai cru pouvoir fixer à 1/10$^{\text{ème}}$ de seconde la limite des pulsations proprement dites. Dans leur domaine, l'amplitude décroît déjà avec la période, à peu près constamment de quelques dizaines de gammas à une fraction de gamma. Mais au dessous de 1/10$^{\text{ème}}$ de seconde cette amplitude devient si faible qu'on perd l'espoir de mettre en évidence la forme précise des phénomènes. On détermine seulement l'énergie mise en jeu dans un certain intervalle de fréquences. Pour une largeur de bande de 1 cycle par seconde, l'énergie observée est celle qui correspondrait à une amplitude fixe de l'ordre du centième de γ vers 10 cycles par seconde, du millième vers 100 cycles, du dix millième vers la fréquence mille, si on en juge par les trois ou quatre expériences assez divergentes qui ont été faites jusqu'ici (par *Menzel* et *Salisbury, Willis, Aarons*). On passerait ensuite à la gamme des bruits solaires, beaucoup mieux étudiée mais qui sort franchement de notre sujet.

Si les expériences que je viens de citer ne concordent pas parfaitement, si les variations de période très courte ont des niveaux extrêmement variables d'un point à l'autre, cela est dû au moins en partie aux différences géographiques de conductivité du sol, qui sont déjà sensibles dans le domaine des pulsations proprement dites. Dans une comparaison entre deux station françaises (Chambon-la-Forêt et St. Michel l'Observatoire) distantes de 500 Km, l'amplitude des mouvements ayant des périodes de quelques minutes était le même, pour autant qu'on pût parler de période dans ces cas. Au contraire, l'amplitude était supérieure de 50 % environ à Chambon, pour les pulsations ayant une période de vingt à trente secondes. C'est évidemment à l'effet pelliculaire (ou skin effect) que l'on doit cette variation : les courants induits dans le sol par les variations magnétiques pénètrent à des profondeurs qui croissent avec la période jusqu'à intéresser toute la croûte, réduisant alors l'importance de la géologie superficielle. On voit l'intérêt d'associer les mesures de courants telluriques aux mesures de champ. *Cagniard* a montré comment, en comparant les deux espèces de variation on pourrait obtenir des données pratiques sur la nature du sous-sol. Inversement on peut utiliser cette comparaison pour s'affranchir des conditions locales.

Reprenons la description des pulsations. Pour qu'elles apparaissent, il faut que la journée soit un peu agitée. Si elle ne l'est pas trop, et cela quelle que soit la forme d'enregistrement adoptée, les pulsations se présenteront différemment aux heures

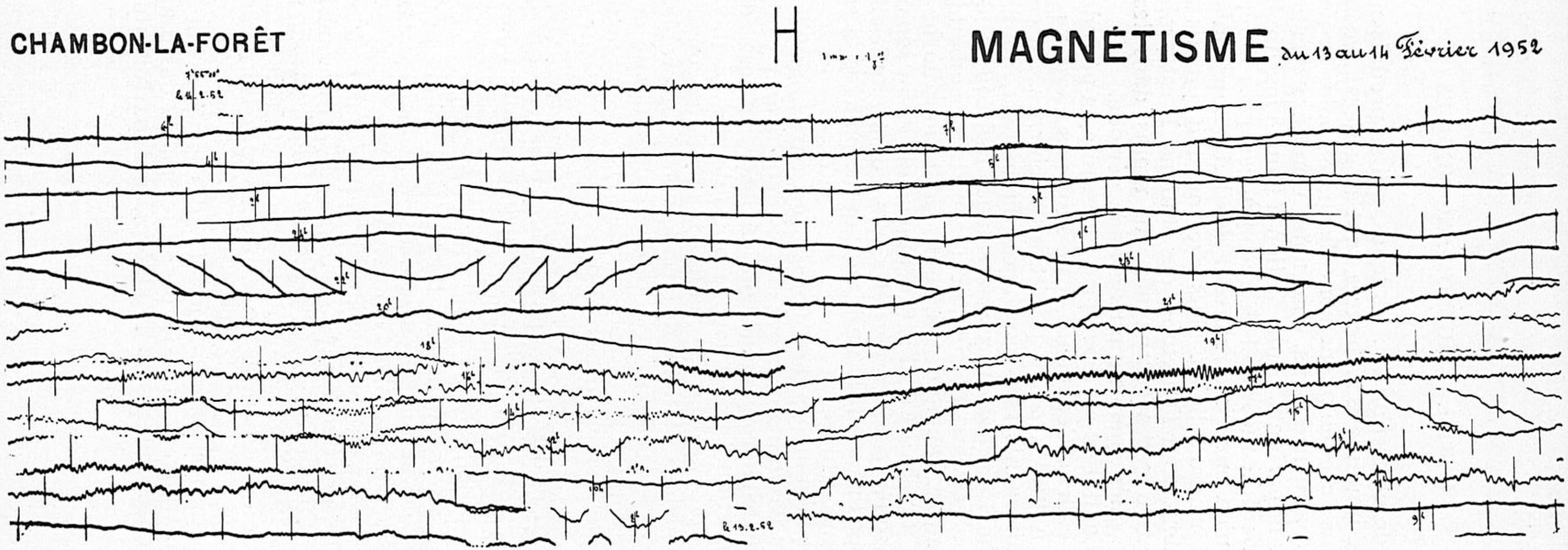

Fig. 1

de jour et de nuit *(Fig. 1)* : les baies, qui se produisent la nuit, avec un maximum vers 23 heures, sont en général accompagnées de pulsations ; c'est le phénomène des p.s.c., polar or pulsational sudden — commencements, dont notre Comité n°9 catalogue les cas les plus importants. D'une station à l'autre les amplitudes de la baie varient beaucoup et de façon à peu près indépendante, au point qu'on enregistre souvent des baies sans pulsations et des pulsations sans baies. Mais ceci ne doit jamais être vrai simultanément pour l'ensemble des stations. Il est probable que toute pulsation est accompagnée, au moins dans les régions polaires, de phénomènes à plus grande période.

Le jour, l'agitation est à peu près incessante, la période des pulsations est courte. Cependant il ne faut pas exagérer leur différence de nature avec les pulsations nocturnes. En comparant des enregistrements faits au Japon d'une part, au Sahara de l'autre, *Kato* et *Ossaka* ont retrouvé dans l'hémisphère diurne les pulsations observées du côté nocturne, très semblables d'une station à l'autre. Donc une partie de l'agitation diurne est aussi attribuable aux baies et il serait important de la séparer. Mais elle est masquée par des périodes plus courtes qui, elles, n'apparaissent pas pendant la nuit, tout au moins avec la sensibilité des récepteurs actuels.

Tous les phénomènes dont nous avons parlé jusqu'ici sont en général très irrèguliers et font simplement penser à une turbulence de l'ionosphère comme celle qu'observent les radioélectriciens. Leur étude serait donc justifiable des méthodes statistiques. La comparaison de champs magnétiques ou telluriques aléatoires en deux stations différentes pose un problème assez intéressant de corrélation vectorielle (indépendante des axe de coordonnées) qui a éte résolu récemment, et on peut espérer obtenir prochainement des précisions numériques sur cette corrélation.

Ce genre d'études statistiques, pour indispensable qu'il soit, paraîtra probablement sévère à beaucoup d'entre nous. Au contraire, ce qui a exité la curiosité des magnéticiens, ce sont les trains d'oscillations, d'une régularité parfois spectaculaire, qui apparaissent inopinément dans les enregistrements au milieu de l'agitation. C'est ce qui se passe dans les régions polaires pour les pulsations géantes. Vous connaissez bien ces pulsations, qui font l'objet cette fois des travaux de notre Comité n°5, et vous savez qu'elles peuvent avoir des amplitudes et des périodes exceptionnelles. Un exemple extrême est donné par la pulsation du ler Mars 1942 *(Fig. 2)* dont la période était de 4 minutes et demie et qui a été bien observée jusque dans les régions tropicales.

Sur les enregistrements rapides des stations de latitude moyenne on trouve de même, parmi les pulsations diurnes, des oscillations plus ou moins régulières, qui parfois durent des

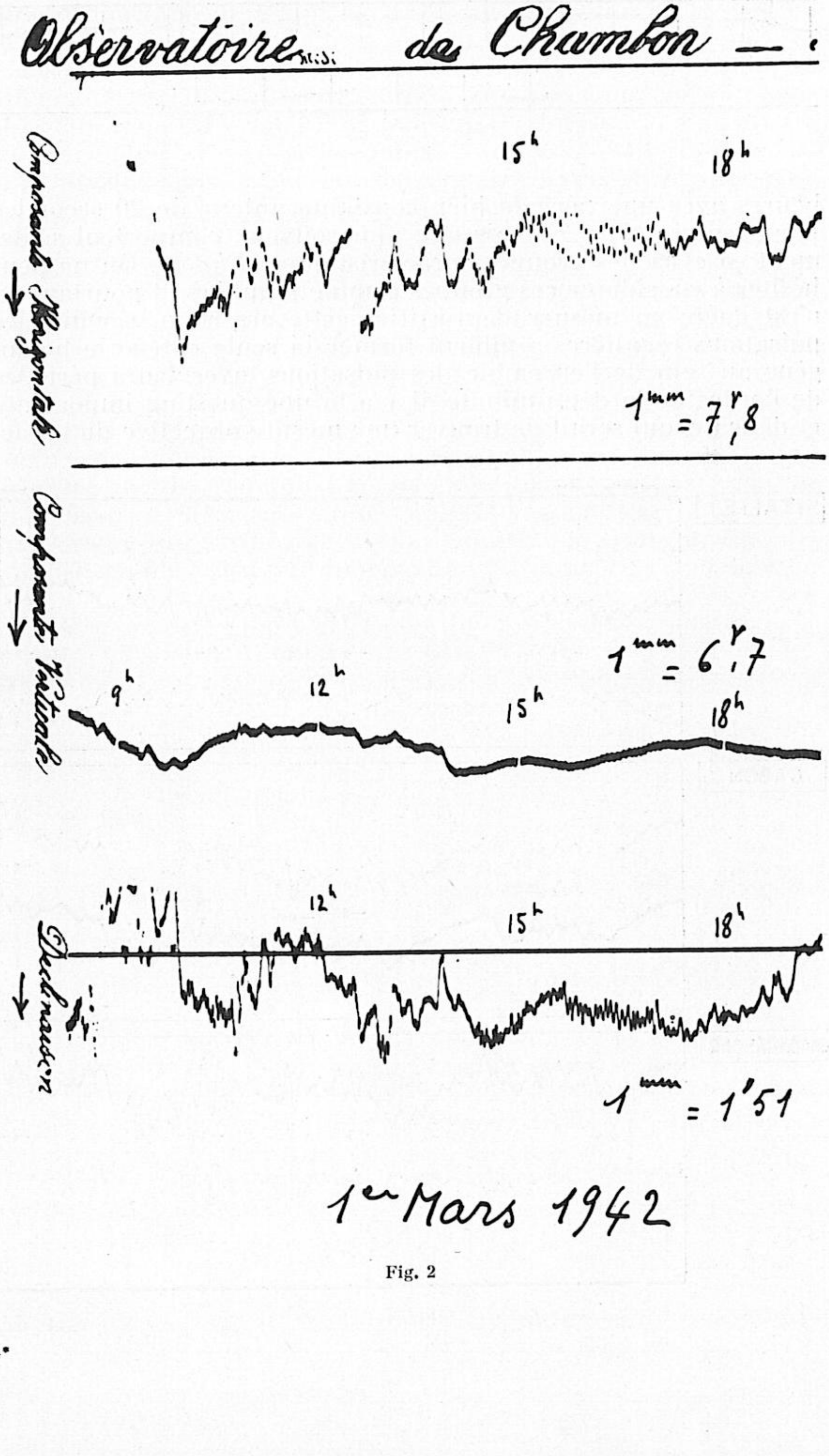
Observatoire du Chambon
Composante Horizontale
15h
18h
1mm = 7γ,8
Composante Verticale
1mm = 6γ,7
9h
12h
15h
18h
Declinaison
12h
15h
18h
1mm = 1'51
1er Mars 1942

Fig. 2

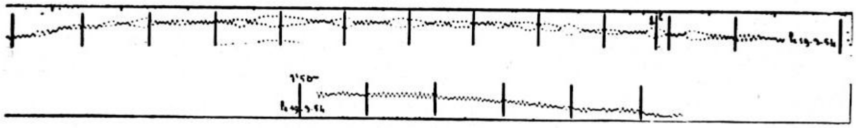

Fig. 3

heures avec une période bien constante autour de 20 secondes par exemple *(Fig. 3)* mais qui, plus souvent, comportent seulement ça et là des groupes caractéristiques *(Fig. 1)*. On ne peut hésiter à considérer ces groupes comme réguliers et pourtant on n'est guére en mesure de justifier cette assertion. Comme les pulsations régulières semblent former la seule catégorie homogène au sein de l'ensemble des pulsations, avec leurs périodes de l'ordre de la demi-minute, il y a là une question importante et délicate, qui serait de trouver une mesure objective du carac-

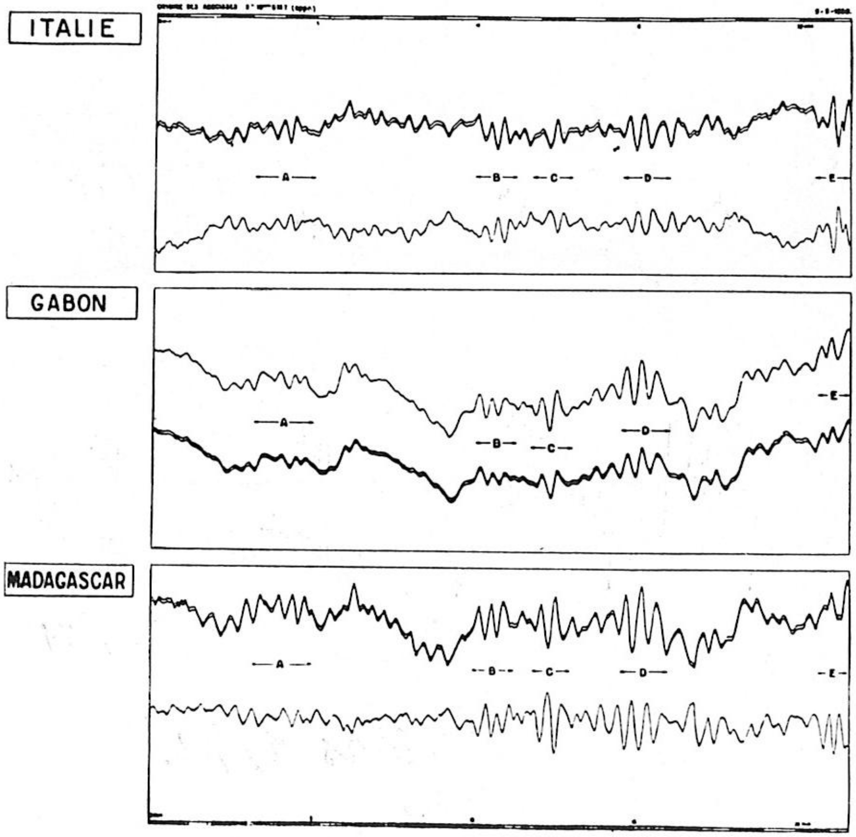

Fig. 4

tère régulier ou irrégulier de chaque portion d'enregistrement. Le critère actuel, savoir la présence de quelques oscillations dont la période soit à peu près constante et l'amplitude lentement variable, nous met dans la situation des sophistes grecs se demandant quel est le nombre minimum des grains de blé pouvant constituer un tas.

Contrairement aux pulsations géantes, qui sont en général restreintes à une région voisine de la zone aurorale et extérieure à celle-ci, les pulsations régulières des latitudes moyennes, quoique beaucoup plus faibles, ont une extension bien plus grande. Les enregistrements telluriques de la Compagnie Générale de Géophysique montrent parfois les mêmes groupes d'ondes en Europe, en Afrique et en Amérique *(Fig. 4)*. Au cours d'une prochaine séance *M. Kunetz* vous donnera des détails à ce sujet. Dans la comparaison plus modeste entre deux points de France, dont je parlais tout à l'heure, la plupart des pulsations, régulières ou irrégulières, se retrouvaient en général sans difficultés d'une station à l'autre. Cependant les courtes périodes étaient favorisées à St. Michel par l'ionosphère locale, au point qu'elles arrivaient parfois à masquer les périodes plus longues.

Je ne vous parlerai pas des variations observées dans la fréquence des pulsations au cours du jour ou de l'année. Vous comprenez que le choix des instruments est essentiel, puisqu'il incorpore dans les statistiques une portion plus ou moins grande de pulsations nocturnes dont la période est plus longue. D'ailleurs l'amplitude, qui est liée à la conductivité de l'ionosphère et du sol, n'a pas une signification aussi universelle que l'heure ou la période d'apparition. Peut-être la différence entre la nuit et le jour est-elle seulement due aux différences de conductivité de l'ionosphère. Cela donnerait un intérêt particulier aux mesures faites au moment des éclipses, si la variabilité coutumière des pulsations ne risquait de noyer toute variation systématique observée.

Il faudrait maintenant aborder la théorie des pulsations. Avouons d'emblée qu'elle n'a pas fait un pas depuis cinquante ans. (Ceci ne doit d'ailleurs pas nous décourager si nous réfléchissons au temps qui s'est écoulé entre l'inauguration des enregistrements magnétiques et le moment où, pour la première fois, un des phénomènes qu'ils pouvaient faire apparaître, celui des crochets magnétiques liés aux éruptions chromosphériques a été bien identifié.). A vrai dire il n'y aurait peut-être pas de très grandes difficultés à comprendre la présence des pulsations irrégulières : les perturbations accidentelles de l'ionosphère dues aux chutes de corpuscules dans la zone aurorale, ou même ailleurs, suffiraient à les expliquer. On a parfois placé dans la couche E le siège de ces perturbations. Mais la scintillation des radio-sources galactiques observées par *Little* et *Maxwell* par exemple conduit à mettre plutôt en cause des fluctuations de structure dans la couche F ou dans des couches plus élevées encore. Quelques résultats de sondages ionosphériques rapides confirmeraient ce point de vue.

La question la plus irritante est celle de la formation des groupes réguliers, si caractéristiques qu'ils ont donné lieu à des expressions comme "pulsation en navette" ou "pulsation en fuseau". Il serait tentant de faire dériver les pulsations régulières des pulsation irrégulières en supposant que celles-ci sont filtrées par un système résonant à bande passante étroite, ou encore qu'une propagation avec dispersion fait prédominer les périodes privilégiées qui correspondent à des maximums ou à des minimums de la vitesse de groupe. Il est possible d'imaginer dans l'ionosphère des mécanismes de résonance ou de propagation dispersive ; on a notamment invoqué des oscillations de plasmas. Mais ces explications, qui se présentent d'elles-mêmes, butent contre la soudaineté et la simultanéité d'apparition des pulsations régulières en des régions écartées.

Si on admet au contraire que les pulsations régulières constituent un phénomène original, on est conduit à leur chercher une cause à la fois peu étendue dans son principe, puisque leurs périodes sont relativement courtes, mais étendue, dans ses effets, à la Terre entière. L'explication ancienne qu'en avait donné *Störmer,* savoir la circulation de nuages d'ions autour de la Terre sur des orbites périodiques, était dans la bonne direction. Elle ne satisfait plus personne aujourd'hui, mais il ne semblerait pas impossible de la moderniser. En attendant, on pourrait l'utiliser, à défaut d'autre guide, pour des projets d'observation. Par exemple, comme l'a fait remarquer *Harang,* ces orbites s'approchent alternativement des deux zones aurorales ; on pourrait donc examiner pendant la prochaine Année Géophysique si une même pulsation géante peut intéresser simultanément des régions arctiques et antarctiques.

Si on se rapelle que l'étude des pulsations liées aux baies nous a conduit à souhaiter aussi une comparaison des hémisphères obscur et éclairé ; si l'on considère que la mise en évidence d'une propagation éventuelle dépend d'observations bien synchronisées en une chaîne de stations proches, chaîne qui figurerait au programme d l'Année Géophysique suivant une heureuse proposition de nos collègues allemands, on voit que la connaissance des variations rapides géomagnétiques exigerait inpérieusement un effort véritablement mondial. Elles représentent donc un modèle des actions communes que notre Association se fait gloire d'entreprendre. C'est là la raison principale pour laquelle je désirais vous en parler.

Au travail maintenant! J'espère, Mesdames, Messieurs, que dans le cadre imposant préparé par nos collègues italiens vous tirerez de vos contacts mutuels le bénéfice et l'agrément ordinaires. L'Assemblée de notre Association est ouverte.

APPENDIX 2

Geophysicists whose deaths have been reported since the Brussels Assembly 1951

Daniel Lyman Hazard (U.S.A.). D. L. Hazard died on September 21, 1951, at the age of 86. He entered the U.S. Coast and Geodetic Survey in 1892, and as Chief of the Division of Terrestrial Magnetism during many years he contributed largely to the development of geomagnetic research in the United States. His "Directions for magnetic measurements" will be well known to magneticians all over the world.

Bruno Collasius (Argentina). B. Collasius of the Geophysical Department of the Servicio Meteorológico Nacional, Argentina, died on October 19, 1951, at the age of 57, after nearly 35 years of service in geophysics. He spent five years at the Orcadas (Laurie Island) Observatory, four of them as Officer-in-Charge.

Alexander Crichton Mitchell (Great Britain). Dr. A. Crichton Mitchell died in Edinburgh on April 15, 1952, at the age of 87. In 1916 he was placed in charge of the Eskdalemuir Observatory and in 1922 he became the first Superintendent of the newly-established Meteorological Office in Edinburgh. His principal interest was terrestrial magnetism, to which discipline he made outstanding contributions, including a valuable review of the subject in its historical aspect.

A. Tanakadate (Japan). A. Tanakadate, Professor Emeritus of Physics, Tokyo University, died on May 21, 1952, in his 96th year. He was well known internationally and was an authority on terrestrial magnetism. He attended and took an active interest in many of the early meetings of the International Union of Geodesy and Geophysics, and was elected first president of its Section of Terrestrial Magnetism and Electricity at Brussels in 1919.

Harold Edgar McComb (U.S.A.). H. E. McComb died on October 11, 1952, at the age of 66. He was appointed magnetic observer in the U.S. Coast and Geodetic Survey in 1909, and took an active part in the general magnetic survey of the country. After the close of World War I he was placed in charge of the magnetic observatory at Honolulu, where he spent nine years. In 1948 he became Chief of Geomagnetism Branch of the Coast and Geodetic Survey. His final important work was the completion of his "Magnetic Observatory Manual", published in 1952 shortly after his death.

Hans Benndorf (Austria). Prof. Dr. H. Benndorf of Graz died on February 11, 1953, at the age of 82. Among geophysicists he will be remembered for his mechanically recording electrometer, used in atmospheric electric research. He also made pioneering contributions in the field of radio-activity, cosmic radiation and meteorology.

Rosendo Octavio Sandoval (Mexico). R. O. Sandoval, Chief of the Magnetic Department, Geophysical Institute of the National University of Mexico, died on April 2, 1953. He was well known in the field of terrestrial magnetism to which he contributed much information pertaining to the values of the magnetic elements and the secular variation in Mexico.

George Ray Wait (U.S.A.). Dr. G. R. Wait, a leading authority on atmospheric electricity, died on April 9, 1953, at the age of 66. He joined the staff of the Department of Terrestrial Magnetism, Carnegie Institution of Washington, in 1920, and from 1921 to 1924 he was in charge of the Watheroo Magnetic Observatory. Dr. Wait contributed largely to the discovery of characteristic features in the diurnal variation of the earth's electric field. After his retirement in 1951 he completed an outstanding study of atmospheric electric observations made at Tucson.

Th. Læssøe Müller (Denmark). Th. Læssøe Müller, the Danish instrument-maker, who proposed the optical temperature compensation of magnetic variometers and in consultation with D. la Cour constructed the monad balance magnet, died on July 10, 1953, in his 77th year.

Nicholas Hunter Heck (U.S.A.). Captain N. H. Heck, Chief of the Division of Terrestrial Magnetism and Seismology of the U.S. Coast and Geodetic Survey for 20 years, died on December 21, 1953, at the age of 71. He was a leading authority on seismology and has published a great number of papers concerning nautical problems, compensation of the magnetic compass, velocity of sound in sea-water, radio-acustic method of determining position in hydrography and other questions.

APPENDIX 3

Report of the Secretary and Director of the Central Bureau for the period 1951—1954

General

The period under review marked a new and gratifying step forward along the line of increasing activity that has for so many years characterized the work of the Association of Terrestrial Magnetism and Electricity.

The world-wide character of the activity of the Association becomes more and more pronounced, not only owing to the steady increase in the number of countries joining the International Union of Geodesy and Geophysics, but also owing to the fact that an increasing number of these countries are implementing a geomagnetic research programme of their own, for the planning of which the advice of the Association and its Special Committees is often requested.

At the same time, and to make allowance for all the varied aspects of Terrestrial Magnetism and Electricity, the scope of the Association seems to have become even wider than before. This is illustrated by the fact that at the Brussels Assembly 1951 not less than 15 Special Committees were established for the coming three-year period. All of these Special Committees have been working efficiently as will be seen from the activity reports presented at the Rome meeting.

According to a resolution passed by the Union at its Brussels meeting it was left to the Central Bureau of the IATME to get in touch with all international organizations concerned in order to obtain within the frames of the IUGG an appropriate and well defined place for the discussion of problems relating to upper atmospheric physics. A preliminary agreement has been reached, which is submitted for the consideration of the Rome Assembly.

At the request of the Special Committee for the International Geophysical Year, the Bureau of the Association initiated in 1953 a general inquiry among all magnetic observatories and geophysical institutions for the purpose of obtaining full information as to the different types of special instrumental equipment used for the registration of rapid variations. The material has been studied by the Chairman of the IATME-Committee on observational technique, Prof. *Thellier,* who has prepared for the Rome Assembly a comprehensive and important report on the subject.

Publications

The Transactions of the Brussels Meeting, IATME Bulletin No 14, were prepared for printing by the retiring Secretary and Director of the Central Bureau, Dr. *J. W. Joyce,* who most generously took upon himself this arduous task. Although at the same time Dr. *Joyce* has had to undertake a steadily increasing amount of official duties which has caused some delay in the preparation of the Transactions he succeeded in getting the volume ready for distribution in July 1954, and it is hoped that practically all member-countries will have received their copies in time for the Rome meeting. The main distribution has taken place through National Committees, with single copies to the Officers of the Association, to the Chairmen of Special Committees and to the Secretaries of other Associations. Preliminary distribution figures are as follows:

To National Committees	1055	copies
To Individuals	35	„
To the General Secretary IUGG and UNESCO	20	„
Held in stock	344	„
Total edition	1454	copies

Dr. *Joyce* has also made the practical arrangements for the printing and distribution of

	Edition
Bulletin 12 f, Geomagnetic Indices K and C, 1951	600
Bulletin 12 g, Geomagnetic Indices K and C, 1952	650

Bulletin 12 h, Geomagnetic Indices K and C, 1953, edition 650 copies, has been printed in Holland under the supervision of Dr. *Veldkamp,* Secretary of the IATME Committee on characterization, and thanks to a remarkable effort on the part of the Committee the Association has succeeded in having also this volume issued in time for the Rome meeting.

Finances

At the Brussels meeting the Association approved the following budget for the period January 1, 1951 to December 31, 1953

ESTIMATED RECEIPTS	$
Cash on hand 1/1 51...	10.530
From Union for period 1/1 51 to 31/12 53, based on guaranteed minimum of £900 per year	7.560
Total	18.090
Estimated payments....	16.170
Estimated balance 31/12 53....................	1.920

ESTIMATED PAYMENTS	$
Management expenses (including expenses since 1/1 51)	1.200
Brussels Transactions..	3.500
Preparation for Brussels (1/1 51 to Assembly)..	600
Preparation for 1954 meeting..............	700
Subventions:	
Outstanding to Journal of Geophysical Research	170
Magnetic intercomparisons	1.000
Equatorial observations	500
Magnetic activity indices	1.250
Lunar studies..........	1.000
Giant pulsations	250
Instrumental program..	6.000
	16.170

NOTE: Estimated expenditures are $8.610 in excess of estimated income. No account has been taken of UNESCO grants. These, if received, will reduce the amount of deficit spending.

Actual receipts and payments for the period are listed in the appended statement of accounts. This statement is a summary statement based on two detailed and audited part-statements, one for the Copenhagen sub-account and one for the Washington sub-account of the Association. The two audited part-statements will be submitted to the special Budget Committee appointed for the Rome Assembly.

When the total payments listed in the statement of accounts seem extraordinary small as compared with those foreseen in the budget for the period, this is due mainly to the following special circumstances:

(1) An unforeseen delay in the preparation of the IATME publications Bulletin 14 and Bulletin 12 g made it impossible to have these volumes printed and distributed before the 31st December 1953. Printing and distribution costs amounting to abt. \$ 1.425 have been defrayed since the 1st January 1954.

(2) Also the disbursement of the subvention \$ 1.000 for lunar studies had to be postponed until early in 1954 and could therefore not be included in the statement here submitted.

(3) The instrumental programme for which a sum of \$ 6.000 was set aside in the budget was deferred to await the results of the latest improvements of the special variograph equipment which the Association had considered to acquire.

Taking into account the above points (1), (2) and (3), the formal balance as of 31 December 1953, \$ 16.133,80, is partly counterbalanced by firm commitments amounting to abt. \$ 8.425 so that the amount actually at disposal for further expenditures will be abt. \$7.700 as against abt. \$ 10.500 at the beginning of the period under review.

UNESCO grants-in-aid have again most efficiently contributed to the furtherance of the programme of the Association. The total of the grants for the period here considered was \$ 4.350, including \$ 500 for travel grants to the Brussels meeting. \$ 1.400 was allocated for international comparisons which amount covered air-transport of QHM-instruments and necessary repairs and completion of instrumental equipment. To assist in the publication of the Brussels Transactions a total of \$ 1.400 was granted and a sum of \$ 1.050 was made available for the publication of geomagnetic indices.

As for future expenditures it seems very likely that the planning of the International Geophysical Year 1957—58 will be reflected also in the activity of the IATME during the coming years, so that in preparing the budget for 1954—57 due regard should be paid to such special requirements as may be expected in connection with the preparations for the AGI.

Preparations for the Rome meeting

The first circular letter giving an outline of the programme was sent to National Committees and Officers of the Association and its Committees in January 1954. It was followed in May 1954 by a second letter giving a provisional agenda for the meeting, and in July 1954 the detailed agenda was prepared and distributed as Circular Letter No 3. An appendix to Circular Letter No 3, containing proposals, reports of Special Committees, abstracts of National Reports and Technical Communications, has been prepared for distribution in Rome. The appendix has also been distributed by mail in so far as such a distribution could be completed in time for the meeting.

APPENDIX 4

Statement of accounts and Budget

International Association of Terrestrial Magnetism and Electricity

Summary statement of accounts from 1st January 1951 through 31st December 1953

RECEIPTS	US dollars	US dollars
Balance 31 December 1950		10530.93
Allocations from the Union:		
1951 £ 900 (Dan. acc.)	2526.78	
1952 £ 900 »	2526.78	
1953 £ 900 »	2526.78	
		7580.34
Grants-in-aid from UNESCO:		
To Dan. acc. / *To US acc.*		
1951 — / $ 2150.00	2150.00	
1952 $ 400.00 / 900.00	1300.00	
1953 $ 500.00 / 400.00	900.00	
		4350.00
Interests:		
Danish savings account	83.44	
US savings account	377.97	
		461.41
Sale of publications:		
Dan. acc.	11.89	
US acc.	209.20	
		221.09
From Temporary Commission for Liquidation of the Polar Year 1932-33 (For publication of K/Kp tables for 1932-33 in IATME Bulletin No. 12e) (US acc.)		72.43
Total receipts		23216.20

PAYMENTS		US dollars	US dollars
Subventions:			
Page charges, Journal of Geoph. Res. (US acc.)		172.00	
Magnetic intercomparisons (Dan. acc.).......		26.62	
Equatorial observations (Dan. acc.)..........		116.65	
Magnetic activity indices			
Dan. acc.	206.81		
US acc.	689.29		
....		896.10	
Giant pulsations (Dan. acc.)		39.70	
Reprints of Thesaurus of Observatory values (US acc.)		14.00	1265.07
Brussels meeting (US acc.)....................			545.03
Management expenses:			
Dan. acc..................................		281.08	
US acc....................................		573.12	854.20
UNESCO grants-in-aid			
1951			
Travel grants to Brussels meeting (US acc.)		500.00	
Aid in publ. of IATME Bull. 12e (US acc.)		400.00	
Intercomparisons of magn. standards (US acc.)		500.00	
Aid in publ. of IATME Bull. 14 (US acc.).		750.00	
1952			
Aid in publ. of IATME Bull. 12f (US acc.)		250.00	
Aid in publ. of IATME Bull. 14 (US acc.).		650.00	
Intercomparisons of magn. standards (Dan. acc.)		400.00	
1953			
Aid in publ. of IATME Bull. 12g (US acc.)		400.00	
Intercomparison of magn. standards (Dan. acc.)		500.00	4350.00
Transferred to Prof. C. Størmer for auroral publications for re-sale (US acc.).........			65.00
Exchange in transferring $ 1000 from Washington to Copenhagen.....................			3.10
Total payments			7082.40
Balance 31 December 1953			
Dan. acc..................................		8001.71	
US acc....................................		8132.09	16133.80
Total			23216.20

The above statement is summarizing the sub-accounts of the Association, the US sub-account, audited by A. David Singer, Accountant, Geophysical Laboratory, Carnegie Institution of Washington, and the Danish sub-account, audited by B. Hoff-Jessen, Chief Accountant, Danish Meteorological Institute. In the summary all receipts and payments in Danish crowns have been converted to US dollars, using as rate of exchange 1 US dollar to 6.8886 Danish crowns. The Danish balance, $ 8001.71, is the dollar equivalent of 55120.68 Danish crowns.

Charlottenlund, 23rd August 1954

V. LAURSEN

Secretary, IATME.

Report of Budget Committee

Le Comité de budget se composant de

Dr. Koenigsfeld
Dr. Olsen
Dr. Elvey
Dr. Veldkamp

a examiné le 20 septembre le rapport du Dr. *V. Laursen* sur le budget du ler janvier 1951 au 31 décembre 1953.

Ce rapport a été approuvé par tous les membres présents.

Le Comité propose que l'Association de Magnétisme et Electricité Terrestres remercie le Dr. *Laursen* pour la clarté du rapport remis et la bonne gestion des finances.

L. Koenigsfeld *Johannes Olsen* *C. T. Elvey* *J. Veldkamp*

Approved budget for the International Association of Geomagnetism and Aeronomy for the period January 1, 1954, to December 31, 1956

ESTIMATED RECEIPTS	$	ESTIMATED PAYMENTS	$
Cash on hand 1/1 1954..	16,130	Management expenses..	1,200
From Union for period 1/1 1954 to 31/12 1956 (£ 900 a year).......	7,560	Brussels Transactions (expenses 1/1 54 to Assembly)............	1,200
Total..................	23,690	Rome Transactions.....	3,500
		Preparation for Rome (1/1 54 to Assembly).	1,500
		Preparation for 1957 meeting................	300
		Magnetic activity indices	2,000
		Magnetic intercomparisons................	1,000
		Lunar studies (including $ 1,000 expended since 1/1 54)..........	2,000
		International Geophysical Year (Meetings and instruments)........	8,500
Estimated payments....	21,200	Total..................	21,200
Estimated balance 31/12 1956.................	2,490		

APPENDIX 5

Proposals

I

Proposal concerning the position within the IUGG of the physics of the high atmosphere

At the Brussels meeting 1951 the IUGG passed the following resolution:

"The means of providing for adequate treatment of the Physics of the High Atmosphere require further careful consideration. This Assembly authorises the International Association of Terrestrial Magnetism and Electricity to continue discussion with the other Associations, Joint Commissions and Scientific Unions concerned, in the hope that a satisfactory solution to the problem may be reached at the next Assembly of IUGG."

In pursuance of this resolution the Bureau of the Association of Terrestrial Magnetism and Electricity initiated a general inquiry among all international organizations concerned with the study of upper atmospheric physics, and on the base of the replies received the two Associations most directly interested, namely the Association of Meteorology and the present Association, agreed upon a proposal which is submitted for the consideration of the Rome Assembly. The proposal was published in the July 1953 issue of the IUGG News-Letter as the report of a special Commission appointed to study the item 8 of the agenda for the Meeting of the Executive Committee of the IUGG, Paris 13—17 April 1953. The official French text of this report is quoted here for reference together with an English translation.

1. Composition de la Commission :
   Président : M. *S. Chapman,* Président de l'Union
   Membres : MM. *J. Coulomb,* Président de l'AIMET
   K. R. Ramanathan, Président de l'AIM
   V. Laursen, Secrétaire de l'AIMET
   J. Van Mieghem, Secrétaire de l'AIM

2. *Conclusion de la discussion :*

   2.1.1. La Commission estime que les problèmes de la physique de l'Ionosphère et de la luminescence de la haute atmosphère intéressent plus particulièrement l'AIMET. Les travaux relatifs à ces problèmes devraient être présentés à l'AIMET, discutés au sein de cette Association et publiés par ses soins.

2.1.2. La Commission estime que les travaux relatifs à l'ozone atmosphérique, aux orages, à la propagation des ondes sonores et à leur réflexion par la haute atmosphère, etc. appartiennent au domaine qui intéresse plus directement l'AIM. Ceux-ci devraient être présentés à l'AIM, discutés au sein de cette Association et publiés par ses soins.

2.1.3. Par contre, les phénomènes de la mésosphère intéressent les deux Associations. Les problèmes situés à la limite des champs d'activité des deux Associations (météorites, nuages lumineux, vent et turbulence dans la mésosphère, etc...) devraient être discutés au cours des séances communes des deux Associations.

2.2.1. En vue de coordonner les activités des deux Associations dans le domaine de la Physique de la Haute Atmosphère et d'établir entre elles une coopération fructueuse dans ce domaine, il faudrait constituer un Comité mixte de la Haute Atmosphère dont les membres seraient élus par les deux Associations.

2.2.2. Le Comité mixte élirait un Président et un Secrétaire et pourrait s'adjoindre par cooptation de nouveaux membres, dont la nomination devrait être ratifiée par les Associations à l'Assemblée Générale suivante.

2.2.3. Le Comité mixte pourrait se réunir sur convocation de son Président en dehors des sessions de l'Assemblée Générale de l'UGGI, à condition d'en aviser les Bureaux des deux Associations.

2.2.4. Le Comité mixte établirait le programme de ses activités et organiserait, au cours des sessions de l'Assemblée Générale de l'UGGI les séances de travail consacrées à la Physique de la Haute Atmosphère en consultation avec les Secrétaires des deux Associations.

2.2.5. A chaque session de l'Assemblée Générale de l'UGGI, le Comité mixte présenterait aux deux Associations un rapport sur son activité au cours de la période triennale écoulée.

2.2.6. La composition du Comité mixte serait réexaminée à chaque session de l'Assemblée Génerale, étant entendu que tout membre sortant est rééligible.

2.3.1. Les travaux du Comité mixte seraient publiés dans les Procès-Verbaux de l'AIM, de l'AIMET, ou des deux Associations.

2.3.2. Les demandes de subsides du Comité mixte seraient présentées et appuyées par les deux Associations.

2.4.1. Si nécessaire, les statuts des deux Associations devraient être modifiés conformément aux alinéas 2.2.1., 2.2.2., 2.2.3.

2.5.1. La Commission propose de substituer l'appellation l'"Association Internationale de Géomagnétisme et de Physique de l'Ionosphère" à l'appellation actuelle d'"Association Internationale de Magnétisme et Electricité Terrestres". Toutefois, cette proposition n'exclut pas toute autre suggestion qui pourrait être faite.

1. Composition of the Commission:

President: Mr. *S. Chapman,* President of the Union
Members: Messrs. *J. Coulomb,* President of the IATME
K. R. Ramanathan, President of the IAM
V. Laursen, Secretary of the IATME
J. Van Mieghem, Secretary of the IAM

2. *Conclusion of the discussion:*

2.1.1. The Commission considers that the problems of the ionospheric physics and the airglow are of a particular interest to the IATME. Papers concerning these problems should be presented to the IATME, discussed by this Association and published under its auspices.

2.1.2. The Commission considers that papers relating to the atmospheric ozone, to the thunderstorms, to the propagation of sound wawes and to their reflexion by the upper atmosphere etc. fall into the domain that interests more directly the IAM. Such papers should be presented to the IAM, discussed by this Association and published under its auspices.

2.1.3. On the other hand the phenomena of the mesosphere will be of interest to both Associations. Problems situated on the borderline between the fields of activity of the two Associations (meteorites, luminous night clouds, wind and turbulence in the mesosphere etc.) should be discussed at joint meetings of the two Associations.

2.2.1. In order to coordinate the activities of the two Associations within the domain of the upper atmospheric physics, and to establish within this domain a fruitful cooperation between them, a joint Committee on the upper atmosphere should be appointed, the members of which should be nominated by the two Associations.

2.2.2. The joint Committee should elect a President and a Secretary, and should have the power to supplement itself by cooptation of new members; the nomination of such members should be approved by the Associations at the following General Assembly.

2.2.3. The joint Committee could be convened by its President to meet at times outside the sessions of the General Assembly of the IUGG, provided that the bureaus of the two Associations have been duly informed of such meetings.

2.2.4. The joint Committee should establish the programme of its activities and organize during the sessions of the General Assembly of the IUGG working meetings on upper atmospheric physics in consultation with the Secretaries of the two Associations.

2.2.5. At each session of the General Assembly of the IUGG, the joint Committee should present to the two Associations a report of its activity during the past triennial period.

2.2.6. The composition of the joint Committee should be revised at each session of the General Assembly it being understood that each retiring member is reeligible.

2.3.1. The papers of the joint Committee should be published in the Transactions of the IAM, of the IATME or of both Associations.

2.3.2. Requests for subventions made by the joint Committee should be presented and supported by the two Associations.

2.4.1. If necessary the statutes of the two Associations should be modified in accordance with paragraphs 2.2.1., 2.2.2., 2.2.3.

2.5.1. The Commission proposes that the actual name "International Association of Terrestrial Magnetism and Electricity" be replaced by the name "International Association of Geomagnetism and Ionospheric Physics". This proposal, however, does not exclude any other suggestion that may be made.

If the Assembly approves the above proposal in principle a decision will have to be taken as to the future name of our Association. In the last paragraph of the proposal the name "Association Internationale de Géomagnétisme et de Physique de l'Ionosphère", "International Association of Geomagnetism and Ionospheric Physics", has been tentatively suggested and such a change of name would necessitate a modification of the first paragraph of the statutes of the Association. The paragraph actually reads:

"L'Association a pour objets :

(1) d'étudier des questions qui concernent le magnétisme et l'électricité terrestres en tant que ces questions exigent la coopération internationale pour en assurer l'étude effective.

(2) ...."

"The objects of the Association are:

(1) The study of questions relating to terrestrial magnetism and electricity in so far as these questions require international cooperation for their effective investigation.

(2) ...."

and in case the above name is adopted the following modified text is submitted for consideration:

"L'Association a pour objets :

(1) d'étudier des questions qui concernent le géomagnétisme et la physique de l'ionosphère (au sens large) en tant que ces questions exigent la coopération internationale pour en assurer l'étude effective.

(2) ...."

"The objects of the Associations are:

(1) The study of questions relating to geomagnetism and ionospheric physics (broadly interpreted) in so far as these questions require international cooperation for their effective investigation.

(2) ...."

It should be noted that any change in the official name of the Association will affect the by-laws of the Union, so that an early decision is required if it is deemed desirable to have the question finally settled at the Rome Assembly.

II

Proposal concerning a change of statutes

In paragraph 5(c) of the by-laws of the IUGG the following rule has been established:

"Le Président de l'Union peut, de sa propre initiative, ou à la demande du Président d'une Association ou d'un Comité national, inviter à assister aux séances de l'Assemblée Générale certaines personnes, soit à titre personnel soit à titre de représentant d'une organisation scientifique. Les personnes invitées ne participent pas aux votes."

"The President of the Union may, on his own initiative or at the request of the President of an Association or at the request of a National Committee, invite representatives of scientific bodies or individuals to attend a General Assembly as guests. Guests will not vote."

In order to bring about conformity with the Union rules on that point it seems necessary to change the wording of paragraph 17 of the statutes of the Association of Terrestrial Magnetism and Electricity. It is suggested that the actual text:

"Avec le consentement du Comité Exécutif, le Président peut inviter comme hôtes des représentants d'institutions ou d'autres personnes intéressées à assister aux séances d'une assemblée générale."

"With the consent of the Executive Committee, the President may invite as guests representatives of institutions or other interested persons to be present at meetings of a general assembly."

be modified into:

"Le Président peut proposer au Président de l'Union d'inviter comme hôtes des représentants d'institutions ou d'autres personnes intéressées à assister aux séances d'une assemblée générale."

"The President may suggest to the President of the Union that representatives of institutions or other interested persons be invited to be present as guests at meetings of a general assembly."

APPENDIX 6

Meetings of the Executive Committee

First meeting

The Executive Committee met on September 14, at 16^h00. The following members were present: Prof. *Coulomb,* Prof. *Bartels,* Prof. *Kaplan,* Dr. *Rayner,* and Mr. *Laursen,* Prof. *Nicolet* was present by invitation in his capacity of Secretary of the Committee on Upper Atmosphere.

The Executive Committee first prepared tentative lists of names to be submitted to the Association as suggested members of the temporary committees of the Rome meeting, namely the Committees on Nomination, on Resolutions and on Budget. Corresponding recommendations were prepared as to the representation of the Association on the Mixed Commission on the Ionosphere and the Mixed Commission on Solar and Terrestrial Relationships.

The possibilities of a simplification of the system of Special Committees within the IATME were thoroughly discussed, and so was a proposal submitted to the Executive Committee by Dr. *F. T. Davies:*

1) That the first open meeting of IATME be asked for proposals for chairmen of committees.
2) That the Nominations Committee *discuss with the chairmen they select* the names of members of committees, then submit their recommendations to open meeting.

As to the publication of the Rome Transactions it was decided to continue the procedure adopted at Brussels in 1951, according to which technical communications should be printed in abstract only.

The Executive Committee finally studied a project submitted by the General Secretary of the Union and aiming at a transformation of some of the Association activities namely the publication of magnetic indices and the comparison of magnetic standards in so-called Permanent Services.

The meeting adjourned at 17^h30.

Second meeting

September 22 at 17^h00

The meeting was attended also by most members of the new Executive Committee. Present were Prof. *Coulomb,* Prof. *Bartels,* Prof. *Nagata* (for Prof. *Hasegawa*), Prof. *Kaplan,* Dr. *Rayner,* Dr. *Roberts,* Prof. *Nicolet,* Prof. *Slaucitajs,* Mr. *Laursen.*

A note had been received from the Secretary of the International Meteorological Association stating that the following had been nominated IAM representatives in the joint Committees with the IATME:

Joint Committee on Upper Atmosphere
W. W. Kellog (U.S.A.)
M. Nicolet (Belgium)
E. Palmén (Finland)
E. Vassy (France)

Joint Committee on Atmospheric Electricity
J. Bricard (France)
H. R. Byers (U.S.A.)
Ross Gunn (U.S.A.)
T. W. Wormell (Great Britain)

In consultation with the Nominations Committee it was recommended that the following be nominated IATME representatives in the same two committees:

Upper Atmosphere
D. Barbier (France)
T. R. Kaiser (Great Britain)
H. E. Newell (U.S.A.)
J. Kaplan (U.S.A.)

Atmospheric Electricity
L. Koenigsfeld (Belgium)
H. Norinder (Sweden)
P. S. Nolan (Ireland)
A. J. Yriberry (Argentine)

The Executive Committee agreed to an arrangement with the IAM that Prof. *Nicolet* be nominated Chairman of the Joint Committee on Upper Atmosphere and that Dr. *L. Koenigsfeld* be nominated Chairman of the Joint Committee on Atmospheric Electricity.

The Executive Committee decided that subject to the consent of the Union the new name of the Association should become effective from the closure of the Rome Assembly.

A draft budget for the period 1/1 1954—31/12 1956 was prepared. This budget was submitted to the plenary session on the 23th September and approved without amendments. Details of the budget are given on p. 62.

The meeting adjourned at 18^h00.

Third meeting

After the final plenary session of the Association the Executive Committee met on the 23th September at 17^h00. Present were Prof. *Coulomb,* Prof. *Kaplan,* Prof. *Bartels,* Dr. *Rayner,* Dr. *Roberts,* Prof. *Nicolet,* Prof. *Slaucitajs* and Mr. *Laursen.*

The resolutions which had just been adopted by the General Assembly were reviewed in order to decide what further action would be required by the Association to carry out the decisions and recommendations laid down in the resolutions.

The meeting adjourned at 17^h45.

Part II

Statutes

Statuts de l'Association de Géomagnétisme et d'Aéronomie de l'Union Géodésique et Géophysique Internationale

I. Objets de l'Association

1. L'Association a pour objets :
   (1) d'étudier des questions qui concernent le géomagnétisme et l'aéronomie en tant que ces questions exigent la coopération internationale pour en assurer l'étude effective ;
   (2) d'encourager l'étude de ces sujets par les différents pays, institutions, ou les particuliers.

II. Membres de l'Association

2. Les pays qui adhèrent à l'Union Géodésique et Géophysique Internationale auront le droit de s'inscrire comme membres de l'Association et de nommer des délégués pour se faire représenter aux réunions de l'Association.

III. Comités Nationaux

3. Avec l'approbation de son Comité National de l'Union Géodésique et Géophysique Internationale, chacun des pays, en devenant membre de l'Association, peut créer un Comité National pour faire progresser les objets de l'Association dans son propre territoire. Ces Comités Nationaux auront le droit de déterminer leur propre constitution et de régler leurs affaires en accord avec ces statuts et ceux de l'Union Géodésique et Géophysique Internationale. Ils auront aussi le droit de nommer des délégués à chaque réunion de l'Association et de soumettre à ces réunions des questions à discuter, pourvu que ces questions soient parvenues au Secrétaire de l'Association au moins quatre mois avant la réunion de l'Assemblée où elles sont à discuter.

4. La correspondance entre un Comité National de l'Association et le Comité Exécutif de l'Association sera conduite par le Comité National local de l'Union Géodésique et Géophysique Internationale.

IV. Administration de l'Association

5. Les travaux de l'Association seront dirigés par l'assemblée générale des délégués choisis par les Comités Nationaux de l'Association.

6. L'Association aura un Comité Exécutif élu par l'assemblée générale.

7. L'intervalle entre la clôture d'une assemblée générale et la clôture de la suivante sera appelé, pour les buts de ces statuts, une période. Le Comité Exécutif comprend le Président, deux Vice-Présidents, le Secrétaire qui est en même temps directeur du Bureau Central de l'Association, cinq autres membres, enfin le Président sortant s'il y en a un.

8. Le Président et les Vice-Présidents sont élus pour une période et rééligibles une seule fois. Le Secrétaire est élu pour deux périodes et rééligible par périodes successives. Les cinq membres additionnels sont élus pour une période et rééligibles par périodes successives. Le Président sortant est membre de droit pour une période seulement.

9. Le Comité Exécutif aura le droit de pourvoir aux vacances qui surviendraient dans son sein pendant l'intervalle entre deux assemblées générales. Toute personne désignée dans ces conditions restera en fonctions jusqu'à l'assemblée générale suivante et sa rééligibilité par conséquent ne sera pas affectée. Si la vacance est celle du Président, le Comité Exécutif nommera un des Vice-Présidents pour le remplacer jusqu'à l'assemblée générale suivante.

10. Le Président présidera toutes les assemblées générales et les séances du Comité Exécutif et, en conférence avec le Secrétaire, réglera les affaires de l'Association entre les assemblées générales.

11. Les Vice-Présidents, l'un ou l'autre, conformément aux dispositions que prendra le Comité Exécutif, présideront les assemblées générales en l'absence du Président.

12. Les fonctions du Secrétaire seront les suivantes : (1) D'expédier toute correspondance relative aux affaires de l'Association ; (2) de recevoir et de gérer les sommes qui peuvent être allouées par l'Union Géodésique et Géophysique Internationale ou d'autre provenance ; (3) de débourser telles sommes conformément aux décisions de l'assemblée générale ou aux instructions du Comité Exécutif ; (4) de tenir le compte de tout l'argent reçu et dépensé et de soumettre ce compte, certifié par un comptable qualifié, à l'examen d'un comité financier nommé à cet effet par l'assemblée générale ; (5) de rédiger et publier les comptes-rendus de l'Association et de procéder à leur distribution selon les directives de l'assemblée générale.

13. Soumis aux directives générales et spéciales de l'assemblée générale, le Comité Exécutif aura le droit : (1) de fixer l'ordre du jour de chaque assemblée générale ; (2) de confier à des commissions spéciales ou à des particuliers la préparation de rapports sur des sujets rentrant dans la compétence de l'Association ; (3) de choisir et de consulter des personnes et des institutions représentatives des pays qui n'adhèrent pas à l'Association, ces personnes ou institutions étant considérées comme membres correspondants de l'Association.

14. Si, pour un motif qui semblerait bon et suffisant, le Comité Exécutif considère nécessaire ou désirable de s'écarter de la décision ou des instructions de l'assemblée générale ou bien de l'interprétation formelle de ces statuts, il en aura le droit pourvu qu'un exposé de l'action réalisée ou non réalisée, appuyé des motifs, soit présenté à l'assemblée générale suivante.

V. Assemblées de l'Association

15. Une assemblée générale ordinaire se tiendra à l'occasion de l'assemblée générale ordinaire de l'Union Géodésique et Géophysique Internationale.

16. Le Président peut, avec l'approbation du Comité Exécutif, convoquer une assemblée générale extraordinaire de l'Association. Il sera tenu de le faire à la demande d'au moins la moitié des voix des pays adhérents à l'Association, exprimée par leurs Comités Nationaux.

17. Le Président peut proposer au Président de l'Union d'inviter comme hôtes des représentants d'institutions ou d'autres personnes intéressées à assister aux séances d'une assemblée générale.

18. Sauf dans le cas de modification de ces statuts ou de questions financières, toutes les questions présentées à une assemblée générale seront décidées à la majorité des voix des délégués. Sur les questions relatives à la modification de ces statuts, chaque pays représenté dans l'assemblée générale aura une voix, laquelle sera donnée par un représentant choisi par les délégués du pays considéré. En ce qui concerne les questions financières, le scrutin se fera selon les statuts de l'Union Géodésique et Géophysique Internationale. Dans tout cas ne concernant pas une modification aux statuts, s'il y a égalité de voix, celle du Président sera prépondérante.

19. L'ordre du jour d'une assemblée générale sera préparé par le Secrétaire et communiqué aux membres de l'assemblée générale au moins trois mois avant l'ouverture de la session. Il y figurera toutes les questions qui auront été soumises par les Comités Nationaux pour être discutées à l'assemblée générale,

avec d'autres questions qui peuvent être mises à l'ordre du jour par le Comité Exécutif. Toute question qui n'a pas été ainsi communiquée ne peut être prise en considération qu'avec l'assentiment de l'assemblée générale.

VI. Budget

20. Le Secrétaire préparera un budget de prévision de recettes et dépenses pour la période comprise entre deux assemblées générales ordinaires successives. Il présentera ce budget au Comité Exécutif au cours des sessions de l'assemblée générale qui précède immédiatement cette période et, après en avoir reçu l'approbation, il peut procéder au déboursement des fonds conformément à cette approbation.

21. A chaque assemblée générale ordinaire, un Comité sera institué pour examiner les comptes et présenter à l'Association un rapport sur les résultats de cet examen.

VII. Interprétation et modification des statuts

22. Le présent texte français servira exclusivement pour l'interprétation à donner à ces statuts.

23. Aucun changement ne pourra y être apporté sauf dans le cas où :

(1) Un pays, par l'intermédiaire de son Comité National, fait savoir son intention de proposer une modification — cette intention ayant été communiquée au Secrétaire au moins six mois avant l'assemblée générale à laquelle la question doit être étudiée.

(2) Le changement reçoit l'approbation d'au moins deux tiers du nombre des pays appartenant à l'Association.

Statutes of the Association of Geomagnetism and Aeronomy of the International Union of Geodesy and Geophysics

I. Objects of the Association

1. The objects of the Association are:

(1) The study of questions relating to geomagnetism and aeronomy in so far as these questions require international cooperation for their effective investigation.

(2) The encouragement of research in the above subjects by individual countries, institutions, or persons.

II. Members of the Association

2. The countries which adhere to the International Union of Geodesy and Geophysics shall be eligible as members of the Association, and may appoint delegates to represent them at meetings of the Association.

III. National Committees

3. With the approval of its National Committee of the International Union of Geodesy and Geophysics, any country becoming a member of the Association may constitute a National Committee for the purpose of furthering the aims of the Association within its territory. Such National Committees shall have power to determine their own constitution and to regulate their own procedure in accordance with these Statutes and the Statutes of the International Union of Geodesy and Geophysics. They have also the right to appoint delegates to each meeting of the Association and to submit subjects for discussion at these meetings, provided that notice of such subjects is received by the Secretary of the Association not less than four months before the meeting of the Assembly at which they are to be discussed.

4. Correspondence between a National Committee of the Association and the Executive Committee of the Association shall be carried on through the local National Committee of the International Union of Geodesy and Geophysics.

IV. Administration of the Association

5. The work of the Association shall be transacted by the general assembly of the delegates appointed by the National Committees of the Association.

6. The Association shall have an Executive Committee elected by the General Assembly.

7. The interval elapsing between the end of one general assembly and the end of the next one, will, for the purpose of the Statutes, be termed one period. The Executive Committee shall consist of the President, two Vice-Presidents, the Secretary who is simultaneously Director of the Central Bureau of the Association, five other members, and the retiring President if there is one.

8. The President and the Vice-Presidents shall be elected for one period and may be reelected once. The Secretary shall be elected for two periods and may be reelected for successive single periods. The five additional members shall be elected for one period and reelected for successive single periods. The retiring President is member ex-officio for only one period.

9. In the event of any vacancy in the Executive Committee occurring in its membership during the interval between two general assemblies, the Executive Committee shall have power to fill the vacancy, such election being valid until the next general assembly, and the eligibility for reelection of the person so elected shall not be affected by such election. Provided that if the vacancy be that of the office of President, the Executive Committee shall appoint one of the Vice-Presidents to act until the next general assembly.

10. The duties of the President are to preside at all general assemblies of the Association and at meetings of the Executive Committee, and, in consultation with the Secretary, to regulate the current business of the Association between general assemblies.

11. It is the duty of the Vice-Presidents, one or other as may be determined by the Executive Committee, to preside at general assemblies in the absence of the President.

12. The duties of the Secretary shall comprise the folloving: (1) To carry on al correspondence relating to the affairs of the Association; (2) to receive and keep charge of such funds as may be allotted by the International Union of Geodesy and Geophysics to the Association, or as may be received from any other source; (3) to disburse such funds in accordance with the decisions of the general assembly or with the instructions of the Executive Committee; (4) to keep the account of all receipts and disbursements and to submit such account, audited by a qualified accountant, for examination by any financial committee appointed for the purpose by the general assembly; (5) to prepare and publish the transactions of the Association, and to arrange for their distribution in accordance with the directions of the general assembly.

13. Subject to the general or special directions of the general assembly, the Executive Committee shall have power: (1) To arrange the agenda of each general assembly; (2) to entrust to special commissions or to particular individuals the preparation of reports on subjects within the province of the Association; (3) to select and consult with persons or representative institutions belonging to countries which are not within the Association, such persons or institutions being deemed corresponding members of the Association.

14. If, for any reasons that may appear to it to be good and sufficient, the Executive Committee considers it necessary or desirable to depart either from the decision or the instructions of the general assembly or from the strict interpretation of these Statutes, it shall have power to do so, provided that a statement of the action taken or not taken, with reasons for the same, shall be laid before the next general assembly.

V. Assemblies of the Association

15. An ordinary general assembly of the Association shall be held in connection with the ordinary general assembly of the International Union of Geodesy and Geophysics.

16. The President may, with the approval of the Executive Committee, call an extraordinary general assembly of the Association. He shall be obliged to do so on the request of not less than one-half of the votes of the countries adhering to the Association, as expressed by their National Committees.

17. The President may suggest to the President of the Union that representatives of institutions or other interested persons be invited to be present as guests at meetings of a general assembly.

18. Except in questions relating to the alteration of these Statutes or to financial questions, all questions before a general assembly shall be decided by the majority of votes of those delegates then present. In questions relating to the alteration of these Statutes, each country represented at a general assembly shall have one vote, to be given by a representative chosen by the delegates from the respective country. In all financial questions, the voting shall be in accordance with the Statutes of the International Union of Geodesy and Geophysics. In all questions not relating to the alteration of these Statutes, if there be an equality of votes, the President has a casting vote in addition to his own deliberative vote.

19. The agenda of a general assembly shall be prepared by the Secretary and circulated to members of the general assembly not less than three months before the opening of the general assembly. It shall include all questions which have been submitted by National Committees for discussion at the general assembly, together with any other questions placed on the agenda by the Executive Committee. Any questions of which notice has not thus been given may only be discussed with the consent of the general assembly.

VI. Budget

20. The Secretary shall prepare, for each period intervening between two successive ordinary general assemblies, a budget estimate of receipts and expenditures during that period. He shall lay this before the Executive Committee during the meetings of the general assembly immediately preceding that period, and, having received its approval, he may proceed with the disbursement of funds in accordance with that approval.

21. At each ordinary general assembly a committee shall be appointed to examine the accounts and to report the results of their examination to the Association.

VII. Interpretation and Alteration of Statutes

22. The French text shall serve exclusively for interpretation of these Statutes.

23. No change may be made in the present Statutes except:

(1) By notice being given by any country, through its National Committee, of its intention to move an alteration, such notice being given to the Secretary not less than six months before the general assembly at which it is intended to be discussed.

(2) By the approval of at least two-thirds of the number of countries included in the Association.

Part III

National Reports

ARGENTINA

National Report on Geomagnetism and Atmospheric Electricity

I. — Geomagnetism.

A. The Servicio Meteorológico Nacional has carried out the following activities:

a) Field work. During the reference period 90 stations were surveyed completely, 36 of which were occupied for the first time, the remaining 54 being repeat stations, some of which were occupied for the fifth time; the distribution by years is as follows:

Years	1951	1952	1953	1954	Total
new stations	6	12	14	4	36
repeat stations	1	28	19	6	54
Total	7	40	33	10	90

At all stations a full set of magnetic measurements was taken, comprising D, H and I; at about 10 % of the stations daily variations were determined.

b) Observatory work. Routine work was continued at the Pilar, La Quiaca and Orcadas Observatories. Work at Pilar was interrupted on the 21st of November 1951 by a heavy storm which destroyed the major part of the installations and equipment. Nevertheless absolute observations could be reassumed after only ten days, and about the middle of 1953 photographic recordings were taken up again. The absolute instruments which were badly damaged could be repaired completely in the workshop of the S.M.N., and it is expected that they will be in operation very soon. Plans for rebuilding the Pilar Observatory on its old site are well under way; it is hoped that every feature of modern observatory technique can be incorporated in the new observatory.

Although no new observatories were installed a special 9 months program of observations was run on Deception Island

(Antártida Argentina) from April to December, 1951, comprising periodical absolute observations, measurements of daily variations in D, H, and I during selected days, as well as a general survey of the Island covering 6 points.

c) Equipment. Beside the complete repair of the Pilar absolute instruments (one Kew magnetometer, earth inductor and Eschenhagen galvanoscope) three quartz fibre magnetometers of the Q.H.M. type were built and it is hoped that they can be in operation within two months.

d) Publications. In "Meteoros" of July 1951, a paper was published on a new method for reducing field observations; this procedure is being used in reducing the data for the magnetic maps of the Argentine Republic. In December 1951 magnetic data for the Orcadas observatory were published for international quiet and disturbed days of two typical years of different solar activity, as well as monthly and yearly summaries. In the second 1954 issue of "Meteoros" a summary of the above mentioned observations from Deception Island will be published. Complete magnetic data from Pilar covering the period 1940 to 1949 have been processed for publication and it is expected that they can be released late in 1954.

B. The Astronomical Observatory of the University of Eva Perón (La Plata) has been active as follows:

1) *Field work on the continent.* During the second half of 1951, determinations of D, H and I were made at three secular stations in the Province of Buenos Aires, paying special attention to the rapid change focus of H near Bahia Blanca City. During 1952 seven points were surveyed paying attention specially to rapid Z variations. Five of these points were in Patagonia and Tierra del Fuego, one near Bahia Blanca and one near Eva Perón City. In 1953, 12 stations in the central and northern parts of Argentina were surveyed taking D, H, and Z values. Some of these were repeat stations.

2) *Antarctic activities.* During the summer of 1953—54 a special Commission was sent to the Argentina Antarctic Sector where D, H, and Z measurements were made at 8 new stations and 4 reoccupations, including one surveyed by *O. Nordenskjöld* in 1901—03. Fourteen auxiliary points were also surveyed with H and Z readings. In all this work Danish QHM and BMZ instruments were used successfully.

3) *New station.* Plans are being matured for the establishment of the proposed geophysical observatory (including a magnetic section) near Lake Viedma (50° S, 72° W). Two complete sets of Ruska variometers and recorders are already at hand for that installation.

II. — Atmospheric Electricity.

A. Activities of the Servicio Meteorológico Nacional:

At the present time the following stations are carrying out work on atmospheric electricity with equipment slightly varying in each case: Buenos Aires, Pilar (Córdoba), Mendoza, Tucumán and La Quiaca; the head office of the Section of Atmospheric Electricity is located at the Buenos Aires Observatory.

As this is the first report on atmospheric electricity in Argentina a brief account of earlier work will be given for each station.

Observatorio Geofísico de Pilar:

Latitude: 31° 40′ 08″ S.
Longitude: 63° 53′ 00″ W.G.
height above sea level: 338 m.

It is located on the right bank of the Río Segundo, in plain territory close to the Sierras de Córdoba.

Routine observations of the electrical potential with photographic recording have been made at this observatory since 1924. A water collector was used until 1938 and was afterwards replaced by a radioactive collector. For observations of the ion content of the air a wooden shelter is available, built in accordance with the ancient Observatorio del Ebro type which permits observations at a height of about one meter. An Elster and Geitel equipment for obtaining the coefficient of electrical dissipation has been in operation since 1924; an Ebert ion aspirator for obtaining the number and mobility of ions and the conductivity has been in use since 1928. Up to 1938 one daily observation of air ionization was made at eleven o'clock Mean Local Time. Beginning in 1940 observations were taken at 8, 10, 12, 14 and 16 o'clock Mean Meridian Time, 60° W., and beginning in 1952 the daily schedule of observations was changed to 4, 8, 12, 16, 20 and 24 o'clock Mean Meridian Time, 60° W.

Observatorio Central Buenos Aires:

Latitude: 34° 35′ 30″ S.
Longitude: 58° 29′ 00″ W.G.
height above sea level: 25 m.

Although it is situated in an urban district general conditions for observation are fairly satisfactory as it is surrounded by a large park belonging to the Faculty of Agronomy and Veterinary Sciences.

Since 1941 an Elster and Geitel equipment for atmospheric dissipation, an Ebert ion counter, and a Gerdien conductivity meter are in operation in a shelter similar to the one used at Pilar. Until 1950 daily observations were taken at 8, 10, 12, 14 and 16 o'clock Mean Meridian Time, 60° W. Later on the schedule was changed to cover the 24 hour interval with six observations.

Observatorio de Mendoza:

Latitude: 32° 54′ 18″ S.
Longitude: 68° 51′ 51″ W.G.
height above sea level: 827 m.

Situated in the San Martin Park in the city of Mendoza it is in operation since 1952 utilizing an Elster and Geitel dissipation equipment and an Ebert ion counter installed in an Ebro type shelter. Readings are taken at 8, 12, and 16 o'clock Mean Meridian Time, 60° W.

Observatorio de Tucumán:

Latitude: 26° 48′ S.
Longitude: 65° 12′ W.G.
height above sea level: 481 m.

The observatory is located far from the populated area, close to the Experimental Field of the School of Agriculture. Work was taken up in 1952 with an Elster and Geitel equipment and an Ebert ion counter. Readings are taken at 8, 12 and 16 o'clock Mean Meridian Time, 60° W.

Observatorio de La Quiaca:

Latitude: 22° 06′ 10″ S.
Longitude: 65° 36′ 16″ W.G.
height above sea level: 3458 m.

Same period, equipment and observations as Tucumán and Mendoza.

At all observatories additional observations of atmospheric nuclei were made by means of Aitken counters. A summary of the Pilar electrical observations was given in two publications, issued in 1952 and 1953, covering the periods from 1924 to 1936 and 1937 to 1950, respectively. In these papers a tentative procedure for processing atmospheric potential data is described.

Steps have been taken to install shelters for recorders of the electrical properties of the air at Buenos Aires and Pilar. These shelters will be ready for use in a near future. Five quadrant electrometers are available for installation at Buenos Aires, and the lay-out is being prepared for putting them in operation. Photographic recorders will be used and it is planned to include observations of medium and heavy ions. Similar observations are expected to start at Pilar Observatory within a short time.

B. The Observatorio de Física Cósmica de San Miguel put in operation in June 1951 its new Geoelectric Section where continuous automatic records are being made since then of the following elements:

1 — Fair weather atmospheric potential gradient
2 — Conductivity of the air (Gerdien method)
3 — Light ion density (2 counters Ebert type)
4 — Large ion density (one counter alternates positive and negative readings)
5 — Stormy weather electric field and lightning analyzing recorder
6 — Total lightning activity recorder (Records are available since 1950)
7 — Aitken nucleus counts (manual, once a day)

Results of items n° 1, 2, 3, 4, and 7 are published regularly in the Boletin Mensual of the Observatory which tries to distribute information within the year. A special Memoir giving all details of this section has also been published at the end of 1952.

During the summers of 1951—52 and 1953—54 special studies of lightning and other atmospheric electric elements were made with portable recording fieldmills, conductivity apparatus and ion counters, in the mountains (23° 50′ S — 66° 05′ W.G.) at 3500 m. height in a region remarkable for its severe lightning storms.

C. Atmospherics. The Servicio Meteorológico Nacional has installed a net of three stations, one near Buenos Aires (at San Miguel Observatory), one in Córdoba City and one in Bahía Blanca City. At each station there is a direction finder, a maximum field strength recorder and an average "spherics" number recorder. All instruments are Lugeon type. During 1952 the equipment was run experimentally and since 1953 it operates regularly. Although these instruments are planned and used principally for weather forecasting they may be useful for some other atmospheric electric research programs.

III. — Earth Currents.

These have been recorded regularly at the San Miguel Observatory since 1950 and results of the N—S and E—W readings giving hourly values, type of curves, etc. are published regularly in its Boletín Mensual. Description of layout and instruments has been reported in the Memoir n° 1, La Sección Geoeléctrica. Some other short time studies have been made with portable recording instruments at other points but those results are not yet published.

IV. — Ionosphere.

The Argentine Navy has been making hourly ionosphere observations since the middle of 1950 in Buenos Aires. In the Argentine Antarctic Sector, at Decepción (63.0° S — 60.7° W.G.)

observations were made during the first half of 1951, and since the beginning of 1952 this service is continuous. Equipment is as follows: At Buenos Aires two automatic recorders, observations made hourly, 1 to 25 Mc automatic sweep in 30 seconds. At Decepción, hourly observations, 1.5 to 16 Mc manual sweep in 15 minutes. New semi-automatic equipment is being prepared for Decepción which will be ready for the next southern summer. Two more stations are planned, one in the northern part of Argentina (about 23° S. Lat.) and the other intermediate between Buenos Aires and Decepción (about 50° S. Lat.). Observations are sent to the U.R.S.I. and regularly published and distributed to interested parties. Although the actual program contemplates only radio propagation forecast, the stations are ready to cooperate in special geophysical projects if required.

V. — Cosmic Radiation.

The Observatorio de Física Cósmica de San Miguel has had the following equipment in service during the summers of 1952—53 and 1953—54 in one of the ships of the Argentine Antarctic Research Expeditions. One three point cosmic shower coincidence recorder and two, 3 coincidence, anticoincidence shielded telescopes for cosmic activity recording. Continuous records were made those summers since the ship left port, covering latitudes between 35° and 68° S. The same equipment was sent on a trip to Northern Europe with continuous recording on the way over and back.

This same Observatory is preparing a Wilson non-magnetic cloud chamber for automatic observations in a temperature regulated chamber, controlled by coincidence and anticoincidence Geiger-Müller tubes. The unit is planned for automatic recording of various cosmic ray activity determinations and it is hoped to have it ready for operation before the middle of 1955. More equipment could be prepared if required for the International Geophysical Year.

The Atomic Energy Commission and the Universidad de Cuyo have also been active in various cosmic ray investigations in different parts of the country.

VI. — Papers published.

A. By the Servicio Meteorológico Nacional:

Otto Schneider. — Acerca de la variación geomagnética de días tranquilos, en Pilar ; en "Meteoros" ; año II, n° 3—4, pág. 149—166.

Otto Schneider. — Rastros de un efecto lunar no eliminado en los índices k de actividad geomagnética ; en "Meteoros" ; año III, n° 2—3, pág. 135—140.

Carlos A. Martinoli. — Nuevo método para la determinación de la relación de capacidades eléctricas en el aspirador Gerdien ; en "Meteoros" ; año III, n° 4, pág. 429—433.

Resumen y Análisis de observaciones de Electricidad Atmosférica, (Pilar), años 1924—1936 ; Publicación de la Dirección General del Servicio Meteorológico Nacional ; Serie B ; 2a. Sección, 3a. Parte, n° 1, Buenos Aires, 1952.
Resumen y Análisis de observaciones de Electricidad Atmosférica, (Pilar), años 1937—1950 ; Publicación de la Dirección General del Servicio Meteorológico Nacional ; Serie B ; 2a. Sección, 3a. Parte, n° 2, Buenos Aires, 1953.
Datos climatológicos y geomagnéticos, Islas Orcadas del Sur, Período 1903—1950 ; Publicación de la Dirección General del Servicio Meteorológico Nacional ; Serie B ; 1a. Sección, 1a. Parte, n° 11, Buenos Aires, 1951.

B. By the Astronomical Observatory of the Universidad de Eva Perón (La Plata):

Leónidas Slaucitajs. — La observación del campo geomagnético ; Publ. Observatorio Astronómica La Plata ; Ser. espec. 13, La Plata, 1951.
Leónidas Slaucitajs. — Resumen de las investigaciones geomagnéticas efectuadas en la Antártida Argentina en el año 1951 ; Mem. I Congreso Nacional de Cartografía, Buenos Aires, 1952.
Leónidas Slaucitajs. — La variación secular geomagnética ; Rev. Cart. 1, Buenos Aires, 1952.
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C. By the Observatorio de Física Cósmica de San Miguel:

A. J. Yriberry. — Memoria n° 1, La Sección Geoeléctrica, Observatorio de Física Cósmica de San Miguel, 1952.
A. J. Yriberry. — Registro del campo electrostático tormentoso en San Miguel y en Kew ; Acta Scientifica, Observatorio de Física Cósmica, Cuaderno n° 2, 1954.

AUSTRALIA

Report presented by the Australian National Committee. I.A.T.M.E.

PART I

Report on geomagnetic variations and upper atmosphere research

(1) *Administration.*

Work on the ionosphere is carried out mainly by the permanent staff of the Radio Research Board, and by University and Government Departments associated with the Board, particularly The Ionospheric Prediction Service of the Commonwealth Observatory.

(2) *Ionosphere Research in Australia 1952—54.*

In this section is outlined the scope of the ionospheric researches at present being conducted in Australia. A detailed bibliography follows, (§ 3).

Ionospheric Winds.

The study of winds, or moving irregularities in the ionosphere continues. At the University of Adelaide a particularly powerful method of measuring winds in the lower ionosphere, by means of radar echoes from meteor trails, is now in regular operation. It seems likely that the results obtained by this method (for the lower ionosphere) will be free from the difficulties of interpretation which accompany other methods of observation in higher regions. Work continues, at Sydney, Brisbane, and Perth, on travelling F2 region irregularities.

As a result of these investigations, taken in conjunction with measurements in other countries, the rough outlines of the world pattern of ionospheric drift has now emerged.

In the F region at moderate latitudes ($>$ 40° geomagnetic) movement is towards the east by day, and to the west by night: In summer, by day, the movement of irregularities is predominantly towards the poles; in winter, by day, towards the equator.

It has been shown that many of the complex patterns obtained occasionally on ionospheric P′-f records are simply ascribable to a horizontally moving corrugation or bulge in the ionisation contours of the F2 region.

In Tasmania Z echoes have been subjected to accurate direction-finding, and it has been established that they occur when a rugosity on the surface of the F2 region permits the incident ray to travel along the direction of the geomagnetic field. This interesting result may throw light on a long-standing controversial issue — the origin of the second echo sometimes received from the F2 region at frequencies *below* the gyro-frequency. (cf. Martyn & Munro: Terr. Mag; p. 1, March 1939). These authors had argued that such echoes must travel along the geomagnetic field; Ellis' observations of higher frequencies show that corrugations on the surface of the F2 region make this possible.

Extensive work has been done on the "dynamo theory" of the magnetic variations. In a series of papers the fundamentals of Balfour Stewart's theory, as developed quantitatively by Schuster and Chapman, have been examined afresh. It has been found that the Hall conductivity is vitally important, and that the polarization set up by Hall current increases the effective conductivity substantially above the "Pedersen" conductivity, so permitting quantitative reconciliation of the known wind velocities and ionisation densities in the ionosphere with the requirements of Stewart's theory, as propounded qualitatively some 70 years ago. It must be almost unprecedented for a theory to endure so many vicissitudes as has the "dynamo theory". Whereas several discoveries in atmospheric physics might have seemed to establish the theory, each has been followed by one which created fresh difficulties. At this juncture, when the matter again seems to be settled in favour, it is interesting to recall that Balfour Stewart's interest in physics was first aroused nearly a century ago, when he made a voyage to Australia, in the employ of a Scottish mercantile company, and that he published his first paper in Australia.

An important by-product of the recent development of Stewart's theory is that there should exist, near the magnetic equators, a narrow ionospheric belt, some hundreds of miles wide, possessed of exceptionally high conductivity. This accounts for the existence of the equatorial "electro-jet", a phenomenon unknown to Stewart.

The above work has been extended to include detailed calculations of the horizontal and vertical drift of ionisation in the ionosphere, under the influence either of air winds or of electric fields. It has been emphasized on many occasions (e.g. Martyn. Proc. Ion. Conf. Pennsylvania 1950) that the observed movements of ionisation in the ionosphere do not necessarily indicate the atmospheric wind vector. An attempt was made to lay the foundations of the theory of the relations between horizontal winds (or electric fields), and the resulting motions of distinguishable patches of ionisation. It is found that the motion of a "blob" of ionisation which differed in density from the surrounding medium had certain peculiarities, if Hall conductivity were important, and it seems unlikely that such "blobs", embedded in a medium of this type, will have stability of motion. Besides being important for the interpretation of measured "winds" in the ionosphere these findings may be significant for the theory of the production of "sporadic E" ionisation.

Considerable work has been done on the morphology of ionospheric disturbance, particularly in the F2 region, which is specially susceptible. In this work the methods developed by geomagneticians, such as Chapman, for the study of geomagnetic storms, were largely followed. At an early stage however an important departure from geomagnetic practice was adopted. Magnetic storms start abruptly and simultaneously all over the earth; ionospheric storms begin gradually, and it is difficult to assess the initial instant or zero of "storm-time". Preliminary studies had suggested that all or nearly all ionospheric storms were accompanied by magnetic storms. "Storm-time, ionospheric" was tentatively measured from the "commencement" of the accompanying magnetic storm, if this were "sudden". This method of timing proved highly successful, and showed immediately that ionospheric storms started certainly within an hour of the *magnetic* storm "sudden commencement", and possibly within minutes of the latter. This discovery was surprising, in view of the impression which had gained currency during the War that ionospheric storms occurred independently of magnetic storms, and that they first appeared near the auroral zones, and moved, (like migratory cyclones) to lower latitudes. All the Australian results are opposed to the latter view, and lead to the almost inevitable conclusion that ionospheric storms, like geomagnetic storms, have a unitary character, and develop almost simultaneously with the magnetic storm over the whole earth. During the recent "Symposium on Ionospheric Storms" in Japan it became clear that Japan's radio-scientists are currently of a like opinion, but it would be well to point out that these views are not necessarily accepted in other countries at the present time.

Another important discovery, which ensued from a direct following of the statistical methods earlier developed by geomagneticians, was that the solar diurnal. (SD) component of ionospheric storms was exceptionally large in proportion to the storm-time (Dst) component, and that SD was fully developed in a time less than one hour after the geomagnetic "sudden commencement". The SD and Dst components of ionospheric storms have now been derived for some nine representative latitudes, ranging from Clyde (completely within the auroral zone) to Huancayo, very near the magnetic equator, and for the three seasons. The results of this work are at present being applied to the practical forecasting of the best operating circuits from time to time during the course of the storm.

In addition a theory of ionospheric storms has been developed. This starts from the novel viewpoint that such storms do *not* arise from local bombardment by solar particles, but are due to the presence throughout the ionosphere of an electrostatic field created by the intense currents in the auroral zones. The field which almost necessarily accompanies these currents is found to have the amplitude and form required to produce not only SD (ionospheric), but also SD (geomagnetic) by causing currents to flow in the F2 and lower (E) ionosphere, respectively. Tentatively, the view is held that Dst (ionospheric) is simply a necessary accompaniment of the disturbance produced in the F2 region by SD (ionospheric), and is *not* due, as probably is Dst (geomagnetic), to a separate current system lying outside the earth's atmosphere. No evidence is found which would support classification of ionospheric storms, by latitude, as of "positive" or "negative" initial phase. The occurrence of such phases in particular storms appears almost certainly to depend on the local time of commencement, the curve of Δ f°F2 beginning almost immediately to follow the course of the SD curve appropriate to the latitude, local time, and season, at a given locality.

F2 Region Anomalies.

Much work has been done on the elucidation of the morphology of the F2 region and its time variations. It is believed that the main features of the seasonal, geomagnetic, and sunspot control of this region are now fairly well known.

In parallel with this investigation the "drift" theory has been extended and applied, in a detailed quantitative attempt to account for the peculiarities of F2 region behaviour. Earlier attempts to apply the theory had been only partially successful. It is now realized that the principal hindrance was imperfect understanding and knowledge of the horizontal polarization field associated with the production of the main current system in the "dynamo" region, which lies in or near the E region. This field controls the drift in the F2 region, and is therefore mainly responsible for the F2 anomalies. As a result of the "dynamo" investigation earlier described it is now realized that the polarization field in the dynamo region is very different in form and magnitude from that earlier deduced by Schuster and by Chapman, who took no account of Hall conductivity in developing Stewart's theory. The resulting changes in field pattern and magnitude appear to have removed the major difficulties formerly encountered in applying the "drift" theory to interpret the F2 region; at the time of writing all major F2 anomalies appear quantitatively explicable by the drift theory. This work will be presented during August and September this year at the various meetings of U.R.S.I., the Mixed Commission on the Ionosphere, I.U.G.G. and at the "Physics of the Ionosphere" conference to be conducted by the Physical Society of London, at Cambridge. Various detailed applications of the "drift theory", in its earlier form, have been made (see Bibliography below). These have helped to draw attention to both the adequacies and inadequacies of the drift theory in its older form, and have thrown light on the relative importance of the various factors such as recombination, ion production, drift, and their height gradients.

Meteoric Dust, Noctilucent Clouds, and Rainfall.

Pre-war work in Australia had shown that in certain seasons there appeared to be a correlation between the day to day variations of ionospheric parameters and the meteorological conditions at the ground. In the past year an attempt has been made to correlate meteor showers with world-wide days of exceptional rainfall, and with the occurrence of noctilucent clouds. The correlation of the latter occurrences with meteor showers, first suggested by Vestine, now seems certain. Later work (see Bibliography) has cast doubts on the validity of a suggested correlation between meteor showers and world-wide days of excessive rain, and also on the reality of the existence of such days.

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PART II

Statement of magnetic surveys in Australia and Sub-Antarctic Islands 1951—1953

by *L. S. Prior*

Abstract

This report summarises the activities of the Geophysical Section of the Bureau of Mineral Resources, Geology and Geophysics of the Department of National Development in so far as the magnetic secular variation at stations under its control is concerned. It is a continuation of previous reports submitted to the International Union of Geodesy and Geophysics, the last of which covered activities during the years 1948—51.

Absolute field observations.

A programme has been drawn up for the re-occupation and/or establishment of some 500 absolute magnetic field stations throughout Australia and its dependencies. During 1952, part of this programme was carried out and the stations re-occupied or established are listed in Appendix 1. Of the 48 stations at which observations were made 29 were in Tasmania and the remaining 19 selected around the border of the Australian mainland. In Tasmania, 18 completely new stations were established, the remainder being proximate or close re-occupations of previous C.I.W. stations. On the continent 7 new stations were created while 12 were exact or close re-occupations of stations previously established by C.I.W. or North Australian Surveys.

It is intended to commence a re-survey of Victoria shortly when it is expected that between 30 and 40 stations will be either established or re-occupied. The survey will then be extended through New South Wales and Queensland. Consideration is also being given to a re-survey of C.I.W. stations on the Canning Stock Route in Western Australia.

Magnetic maps of Australia.

As a result of the above survey an isogonic map of Australia for epoch 1955.5 was prepared. The main points to note about this map, when compared with the previous one produced for epoch 1950.5 are:

(i) That the declination over Tasmania is from two-thirds to three-quarters of a degree more easterly than would have been expected from the 1950.5 map.

(ii) The annual rate of change of declination over the south-eastern part of Australia shows an increased positive or easterly value.

(iii) The annual rate of change of declination over the north-western part of the mainland now shows a small negative or westerly value instead of the small positive value shown in previous years.

Magnetic maps of Tasmania for declination, horizontal intensity and inclination are in course of preparation.

Magnetic observatories.

Magnetic observatories at Watheroo (Lat. 30° 19′ S, Long. 115° 53′ E) and Toolangi (Lat. 37° 32′ S, Long. 145° 28′ E) have been maintained and all observations carried out to ensure adequate base line and temperature control of variometers. Intercomparisons of absolute equipment at these observatories have been made with C.I.W. Magnetometer No 18 and with QHM's on world circuit.

Magnetic observatories at Heard Island (Lat. 53° 02′ S, Long. 73° 22′ E) and Macquarie Island (Lat. 54° 30′ S, Long. 158° 57′ E) have been established on full-time basis and since March 1952 continuous recording of the earth's magnetic field and requisite instrumental control have been maintained.

An observer has accompanied the Australian National Antarctic Research Expedition to the Antarctic continent and he will set up an absolute magnetic field station during the ship's stay in Antarctic waters. Provision has been made for declination observations to be taken with a compass-theodolite by a member of the party during sledging trips to be undertaken in the next year. A search will also be made for a site suitable for the establishment of a magnetic observatory.

A site suitable for the establishment of a magnetic observatory in New Guinea has been found about eight miles south-east of Port Moresby. Negotiations are now taking place for the acquisition of the land and it is hoped to commence regular absolute observations during 1954.

Since September 1952 the Department of National Development has been issuing each month the "Geophysical Observatory Report" containing magnetic disturbance indices and preliminary mean monthly values of the magnetic elements reported from the observatories under its control. The report is distributed to 100 collaborating observatories and institutions.

In Appendix 2 are listed:

Provisional Values of the Magnetic Elements for Watheroo 1951—52—53.
Provisional Values of the Magnetic Elements for Toolangi 1951—52—53.
Absolute observations made at Heard Island 1951—52.
Absolute observations made at Isles de Kerguelen 1952.
Final Values of the Magnetic Elements at Heard Island 1952.
Provisional Values of the Magnetic Elements at Heard Island 1953.
Final Values of Declination at Macquarie Island 1952.
Provisional Values of Horizontal Intensity and Vertical Intensity at Macquarie Island 1952.
Provisional Values of the Magnetic Elements at Macquarie Island 1953.

Aeromagnetic surveys.

During the report period, approximately 24.000 sq. miles of the continent have been surveyed magnetically from the air. This area is made up of seven smaller areas ranging from 1.000 sq. miles to 9.000 sq. miles. Only changes in total force have been measured so far, but steps are being taken to develop a technique to determine three components of the field intensity during flight.

Reports issued.

"Geophysical Observatory Report" issued at monthly intervals.
Observations of Terrestrial Magnetism at Heard, Kerguelen and Macquarie Islands 1947—48 — N. G. Chamberlain.
A Provisional Isogonic Map of Australia and New Guinea — F. W. Wood and I. B. Everingham.
Magnetic Observations at Heard, Kerguelen and Macquarie Islands 1947—51 — F. Jacka (Australian National Antarctic Research Expedition).

Reports in preparation.

Magnetic Results from Heard Island 1952 — L. N. Ingall.
Magnetic Results from Macquarie Island 1952—P. M.Mc Gregor.

APPENDIX 1

Field magnetic observations, 1952

Name of Station	Latitude	Longitude	Date	Declination		Horizontal Intensity		Inclination		Remarks
				L.M.T.	Value	L.M.T.	Value	L M.T.	Value	
	° ′	° ′	1952	h m	° ′	h m	Gammas	h m	° ′	
Hobart "E", Tasmania.	42 52.2S	147 19E	March 7					16 58	—72 02.1	New station. Proximate reoccupation of C. I. W. station A, B, C & D only.
			„ 8	11 05	+11 41.8	12 30	19425			
				15 01	+11 46.8	14 34	19431			
Southport "A", Tasmania.	43 25.9	146 57	„ 10	11 22	+13 17.9	12 06	18447	10 35	—72 55.6	Close reoccupation of C.I.W. station 1914, 1923.
				14 31	+13 24.1	14 03	18472	15 17	—72 53.0	
Hastings Caves, Tasmania.	43 25.0	146 53	„ 11	14 54	+11 24.2	12 05	18837	13 50	—72 37.5	New station. Established check on Southport which is disturbed.
			„ 12	12 43	+11 18.9	15 26	18883	14 00	—72 37.2	
National Park, Tasmania.	42 41.7	146 44	„ 18	14 28	+11 28.0	14 59	19376	11 00	—72 10.1	New station.
				17 24	+11 26.1	16 57	19386			
			„ 19					09 32	—72 09.3	
Dee Bridge "B", Tasmania.	42 17.2	146 35	„ 20	09 22	+13 48.4	09 53	20020	12 20	—71 09.8	Practical reoccupation of C.I.W. station of 1914.
				11 31	+13 53.0	11 03	20018	16 50	—71 08.9	
Derwent Bridge, Tasmania.	42 09.0	146 14	„ 24	15 17	+11 27.1	15 52	19742	10 45	—71 41.3	New station.
				17 34	+11 20.5	17 08	19761	14 25	—71 43.0	
Gormanston, Tasmania.	42 04.2	145 37	„ 27	14 03	+11 05.0	14 47	19789	10 26	—71 47.3	New station.
				16 07	+11 04.2	15 42	19785	17 34	—71 46.6	
Strahan "B", Tasmania.	42 19.6	145 21	April 1	13 19	+11 08.5	13 47	19662	17 12	—71 51.7	Proximate reoccupation of C.I.W. station 1914.
				15 39	+11 10.8	14 58	19674	17 25	—71 52.5	
Caveside, Tasmania.	41 36.5	146 25	„ 3	13 42	+11 10.6	14 20	20032	11 29	—71 21.0	New station.
				16 07	+11 17.3	15 35	20053	17 12	—71 18.5	

Name of Station	Latitude	Longitude	Date	Declination		Horizontal Intensity		Inclination		Remarks
				L.M.T.	Value	L.M.T.	Value	L.M.T.	Value	
	° ′	° ′	1952	h m	° ′	h m	Gammas	h m	° ′	
Latrobe,	41 15.3S	146 24E	April 7	10 41	+11 25.4	11 13	20316	09 51	—71 06.9	Proximate reoccupation of C.I.W. station 1914 & 1923.
Tasmania.				12 45	+11 28.7	12 19	20329	13 58	—71 03.2	
Guildford Junction,	41 25.6	145 41	„ 10	13 47	+11 19.1	14 27	20059	11 32	—71 21.9	New station.
Tasmania.				15 20	+11 15.1	15 40	20093	15 54	—71 20.3	
Corinna,	41 39.5	145 04	„ 11	17 11	+10 30.1	11 29	19991			New station.
Tasmania.						15 57	20026			
			„ 12	11 01	+10 30.3			10 25	—71 24.0	
								12 28	—71 23.6	
Rockey Cape,	40 52.4	145 31	„ 15	14 59	+10 35.4	14 24	20574	11 48	—70 46.2	New station.
Tasmania.			„ 16	12 22	+10 31.8	15 52	20577	14 07	—70 45.7	
Marrawah,	40 54.6	144 38	„ 17	14 10	+10 28.3	14 44	20443	13 26	—70 55.3	New station.
Tasmania.				16 21	+10 24.8	15 52	20440	16 53	—70 53.4	
Langford,	41 35.9	147 06	„ 21	13 26	+11 29.1	14 00	20112	11 53	—71 12.3	Close reoccupation of C.I.W. station of 1913, 1925 & 1936.
Tasmania.				15 30	+11 29.0	15 04	20121	16 02	—71 12.7	
Bridport,	41 01.4	147 24	„ 23	11 42	+11 35.4	14 09	20638	10 58	—70 41.0	New station.
Tasmania.				15 50	+11 39.3	15 20	20662	16 29	—70 40.5	
Gladstone "B",	40 58.1	148 00.7	„ 25	09 55	+11 41.9	10 25	20729	09 03	—70 32.0	Proximate reoccupation 1/4 mile east of C.I.W. station of 1914.
Tasmania.				11 45	+11 43.0	11 32	20727	13 32	—70 32.0	
Scamander "C",	41 28.1	148 16	„ 27	15 45	+12 00.7	16 14	20431	14 21	—70 52.9	Practical reoccupation of C.I.W. station of 1914.
Tasmania.			„ 28	10 26	+11 52.8	09 59	20440	11 11	—70 52.8	
Douglas River,	41 47.3	148 15.6	„ 29	16 56	+11 55.2			16 00	—71 12.8	New station.
Tasmania.			May 1	11 37	+11 48.2	10 22	20109	13 07	—71 13.3	
						11 14	20102			

Name of Station	Latitude	Longitude	Date	Declination		Horizontal Intensity		Inclination		Remarks
				L.M.T.	Value	L.M.T.	Value	L.M.T.	Value	
	° ′	° ′	1952	h m	° ′	h m	Gammas	h m	° ′	
Coles Bay, Tasmania.	42 08.6S	148 19E	May 3	10 36 14 52	+11 59.0 +12 00.8	11 07 14 20	20000 20042	15 46 16 59	—71 23.0 —71 22.3	New station.
Campbell Town, Tasmania.	41 56.3	147 30	„ 5	10 21 13 53	+11 44.6 +11 47.4	10 52 13 26	20013 20069	09 39 14 31	—71 30.2 —71 27.4	New station.
Conara Jnctn. Tasmania.	41 50.3	147 26	„ 6	10 29 14 35	+12 23.1 +12 25.4	13 03 14 07	20381 20376	09 41 15 16	—71 02.3 —71 03.2	New station.
Oatlands "B", Tasmania.	42 18.6	147 23	„ 8	13 21 15 25	+11 36.2 +11 32.9	13 51 14 57	19671 19713	11 29 16 41	—71 42.5 —71 41.6	New station. Proximate reoccupation of C.I.W. station of 1914.
Interlaken, Tasmania.	42 09.1	147 10.2	„ 10	11 12 12 56	+11 37.2 +11 39.3	11 50 12 35	19643 19648	11 17 14 39	—71 48.0 —71 46.5	New station.
Triabunna, Tasmania.	42 30.5	147 56	„ 13	10 45 12 47	+12 17.5 +12 22.0	11 18 12 21	19668 19666	11 20 14 55	—71 48.4 —71 48.3	New station.
Sorrell, Tasmania.	42 47.2	147 34	„ 14	14 24 16 12	+14 07.3 +14 05.7	14 54 15 50	19352 19350	09 36 13 45	—72 06.8 —72 07.6	Close reoccupation of 1936 station.
Stromlea, Tasmania.	43 10.6	147 45	„ 16	13 16 15 08	+11 48.9 +11 51.0	13 46 14 42	19444 19456	11 30 15 52	—71 57.5 —71 57.4	New station.
Eaglehawk Nook, Tasmania.	43 01.2	147 56	„ 17	12 57 14 35	+12 27.1 +12 28.6	13 24 14 12	19368 19375	11 19 15 18	—72 06.3 —72 06.1	New station.
Cox's Bight, Tasmania.	43 29.7	146 13	„ 23	12 54	+11 35.7	13 24	18893	11 33	—72 40.1	New station.
Amberley, Queensland.	27 39.2	152 44	July 15	11 18 14 57	+09 41.8 +09 43.5	13 46 14 36	29411 29437	10 47 15 50	—57 27.9 —57 21.2	New station.

Name of Station	Latitude	Longitude	Date	Declination		Horizontal Intensity		Inclination		Remarks
				L.M.T.	Value	L.M.T.	Value	L.M.T.	Value	
	° ′	° ′	1952	h m	° ′	h m	Gammas	h m	° ′	
Brisbane, Queensland.	27 31.1S	153 09E	July 18	11 14	+09 46.8	13 41	29513	10 28	—57 02.6	Reoccupation of 1944 station.
				15 38	+09 49.5	15 04	29510	16 26	—57 03.9	
Garbutt, Q'ld. Townsville R.A.A.F.	19 16.0	146 45.8	„ 22	09 42	+06 49.8	10 10	33696	13 45	—47 33.1	New station.
				11 20	+06 48.9	10 59	33719	16 30	—47 34.4	
Thursday Island "B".	10 35.0	142 13.2	„ 24	12 59	+05 02.2	13 25	36552	11 31	—34 27.3	Proximate reoccupation of C.I.W. station.
				15 06	+05 02.3	14 30	36552	16 10	—34 31.1	
Cloncurry "A", Queensland.	20 41.8	140 30	„ 29	12 18	+05 08.4	14 10	33265	10 14	—50 21.6	Reoccupation of Aust. Survey station of 1939.
				15 47	+05 10.3	15 18	33270	11 26	—50 19.5	
Tennant Creek, N.T.	19 33.6	134 14	Aug. 1	11 42	+04 30.1	13 26	33175			Reoccupation of Nth. Aust. Survey station of 1945.
				14 26	+04 32.1	14 06	33180			
Darwin "A", N.T.	12 26.8	130 49.8	„ 8	14 04	+03 40.8	14 26	36102	15 03	—39 02.1	Reoccupation of Nth. Aust. Survey station of 1945.
				15 34	+03 40.4	15 12	36996	15 52	—39 02.6	
Wyndham, W. Aust.	15 29.5	128 07	„ 18	10 27	+03 19.5	11 06	34899			New station.
				15 05	+03 23.9					
Broome "B", W. Aust.	17 58.5	122 14	„ 21	09 20	+02 33.9	09 47	33348			Close reoccupation of Nth. Aust. Survey station of 1944.
				11 03	+02 31.9	10 38	33330			
Port Hedland, W. Aust.	20 18.7	118 35	„ 23	09 41	+01 28.6	10 23	31754			Close reoccupation of N.A.S. station of 1944.
				11 59	+01 25.8	11 28	31758			
Carnarvon "B", W. Aust.	24 52.6	113 39	„ 25	15 56	—00 57.9	16 20	28167			Close reoccupation of N.A.S. station of 1944.
				17 27	—00 58.2	17 06	28167			

7

Name of Station	Latitude	Longitude	Date	Declination		Horizontal Intensity		Inclination		Remarks
				L.M.T.	Value	L.M.T.	Value	L.M.T.	Value	
	° ′	° ′	1952	h m	° ′	h m	Gammas	h m	° ′	
Geraldton, W. Aust.	28 47.0S	114 38E	Aug. 26	15 39	—01 54.2	16 09	25881			Reoccupation of N.A.S. station of 1944.
				17 41	—01 55.5	17 14	25882			
Onslow, W. Aust.	21 36.4	115 09	„ 27	15 60	+00 44.0	16 17	30285			New station.
				17 16	+00 43.1	16 56	30306			
Augusta "B", W. Aust.	34 19.2	115 09	Sept. 3	14 49	—03 52.6	15 21	21779			New station.
				17 06	—03 59.9	16 37	21787			
			„ 4	10 25	—03 57.8	11 00	21777			
Mt. Yokine, W. Aust.	31 53.1	115 50	„ 8	11 06	—03 05.2	11 32	23968			Reoccupation of N.A.S. station of 1944.
				14 28	—02 56.8	13 54	23934			
Esperance "B", W. Aust.	33 52.1	121 53	„ 11	10 48	—00 39.0	11 13	23230			Close reoccupation of N.A.S. station of 1944.
				13 11	—00 35.3	12 44	23183			
Forrest, W. Aust.	30 51.0	128 06	„ 19	10 34	+02 25.5	14 35	25942			New station.
				15 57	+02 32.8	15 33	25943			
Tarcoola, S. Aust.	30 42.5	134 34	„ 22	11 01	+05 00.0	13 39	26436			New station.
				14 55	+05 06.0	14 32	26443			
Belair, S. Aust.	35 00.8	138 37	„ 26	11 14	+06 43.3	13 39	23815			Reoccupation of N.A.S. station of 1944.
				14 56	+06 44.5	14 34	23810			

APPENDIX 2

Provisional values of magnetic elements at Watheroo, 1951-53

Date	Declination West		Intensity	
			Horizontal	Vertical
1951	Degrees	Minutes	Gammas	Gammas
January	02	48.9	24849	—52088
February	02	48.8	24842	—52065
March	02	48.4	24840	—52067
April	02	49.0	24832	—52067
May	02	48.1	24832	—52085
June	02	49.3	24838	—52062
July	02	48.4	24836	—52059
August	02	48.4	24839	—52098
September	02	48.4	24819	—52126
October	02	48.6	24834	—52158
November	02	48.7	24853	—52110
December	02	48.4	24848	—52103
Annual Mean	02	48.6	24838	—52091

Date	Declination West		Intensity	
			Horizontal	Vertical
1952	Degrees	Minutes	Gammas	Gammas
January	02	48.5	24850	—52117
February	02	48.2	24844	—52112
March	02	48.0	24841	—52122
April	02	48.2	24833	—52103
May	02	47.6	24842	—52128
June	02	47.4	24841	—52121
July	02	47.3	24855	– 52136
August	02	47.5	24848	—52113
September	02	47.2	24838	—52106
October	02	47.9	24846	—52108
November	02	47.4	24859	—52119
December	02	47.5	24858	—52129
Annual Mean	02	47.7	24846	—52118

Date	Declination West		Intensity	
			Horizontal	Vertical
1953	Degrees	Minutes	Gammas	Gammas
January	02	46.8	24854	—52112
February	02	47.0	24865	—52159
March	02	47.6	24848	—52133
April	02	46.8	24848	—52121
May	02	46.5	24841	—52131
June	02	46.9	24856	—52140
July	02	46.6	24850	—52146
August	02	46.1	24841	—52135
September	02	46.9	24837	—52152
October	02	47.0	24864	—52163
November	02	47.1	24867	—52184
December	02	46.9	24874	—52150
Annual Mean	02	46.9	24854	—52144

Provisional values of magnetic elements at Toolangi, 1951-53

Date	Declination East		Intensity	
			Horizontal	Vertical
1951	Degrees	Minutes	Gammas	Gammas
January	09	36.5	22825	—56374
February	09	37.3	22814	—56385
March	09	37.9	22807	—56391
April	09	38.4	22796	—56392
May	09	39.0	22796	—56401
June	09	39.3	22805	—56402
July	09	39.6	22803	—56410
August	09	39.9	22801	—56410
September	09	40.4	22783	—56415
October	09	40.6	22792	—56413
November	09	40.6	22801	—56411
December	09	40.9	22803	—56409
Annual Mean	09	39.2	22802	—56401

Date	Declination East		Intensity	
			Horizontal	Vertical
1952	Degrees	Minutes	Gammas	Gammas
January	09	41.3	22798	—56412
February	09	42.1	22790	—56413
March	09	42.9	22787	—56428
April	09	43.2	22778	—56429
May	09	43.7	22780	—56434
June	09	44.1	22787	—56426
July	09	44.9	22785	—56423
August	09	45.1	22788	—56422
September	09	45.4	22781	—56428
October	09	46.0	22784	—56427
November	09	46.4	22794	—56427
December	09	46.3	22794	—56431
Annual Mean	09	44.3	22787	—56425

Date	Declination East		Intensity	
			Horizontal	Vertical
1953	Degrees	Minutes	Gammas	Gammas
January	09	46.8	22796	—56438
February	09	47.5	22798	—56426
March	09	48.0	22780	—56434
April	09	48.7	22780	—56434
May	09	49.0	22774	—56443
June	09	49.2	22779	—56427
July	09	49.5	22775	—56434
August	09	49.9	22774	—56439
September	09	50.3	22768	—56442
October	09	50.8	22774	—56429
November	09	51.1	22776	—56414
December	09	51.1	22791	—56431
Annual Mean	09	49.3	22780	—56433

Absolute magnetic observations at Heard Island and the Isles de Kerguelen

(i) *Heard Island*
1951—1952

Date	Declination West		Horizontal Intensity	Inclination	
1951	Degrees	Minutes	Gammas	Degrees	Minutes
27 July	49	40.3			
30 „				—69	34.5
31 „	49	43.9			
17 August				—68	33.9
18 „			18467		
4 October				—68	37.5
6 „	49	48.4	18460		
21 November	49	44.1	18462	—68	35.7
1952					
22 January	49	46.8	18483	—68	33.1

(ii) *Isles de Kerguelen*
1952

Date	Declination West		Horizontal Intensity	Inclination	
1952	Degrees	Minutes	Gammas	Degrees	Minutes
5 March	48	34.0	18208		

Final values of magnetic elements at Heard Island 1952

Month	Declination West		Intensity	
			Horizontal	Vertical
	Degrees	Minutes	Gammas	Gammas
March	49	54.4	18450	—47077
April	49	57.4	18432	—47081
May	49	57.1	18445	—47088
June	49	56.0	18463	—47102
July	49	57.2	18467	—47109
August	49	58.3	18470	—47114
September	49	59.8	18460	—47117
October	49	59.9	18466	—47120
November	50	00.1	18477	—47136
December	50	00.7	18478	—47142

Provisional values of magnetic elements at Heard Island 1953

Month	Declination West		Intensity	
			Horizontal	Vertical
	Degrees	Minutes	Gammas	Gammas
January	50	01.4	18483	—47150
February	50	03.6	18470	—47151
March	50	06.3	18461	—47158
April	50	06.9	18472	—47172
May	50	07.6	18473	—47181
June	50	08.1	18482	—47189
July	50	09.4	18477	—47196
August	50	10.4	18476	—47205
September	50	12.1	18470	—47210
October	50	12.2	18479	—47213
November	50	12.2	18489	—47227
December	50	12.8	18496	—47231
Annual Mean	50	08.6	18477	—47190

Final values of declination and provisional values of horizontal intensity and vertical intensity at Macquarie Island 1952

Month	Declination East Final		Intensity	
			Horizontal Provisional	Vertical Provisional
	Degrees	Minutes	Gammas	Gammas
April	24	02.9	13345	—64556
May	24	03.2	13336	—64557
June	24	03.9	13351	—64555
July	24	05.0	13355	—64544
August	24	05.2	13375	—64545
September	24	05.3	13346	—64548
October	24	05.6	13344	—64537
November	24	06.4	13354	—64532
December	24	08.0	13352	—64538

Provisional values of magnetic elements at Macquarie Island 1953

Month	Declination East		Intensity	
			Horizontal	Vertical
	Degrees	Minutes	Gammas	Gammas
January	24	08.0	13350	—64543
February	24	09.3	13348	—64540
March	24	11.1	13330	—64539
April	24	11.1	13345	—64534
May	24	12.9	13345	—64539
June	24	13.7	13360	—64535
July	24	15.4	13355	—64536
August	24	16.7	13345	—64536
September	24	17.1	13335	—64534
October	24	19.0	13332	—64536
November	24	20.4	13343	—64518
December	24	18.1	13367	—64513
Annual Mean	24	14.4	13346	—64534

AUSTRIA

Bericht über erdmagnetische Arbeiten der Zentralanstalt für Meteorologie und Geodynamik, Wien

Observatorium: Ende Juni 1952 musste der Betrieb des erdmagnetischen Observatoriums *Wien-Auhof* (φ = 48° 12′1, λ = 16° 14′1) eingestellt werden, da durch die Errichtung des grossen Umspannwerkes Wien-West in unmittelbarer Nachbarschaft die dadurch erzeugten technischen Störungen jedes erträgliche Mass weit überschritten hatten.

Als Ersatz wurde während 1953 das neue Observatorium *Wien-Kobenzl* (φ = 48° 15′1, λ = 16° 19′1) erbaut. Es liegt zwischen Reisenberg und Latisberg am Nordwestrand von Wien innerhalb des die Stadt umgebenden Wald- und Wiesengürtels und ist von der Zentralanstalt für Meteorologie und Geodynamik, der das Observatorium unterstellt ist, bequem und in kurzer Zeit zu erreichen. Der Betrieb soll im Laufe des Jahres 1954 begonnen werden. Die zeitlichen Veränderungen sollen durch zwei Registriersätze aufgezeichnet werden, von denen einer auch fallweise zur Schnellregistrierung eingesetzt werden kann. Später soll auch die Registrierung von dH/dt aufgenommen werden. Die Absolutwerte sollen nach zwei verschiedenen Methoden (Theodolit, Erdinduktor, HTM, BMZ) abgeleitet werden.

Vermessungstätigkeit: In den Jahren 1951—53 wurden an weiteren 1936 Punkten des Präzisionsnivellements Messungen der Vertikalintensität mit der Schmidtschen Feldwaage ausgeführt. Insgesamt sind nun seit Beginn dieser Arbeit 3554 Neupunkte bestimmt worden. Die Arbeiten werden auch heuer fortgesetzt.

Publikationen:

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M. TOPERCZER: Der tägliche Gang der erdmagnetischen Elemente zu Wien 1933—1934, Jahrbuch d. Zentralanst. f. Met. u. Geod. Wien 1952, Anhang 7 (1953).

M. TOPERCZER: Der Verlauf der magnetischen Deklination zu Wien 1851—1950, Festschrift Eduard Dolezal 1952.

E. TRAPP: Tages- und Monatsmittelwerte der Deklination nach den Beobachtungen zu Wien-Auhof (September 1951—Mai 1952), Jahrb. d. Zentralanst. f. Met. u. Geod. Wien 1952, Anh. 5, (1953).

BELGIUM

Rapport National de la Belgique

Par Edm. Lahaye

Enregistrements du champ magnétique terrestre.

Pendant le période 1951—1954 la station magnétique de l'Université de Liège à Manhay à fonctionné normalement ; les enregistrements de D, H et Z ont été faits d'une manière continue. Un ensemble de variomètres la Cour avec enregistreur à marche rapide est installé. Les observations de 1951 et 1952 vont bientôt paraître.

La station magnétique de l'Institut Royal Météorologique à Uccle a continué à enregistrer la déclinaison jusqu'au début de 1953.

En mars 1952, le Centre de Physique du Globe établi à Dourbes par l'Institut Royal Météorologique a commencé l'enregistrement de D, H et Z au moyen de variomètres la Cour avec enregistreurs à marche normale et à marche rapide. Ces enregistrements se sont poursuivis d'une manière ininterrompue, sauf pour l'enregistreur à marche rapide qui est en cours de revision, et il sera bientôt remis en fonction et la sensibilité des variomètres H et Z correspondants sera fortement accrue. Les observations seront publiées à partir de 1955.0.

Comparaisons des instruments.

Des mesures de comparaison ont été faites entre Manhay, Cape Town, Copenhague et Elisabethville.

Levé magnétique de la Belgique.

Grâce à la mise en fonction des installations magnétiques du Centre de Physique du Globe à Dourbes, le levé magnétique de la Belgique a commencé en juillet 1952 et s'est poursuivi au cours de 1953. Actuellement, les valeurs de H et Z ont été mesurées en 400 stations, sur les 550 prévues. Les mesures ont été faites en chaque station par 2 membres du personnel scientifique au moyen de deux balances BMZ et de deux QHM. Les appareils ont été contrôlés régulièrement à Dourbes au moyen d'appareils absolus. Les stations de variation séculaire ont été réoccupées en 1952 et 1953. Le levé de D sera fait après celui de H et Z.

Prospections géomagnétiques.

Un levé magnétique détaillé du massif du Serpont a été effectué de septembre à décembre 1951 par MM. Hoge et Gaibar-Puertas. Il a mis en évidence une anomalie assez étendue et certaines anomalies locales très élevées (12.000 γ en Z sur une distance de 13 mètres). Ce sont les plus importantes anomalies actuellement connues en Belgique. Des sondages peu profonds (80 mètres) ont révélés la présence de minéralisation en pyrrhotine.

Une autre prospection a été faite par M. J. Raynaud du massif de la Gette.

Ces prospections ont fait l'objet de publications.

Centre de Physique du Globe à Dourbes.

La réalisation de ce centre, créé par l'Institut Royal Météorologique de Belgique, s'est activement poursuivie. Actuellement, les pavillons des mesures magnétiques sont en fonction et disposent de la majeur partie des appareils prévus ; ils seront complètement équipés pour l'automne 1954. Le Pavillon des mesures ionosphériques est à peu près terminé et le sondeur ionosphérique pourra bientôt être installé. Le Pavillon d'études et de rayonnement solaire sera terminé pour la fin de 1954. Il comportera notamment les installations de distribution de l'heure, les enregistreurs des courants telluriques, les enregistreurs du champ électromagnétique, les enregistreurs du rayonnement cosmique, les enregistrements du rayonnement solaire, les laboratoires pour le contrôle et les étalonnages électroniques et électrostatiques. Il lui est adjoint une cave souterraine indépendante pouvant être équipée de neuf séismographes ; elle sera mise en fonction fin 1954. Deux tours, l'une qui abritera un radiogoniographe Lugeon-Nobile pour le repérage en azimut des foyers orageux, l'autre un appareil étalon pour la mesure des champs électromagnétiques, sont en construction et pourront être mises en fonction pour la fin de 1954. Enfin la construction du Pavillon des mesures électriques atmosphèriques (gradient du potentiel, conductibilités, nombres d'ions) sera entamée au cours de l'été 1954.

Electricité atmosphérique.

Les enregistrements continus du gradient du potentiel au voisinage du sol se sont poursuivis sans interruption à Uccle. Il a été procédé également à des mesures du gradient en altitude grâce à l'adaptation à la radiosonde du procédé électrométrique électronique mis au point par MM. Koenigsfeld et Piraux. Le nombre de ces sondages a été progressivement accru : il s'est élevé à une centaine entre décembre 1953 et avril 1954.

Au cours de l'éclipse solaire totale du 25 février 1952, M. Koenigsfeld a fait au Congo Belge des observations de gradient au sol et en altitude. Des variations importantes résultant de l'éclipse ont été mises en évidence.

Des mesures du gradient en campagne ont été faites au moyen de l'électromètre électronique établi par MM. Koenigsfeld et Piraux. Ces observations ont donné des résultats encourageants.

Un radiogoniographe Lugeon-Nobile, pour l'enregistrement de la direction des foyers d'atmosphériques, a été mis provisoirement en fonction, mais à titre expérimental, la tour qui doit l'abriter n'étant pas terminée.

Physique de la haute atmosphère.

Ce domaine a fait l'objet de recherches de M. Nicolet, qui ont porté notamment sur le problème de l'émission spectrale du ciel nocturne et des aurores, sur l'azote atmosphérique et moléculaire dans la haute atmosphère (en collaboration avec M. Pastiels), sur la fréquence de collision des électrons dans l'ionosphère, sur les mouvements atmosphériques et la dissociation de l'oxygène dans la haute atmosphère, sur la diffusion des atoms d'azote et des molécules d'oxygène dans la région F ; ces recherches ont été publiées.

CANADA

National Report on Terrestrial Magnetism and Electricity

Magnetic Work of the Dominion Observatory

Magnetic Surveys.

Two hundred and forty-one magnetic stations, of which 94 were repeat and 147 new, were occupied in an area extending 37 degrees in latitude and 86 degrees in longitude or more specifically between latitudes 42° N and 79° N and longitudes 56° W and 142° W. An average of twenty stations were occupied in each of the territorial divisions of Canada. The average number of complete sets of observations for each of the elements D, I, and F, was 15 at each station extending over a two-day period. These observations were made with the electrical type magnetometers designed and constructed by the Dominion Observatory whereby a complete set of observations for the determination of any one element may be made in four minutes of time.

In addition to the regular magnetic survey operations, intensive vertical intensity surveys were made in two areas. A suspected meteor crater of possibly paleozoic age situated near Brent, Ontario, was investigated and 125 stations occupied. The environs of Meanook Magnetic Observatory, Alberta, were surveyed and 249 stations occupied. This latter survey was undertaken to supply essential data for use in standardizing airborne magnetometers in flight since, for obvious reasons, it is not always possible with a four-engine aircraft at a height of 2,500 feet

(762 m.) to approach from a distance of 20 miles (32.2 km.) and pursue an undeviating line so as to pass exactly over a magnetic observatory. The survey will continue until an area of 25 miles radius (40.3 km.) from Meanook has been surveyed for D and H in addition to Z.

The Universal Airborne Magnetometer, designed and constructed by the Dominion Observatory, was employed in regular survey operations in September, 1953. Continuous measurements, expressed in absolute values of D, H, and Z, were maintained during flights totalling 15,000 miles (24,155 km.) which followed, approximately, the perimeter of Canada. The average height of the aircraft above the ground was 8,000 feet (2.4 km.).

Magnetic Maps.

All magnetic field and observatory results were reduced to 1955.0 in preparation of the publication of isomagnetic maps of Canada applying to that epoch. The H and I maps were completed and the processing of data for the D, Z, F, and X and Y components for final draughting neared completion.

Magnetic data applying to topographical map sheets and marine and air navigation charts were supplied for a total of 3,878 items. Of these, 2,093 were for the Department of Mines and Technical Surveys, 1,530 for the Department of National Defence, and 255 for other than governmental agencies.

Statistical data do not give a complete presentation of the research and time necessary to derive the particular type of magnetic maps required for specific purposes. Marine and air navigation charts require somewhat rigorously smoothed values except in the cases of approaches to harbours and landing fields. Agencies engaged in geophysical prospecting require magnetic maps depicting a mass of detail since every local anomaly may be significant whether on the surface or at depth.

It has become apparent that an urgent necessity has arisen for magnetic anomaly maps of Canada and a beginning was made on the construction of a declination anomaly map of the Province of Alberta. Once these maps are produced they will need no revision except when additional information becomes available. The patterns of the isomagnetic lines should persist as they are associated with the geology of the area.

Magnetic Observatories.

The four Canadian magnetic observatories situated at Agincourt, Ontario; Meanook, Alberta; and Baker Lake and Resolute Bay, Northwest Territories; were in continuous operation throughout the period. The geographical and geomagnetic coordinates of the observatories are:

	Geographical		Geomagnetic	
	° ′	° ′	°	°
Agincourt, Ontario	43 47 N	79 16 W	55.0 N	13.0 W
Meanook, Alberta	54 37	113 20	61.8	59.0
Baker Lake, N.W.T.	64 19	96 02	73.7	44.7
Resolute Bay, N.W.T.	74 41	94 51	83.0	71.0

The approximate mean values of the magnetic elements applying to the period under review were as follows:

	D	H	Z	I
	° ′	gammas	gammas	° ′
Agincourt	7 15 W	15,491	56,224	74 36
Meanook	24 40 E	12,900	59,000	77 40
Baker Lake	2 39 E	3,735	60,200	86 27
Resolute Bay	94 00 W	950	57,500	89 03

Relevant information appertaining to the magnetic observatories is as follows.

At Agincourt, additional land was purchased to prevent encroachment by new highways and housing projects. A complete set of Ruska photographic recording variometers was purchased to replace the obsolete Kew type variometers. The Ruska set when installed will be supplementary to the la Cour set of standard sensitivity.

At Resolute Bay a set of Ruska photographic recording variometers was installed in 1953. Hitherto continuous records of D, I, and Z were maintained by electrical type variometers and D by a la Cour photographic recording declinometer and Z by an Askania type vertical force magnetometer adapted for photographic recording. The Ruska variometers record changes in Z and the X and Y components and are giving very satisfactory performance.

At Meanook, a new non-magnetic observatory building was constructed to replace the old observatory built in 1916. The new building is entirely above ground and measures approximately 110 by 22 feet (34 by 7 m.). The absolute room measures 60 by 20 feet (18 by 6 m.) and the variometer room 30 by 20 feet (9 by 6 m.), approximately. Both rooms are temperature controlled, being heated by specially designed non-magnetic furnaces employing propane gas as fuel. In the variometer room each set of variometers is located in a separate insulated compartment measuring 7 by 7 feet (2 by 2 m.), which, by the situation of the recording drums, do not need to be entered when changing photographic papers: The two sets of la Cour variometers have been moved to the new building. The absolute instrumentation was increased by an electrical type magnetometer, designed and constructed by the Observatory, whereby measurements of D, I, F, H, and Z may be made independently and rapidly. QHM No. 258 was installed for base-line determinations.

The scaling of magnetograms was kept up-to-date at all observatories. Tabulations of the three-hour K-indices were sent monthly to research centres in the Netherlands, Germany, the United States of America, and Canada. Similar K-indices were measured for the two Arctic magnetic observatories and in future these will be made available for distribution. For the Arctic observatories, the value $K_9 = 2{,}500$ gammas has been chosen for Baker Lake and 1,500 gammas for Resolute Bay. It has been noted that for these observatories situated within the area circumscribed by the northern limit of the auroral zone, the majority of K values lie in the middle of the range which might indicate an integrated effect on disturbances.

Photostats of observatory magnetograms were made available to all major geophysical prospecting agencies operating in Canada and all magnetic results were made available for detailed analyses on request. The congestion of unpublished magnetic observatory results was somewhat relieved by making the results of ten years ready for publication.

Magnetic Laboratory.

The major effort of the Laboratory was the completion and testing of the Dominion Observatory Universal Airborne Magnetometer. Test flights were made between August 30th and September 17th, 1953. The magnetometer was installed in the National Research Council's de-icing research North Star aircraft and flown by the Experimental and Proving Establishment of the Royal Canadian Air Force. The aircraft was swung over Agincourt and Meanook magnetic observatories to determine the coefficients representing the induced and permanent fields. A swing consisted of eight flights over the observatory on different headings at a height of 2,500 feet (762 m.). From the coefficients thus determined, correction curves were computed and used to correct the measured values of the direction and intensity of the earth's magnetic field in all parts of Canada. During the 77 hours flying time the magnetometer was out of operation for a total of three hours owing to failure of electrical components. This performance was considered satisfactory in view of the large number of electronic tubes employed numbering about three hundred. The stabilized platform supporting the magnetometer head was steady to three minutes of arc under good flying conditions which was about 75 % of the time.

Following these test flights, modifications were made in the magnetometer circuits to ensure operation in all parts of the world.

Aeromagnetic Work by the Geological Survey of Canada

Since September, 1951, the Geological Survey of Canada has flown approximately 100,000 line miles of aeromagnetic total force profiles. The majority of this work has been over potential mineral bearing areas rather than over the sedimentary areas because the oil companies have had most of the potential oil-bearing areas in Canada flown commercially. In mineral work, the proportion of government to commercial flying is about one to three.

There have been no finds which have been directly attributable to these surveys since 1949 when a large magnetic body was found under a thin cover of Palaeozoic rocks at Marmora in the province of Ontario.

It has, however, been observed that prospecting interest is greatly stimulated in areas where aeromagnetic information has been made available to the public. Three large base metal bodies in the province of New Brunswick were found when interest was aroused in geological structure indicated by aeromagnetic maps.

Geologists are finding aeromagnetic information more useful in helping them map geologic structure and trace rock contacts under lakes and overburden rather than as a direct prospecting aid.

It is interesting to note that in over 300,000 line miles flown by the Geological Survey in Canada over rocks of all ages, negative anomalies recorded number less than ten. Field investigation of the rocks causing these anomalies has just been started.

A Review of Canadian Work in the Field of Atmospheric Ionization during the Period 1951—54

This report includes a bibliography of Canadian publications which have a bearing on the subject of atmospheric ionization. The material is divided into the different fields which contribute to our knowledge of atmospheric ionization and related phenomena.

Ionospheric and Magnetic Research.

Considerable progress has been made in recording and correlating the various aspects of a disturbance in the upper atmosphere. Mr. J. H. Meek of the Defence Research Telecommunications Establishment, presently at the University of Saskatchewan, has studied the relationship between magnetic bays, conditions in the ionosphere and the presence and position of the aurora as seen from Saskatoon. It is found that during magnetically quiet periods the aurora is either absent or located near the northern horizon at an elevation of less than 20°. When a positive magnetic bay appears (always before local midnight) bright aurora is seen to the north at low elevations, while ionospheric soundings show intense sporadic-E ionization to the north and overhead. The presence of a negative magnetic bay is accompanied by aurora which extends from the north to the zenith, an increase of high frequency radio absorption and sporadic-E with a maximum reflection frequency of over 6 Mc/s.

Magnetic records from Meanook, Baker Lake and Resolute Bay have been studied and the occurrence of magnetic bays compared with the predictions of Martyn's theory. It appears that the magnetic changes observed at Meanook can be explained in terms of Martyn's theory, but this is not the case at Baker Lake and Resolute Bay.

An analysis of the records from the Canadian ionospheric stations has yielded useful information on F-region frequencies during disturbed periods. The maximum depression of f_0F_2 is at local noon, often with a secondary dip near 1800 LMT. The region of maximum depression of f_0F_2 in North America, is a band roughly parallel to but just south of the zone of most frequent occurrence of auroral light. A longitude effect exists, with deeper depressions over Newfoundland and the Aleutians. Abnormal absorption is most frequent before local noon and shows a longitude effect.

A preliminary study of ionospheric blackouts at high latitudes has been completed. It is found that blackouts are most frequent in the morning hours, and that the time of a blackout is a linear function of latitude, being later at higher latitudes. The curve showing the number of blackouts as a function of latitude appears to have a maximum and a minimum near the latitudes of Churchill and Baker Lake respectively, the number increasing again at still higher latitudes.

A theoretical study has been made of the origin of the D-region, and the lowering of reflection height of very low frequency waves from this region prior to ground sunrise. It appears that the only theoretically acceptable process which can form the D-region is the ionization of nitric oxide by Lyman-alpha radiation. From the geometry of the pre-sunrise situation it can be shown that normal daytime ionization of atmospheric particles is not responsible for the lowering of reflection height. The conclusion is that the effect is due to the release of electrons from negative ions by visible and infrared radiation.

An analysis of the true heights of maximum ionization in the F-region above Churchill and Prince Rupert has yielded interesting results. The diurnal variation of electron density has been determined at several heights and the rates of electron production computed.

A preliminary study of the effect of lunar tides on the height of the E-layer during a three month period has been made at Ottawa. The amplitude of the variation is some 1.5 km; and the phase of the variation differs by six hours from that predicted by Martyn's theory.

Winds in the upper atmosphere are being investigated using the spaced receiver method. It has been established that there are regular diurnal and seasonal variations in the winds, and it appears that a real transport of the ionized gases is taking place. Although the observed effects are due to irregularities in ionization, it has not been determined to what extent if any the wind motions of amplitude 50 to 100 meters/sec. contribute directly to the irregularities. Some evidence has been obtained of an increase in wind velocity during disturbed periods, when the irregularities in ionization are also much more pronounced.

Meteoric Ionization.

The ionization produced in the upper atmosphere by meteors is being studied with optical, radar and radio equipment at the Dominion Observatory, the National Research Council and the Radio Physics Laboratory.

Dr. P. Millman has reported that the mean height of the night time meteors at Ottawa is 97.8 km and the total ionization rate due to all meteors is $5/cm^3$/hour. This is too small to account for the night time ionization in the D-region and an additional source of nocturnal ionization must be present.

Radio signals at frequencies near 50 Mc/s propagated over path lengths of the order of 1000 km have been recorded for a period of one year. These are forward scattered signals from meteor trails. Information is accumulating on the diurnal and seasonal variations in the incidence of sporadic meteors and in the rate of decay of the signals from meteor trails.

Radar Studies of the Aurora.

Radar has proved to be a useful tool for determining the density and geometry of the electrons in the aurora. Three radar sets of frequencies 56, 106 and 3000 Mc/s have been used at the University of Saskatchewan, and it appears that radio energy is returned from the aurora by a reflection rather than a scattering process. If this is so, then the electron density in the reflecting region is at least $10^8/cm^3$. It is unlikely that the high ionization is produced in localized regions. It has been found also that a frequency of 56 Mc/s is weakly scattered from a region which may be in or below the normal E-layer, and it is likely that this same region is responsible for the scatter which makes long distance VHF communication possible. A good deal of information has been obtained regarding the diurnal variation and latitude distribution of auroral radar echoes. The evidence favours the occurrence of aurora during daylight hours. The 106 Mc/s echoes are found to occur most frequently within the auroral zone and the 56 Mc/s echoes some distance to the south. It follows that centres in auroral displays with high electron densities become more frequent as the auroral zone is approached.

The emission from the aurora of short-lived bursts of 3000 Mc/s radiation observed in 1949, has been searched for with improved equipment. No emissions were found during 1951 and 1952, possibly due to the decrease of the intensity of auroral displays and of sunspot activity.

Auroral, Twilight and Airglow Spectroscopy.

A number of auroral spectrographs have been constructed and put in operation during the past three years. These instruments make use of plane gratings and Schmidt cameras; the camera speeds vary between f0.8 and f2.5, and the dispersions in the third order spectra are between 40 and 7 A/mm.

The analysis of spectra secured with these instruments has cleared up the uncertainties regarding the identification of all but the weakest auroral spectral features. Average intensities of the major features have been determined, and progress made in understanding the exitation of the aurora. It is now clear that both primary protons and either or both primary and secondary electrons produce certain of the auroral radiations, the proton and electron effects being partially separable.

The relatively high dispersion spectra secured with these spectrographs have made possible a better determination of the rotational temperatures of nitrogen band systems. Although work remains to be done on this problem, it appears that the low temperature values obtained earlier from low dispersion spectra are incorrect, and that these newer values agree reasonably well with the rocket results.

Infrared auroral and airglow spectra in the wave-length interval 1—2 microns have for the first time been secured with reasonable resolution. A lead sulphide cell was inserted in the Schmidt camera of one of the auroral spectrographs. The main features of the airglow spectrum in this wave-length region are OH bands.

A photomultiplier scanning spectrometer developed at the University of Saskatchewan has proved to be successful in detecting changes in the auroral spectrum. It has been used also to record hydrogen lines in the spectra, to analyze the lower red borders associated with certain displays and to record the profiles of nitrogen bands from which rotational temperatures may be determined. This latter development is especially promising, since it is possible to scan across an auroral structure and measure the temperature as a function of height. The twilight enhancement of the sodium radiation is being investigated with the scanning equipment and information obtained on the height of the sodium emission.

The appearance of the 3914A band of $N2^+$ in the twilight has been studied with one of the spectrographs. This radiation has been detected only during disturbed periods and the evidence is that $N2^+$ ions do not exist in appreciable numbers in the E-region. An unsuccessful search has been made in the twilight for the forbidden NI line at 5200A, and we must conclude that during the observation period of some two months few nitrogen atoms were present in the E-region.

Spectra of the airglow in the region 3400—3800A were secured from Resolute Bay during January and February 1954. The results indicate that there is little or no atmospheric emission in the spectral region studied, which is perhaps not surprising in view of the fact that the section of the atmosphere examined had not been exposed to sunlight for a long period of time.

Cosmic Rays.

Experiments have continued at the University of Montreal on the fabrication and flight testing of high altitude balloons. Polythene has been used with considerable success and heights of 25 km reached. The use of nylon and newer plastics produced by Dupont appears to be promising for the production of balloons, and it seems feasible to reach heights of some 40 km.

Continuous records of the intensity of cosmic rays continue to be taken at Ottawa and Resolute Bay. On a few occasions sudden changes in intensity have taken place during solar flares and it is important that this work continue for some time.

Radio Astronomy.

A start has been made on the problem of studying the radiation from "radio stars". The twinkling of these sources due to changing diffraction patterns from moving electron clouds gives information on the fine structure of the ionosphere and the motions of this structure. One equipment operating at a frequency of 50 Mc/s is installed at Ottawa and a second is being built at the University of Saskatchewan. Both will record continuously the radiation from the radio star in Cassiopeia.

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CZECHOSLOVAKIA

Rapport du Comité National de Géodésie et de Géophysique près de l'Académie Tchécoslovaque des Sciences

PART I

Report on Magnetic Work

By J. Bouska

The magnetic observatory at Pruhonice (near Prague) $\varphi = 49° 59' 18''$, $\lambda = 14° 32' 34''$, geomagnetic coordinates $\Phi = 49° 54'$, $\Lambda = 97° 18'$, $\psi = 17° 55'$ has started its work in 1946 and has functioned with interruptions during the period from 1946—

1953. Annual values of geomagnetic elements at the observatory are shown in the following table:

Year	D	H	Z	Remarks
1946	2°28,7′	19427	42631	incompl. July-November
1947	2°22,5′	19427	42674	„ April-November
1948	2°14,8′	19427	42704	„ May-August
1949	2°07,9′	19430	42733	„ January-November
1950	2°00,9′	19440	42780	preliminary values
1951	1°53,7′	19452	42826	„ „
1952	1°47,0′	19463	42856	„ „
1953	1°41,3′	19477	42883	„ „

From 1953 the observatory Pruhonice sends quarterly reports containing K-indices and data about special effects (storm sudden commencements ssc, polar or pulsational commencements psc, sudden impulses si, solar-flare effects sfe) to the C+K-center at De Bilt.

K-indices and special effects were derived already for the years 1950—1952.

Tables of principal magnetic storms (beginning and ending storm-time, type and amplitudes of sudden commencement, degree of activity, maximum activity on K-scale 0 to 9 and ranges of D, H, Z) were prepared for the years 1948—1953.

The net of secular-variation stations in Czechoslovakia includes the following 10 stations:

Name of station	λ (E)	φ	Height above sea-level	Type of station
As	12°12′48″	50°13′18″	734 m	Sec. Var. Station
Cierna p.C.	Geogr. coordinates not yet estimated		103 m	Contemplated Sec. Var. Station
Frydlant	15°03′30″	50°56′11″	351 m	Sec. Var. Station
Hurbanovo, formerly St. Dala (Ogyalla)	18°11′24″	47°52′30″	114 m	Magn. Observatory
Lanzhot	16°58′47″	48°44′13″	175 m	Sec. Var. Station
Mor. Ostrava	18°16′25″	49°55′04″	267 m	Sec. Var. Station
Policka	16°15′56″	49°44′03″	603 m	Sec. Var. Station
Pruhonice	14°32′34″	49°59′18″	329 m	Magn. Observatory
Strba	20°03′42″	49°04′12″	926 m	Contemplated Sec. Var. Station
Vyssi Brod	14°19′19″	48°36′47″	593 m	Sec. Var. Stat.

At secular-variation stations measurements of all magnetic components are performed every second year. These measurements began at As in the year 1946, at Frydlant v Cechach, Lanzhot, Policka, Vyssi Brod in 1947, at Mor. Ostrava in 1948.

The stations Cierna p. C. and Strba started their work in 1951.

The Institute of Geophysics in Prague organized *magnetic surveys* in Bohemia and Moravia-Silesia. Field observations have been made in the years 1946—1948 at 161 stations. The new geomagnetic measurements have been performed with the consent of the National Geodetic and Geophysical Committee. The execution of the field work was made possible by the generous help of the Military Geographical Institute in Prague. The observed values of the geomagnetic elements were reduced to the epoch 1950,0 according to the magnetograms of the Pruhonice observatory. The construction of the magnetic charts of isogones, isoclines, isodynams H, X, Y, Z and T was carried out using the compensational method of cylindrical representation, which preserved the lengths of the meridians and of the parallel $\varphi = 49° 45'$ N. The author gives also the average yearly changes of geomagnetic elements, derived from the results of Pruhonice Observatory and the secular-variation stations in the interval between 1946 and 1952.

Corresponding work is done in Slovakia by the Geophysical Observatory SAV in Hurbanovo (previously Stara Dala).

International comparisons. — The Czechoslovak Academy of Sciences extended 1953 an invitation to the Hungarian geophysicists Dr. S. Haaz, Dr. G. Barta and M. Killman of the Roland Eötvös Geophysical Institute in Budapest, who brought to Czechoslovakia instruments of Danish manufacture QHM 227 and BMZ 59. Comparative measurements were carried out on July 10, 11 and 28 at Pruhonice, and on July 20 and 21, 1953 at the Geophysical Laboratory of the Slovak Academy of Sciences at Hurbanovo. — In January 1954, the Czechoslovak Academy of Sciences enabled Dr. J. Bouska, K. Bodlak and B. Peclinovsky, members of the Geomagnetic Department of the Geophysical Institute of the Academy to perform comparative measurements at the Niemegk observatory in the German Democratic Republic. The comparative measurements in Niemegk were carried out on January 6, 7 and 9, 1954. After the performance of comparative measurements with the Hungarian geophysicists and at the observatory in Niemegk, we have adopted for Pruhonice the corrections $\Delta D = +0.5'$, $\Delta H = -84\ \gamma$ and $\Delta Z = -183\ \gamma$.

PART II

Recherches sur l'influence de l'activité solaire sur le magnétisme terrestre

Une partie de la section géomagnétique de l'Institut Géophysique de l'Académie tchécoslovaque des Sciences s'occupe des recherches sur l'influence de l'ativité solaire sur le magnétisme terrestre, en employant des valeurs trouvées à l'observatoire Pruhonice. Au premier stage de ces études, supposée la validité de la théorie corpusculaire, on cherche les sources des courants de corpuscules, qui viennent du soleil dans l'atmosphère terrestre.

Basé sur les faits qui résultent de nos travaux et qui exigent des observations encore plus complètes que ceux d'auparavant et surtout les observations spéciales des protubérances, de leurs positions, de leurs formes et de leur développement, nous proposons à l'Union Géodésique et Géophysique Internationale de faire appel à l'Union Astronomique Internationale et à la Commission pour l'étude des relations entre les phénomènes solaires et terrestres, pour que les observations des protubérances soient publiées de la manière dont s'est servi M. le Prof. Brunner dans les Astronomische Mitteilungen, c'est à dire jour par jour et les bords est et ouest séparément, et s'il est possible, encore mieux qu'on publie de nouveau les "Immagini spettroscopiche del bordo solare" comme on l'a fait avant 1934.

Publications:

B. Bednarova: Srovnani slunecni a geomagneticke aktivity /Comparaison de l'activité solaire et géomagnétique/, Geofysikalni sbornik 1953, No 11, CSAV.

B. Bednarova, M. Karnik: Pozorovani slunecnich protuberanci a jejich pouziti pri studiu zmen vnejsiho pole geomagnetickeho /Observations des protubérances solaires et leur application à l'étude des changements du champ magnétique terrestre extérieur./

B. Bednarova: Srovnani slunecni a geomagneticke aktivity za leta 1950, 1951 a 1952, cast II. Rozpravy CSAV /préparée pour l'impression/ /La comparaison de l'activité solaire et géomagnétique pendant les années 1950, 1951 et 1952. IIe partie./

Bouska J.: Vysledky geomagnetickych mereni na observatori Pruhonice u Praha za rok 1952 /Results of Geomagnetic Measurements at the Obvervatory Pruhonice near Prague for the Year 1952/. — CSAV, Praha 1953.

Bouska J.: Vysledky geomagnetickych mereni na observatori Pruhonice u Praha za rok 1953 /Results of Geomagnetic Measurements at the Observatory Pruhonice near Prague for the Year 1953/. — CSAV, v tisku.

Bouska J. — Bodlak K.: Mezinarodni srovnavaci mereni /International Comparative Measurements/.

Bouska J.: Rozlozeni geomagnetickeho pole v ceskych zemich k epose 1950,0. /Distribution of the Geomagnetic Field in Bohemia and Moravia-Silesia, epoch 1950,0/. — CSAV, v. tisku.

Pavluchova M.: Sledovani geomagneticke aktivity methodou K-indexu /Geomagnetic Activity by K-Indices/. — Geofysikalni sbornik 1953, Praha.

DENMARK

Report on magnetic work in the years 1951—1953
by J. Egedal, V. Laursen and J. Olsen

The magnetic observatory at *Rude Skov* has functioned without interruptions during the period 1951—1953. For further information see the report to the Brussels meeting (1951).

Field observations have been made in Jutland in the years 1951, 1952 and 1953.

The results of the observations at Rude Skov are published by the Danish Meteorological Institute in the Annuaire Magnétique 1ère Partie. The yearbook for 1951 contains the results of a determination of the lunar-diurnal variation of the magnetic declination at Rude Skov in the years 1941—1951. In "Communications Magnétiques, etc." No 21 an account is given of the lunar-diurnal variation of the declination at Rude Skov in the years 1908—1951.

The Rude Skov observatory has continued to serve as a center for the international comparison programme carried out under the auspices of the I.A.T.M.E. by means of travelling QHM-magnetometers. The staff of the observatory has further been heavily engaged in the adjustment and routine calibration of a great number of La Cour instruments supplied to foreign institutions. Studies of QHM have resulted in the following paper by *K. Thiesen*: On the determination of D by means of QHM. Geophysica 5: 2, Helsingfors 1954.

At *Godhavn,* Greenland, the magnetic observatory has been in continuous operation during the period under review. Mr. K. Lassen has been in charge of the station, replaced during his vacation in Denmark in the summer of 1952 by Mr. H. Neltrup. At the same time Mr. Johannes Olsen visited the observatory for inspection.

The instrumental equipment is unchanged. Sensitive and insensitive normal records of D, H and Z as well as quick-run records (180 mm/h) of the same elements are available.

Every year a QHM and a BMZ have been sent from Denmark to Greenland to secure that the results obtained at Godhavn are in accordance with the values of the Rude Skov observatory.

The results of the magnetic observations made at Godhavn are being published in the Annuaire Magnétique, Le Groenland, of which the volumes covering 1942, 1943, 1944, 1945, 1946, 1947 and 1948 have been completed and published during the period.

The cosmic-ray observatory at Godhavn, established in 1938 has continued in operation. The records are being sent to the Carnegie Institution of Washington for examination.

A regular Ionospheric Sounding Station was established at Godhavn in the autumn of 1951 on the initiative of the Danish National Committee for U.R.S.I. The equipment used is placed at disposal by the National Bureau of Standards, Washington. The magnetic observatory, the cosmic-ray observatory and the ionospheric station now form parts of *the Geophysical Observatory,* Godhavn, operated under the authority of the Danish Meteorological Institute.

Owing to unforeseen artificial perturbations the observations at the magnetic observatory at *Thule,* Greenland, had to be discontinued in 1952. The station will be replaced by a new observatory situated some 100 kilometers farther north (in 89° geomagnetic latitude) where the necessary buildings are already under construction and where routine observations will probably get started sometime during 1955. The observations made at the old site from 1947 to 1952 are being prepared for publication in the Annuaire Magnétique.

FINLAND

Report of the Finnish National Committee 1951—1954

By E. Sucksdorff

A. Geophysical Observatory, Sodankylä.

Extensive repairing works were performed in the magnetic variation house of the observatory in June 1953. In conjunction with them, a quick-run recorder (180 mm/h) and a slow-running (abt. 2 mm/h) insensitive storm recording set were installed in the house to supplement the already existing normal recording set (15 mm/h) All variometers and recorders are of *la Cour*-type, manufactured by Andersson & Sørensen, Copenhagen. The scale values of the records are of the order 4, 30 and 10 γ/mm, respectively.

It is planned to establish at Sodankylä, in good time before the International Geophysical Year, also a recording earth current station for which the electrodes and cables already exist.

During the years 1951—1954, Mr. *E. Kataja,* M. A., acted as observer-in-charge at Sodankylä.

B. Magnetic Observatory, Nurmijärvi.

This new observatory is situated about 40 km NNW of Helsinki, on the southern shore of a small lake (60° 30′ N, 24° 39′ E). The construction of the variation house and the absolute house was completed in the autumn of 1951, as mentioned in our report for the Brussels meeting.

The *variation house* is built of non-magnetic bricks, with double walls, and dug half-way into a slope. The variometer-stands resemble chimneys in shape and are covered with marble squares. They are built of limestone bricks. The house is heated electrically. The temperature in the recording room is kept constant (in winter 10°, in summer 18° C) by means of a thermostat arrangement. A boarded partition divides the room into two parts: the variometers are located in the inner part, the recorders run and are cared for in the outer part. Besides, the variation house has a small anteroom for the central clock, accumulators, relays etc.

In the variation house there are installed three recording sets of *la Cour*-type: a normal, a quick-run and a storm recording set, with time-scales similar to those in Sodankylä. The scale-values are of the order 8, 3 and 25 γ/mm, respectively. The recorders run since April 1952.

According to tests performed, the magnets of the variometers lie fairly well in their regular directions. In the normal recording set the temperature coefficients are exceedingly small. The change of the base-line values goes on slowly and steadily in one direction.

The *absolute house* is a wooden building on the top of a small hill, some 35 m off the variation house. There are three limestone pillars for the magnetometers. Also this house is heated electrically. As absolute instruments the *Askania* theodolite-magnetometer Nr. 5113998, whose constants were determined by Dr. *F. Burmeister* in Fürstenfeldbruck, Germany, and a *Wild-Edelmann* earth-inductor are used. — The base values of the H- and Z-variometers were, however, in most cases determined by using the *la Cour* magnetometers QHM Nr. 84, 85 and 86, and the BMZ Nr. 25, whose constants have been yearly determined in the magnetic observatory Rude Skov, Denmark.

The declination mire is erected on the northern (opposite) shore of the lake, at a distance of 680 m from the main pillar of the absolute house. The mire is cast of concrete and grounded carefully; it has on a white square three black pointing marks which form a triangle.

The total *costs* of the observatory and of its equipment, exclusive of the already existing earth-inductor, a BMZ-magnetometer, the central-clock and three QHMs amount to:

	U.S. dollars
Two magnetic buildings	6,710.—
Electric power-lines and installations	2,946.—
Recording instruments	2,978.—
Absolute instruments	2,988.—
Road construction	260.—
Miscellaneous	81.—
Total $ ...	15,963.—

The observatory Nurmijärvi is designed to work as a first-order geomagnetic station. So far, however, it lacks permanent personnel and a dwelling-house (with study, dark-room, laboratory etc.) for the staff. It is to be hoped that this serious deficiency will soon be remedied.

In September of 1952 the new observatory was inaugurated in a five-day Nordic geomagnetic conference and through a comparison of magnetic observation instruments, with participants from Denmark, Norway, Sweden and Finland.

C. *Field work performed by the Finnish Meteorological Office.*

During the summers of 1951, 1952 and 1953, 5, 23 and 23 magnetic secular stations, respectively, were re-measured. As instruments were used the magnetometers QHM Nr. 84, 85 and 86, the BMZ Nr. 25 and the theodolite-magnetometer *Chasselon* Nr. 82; likewise the horizontal circle *Andersson & Sörensen* Nr. 11. The observation instruments were compared before and after the expeditions in the observatories Sodankylä, Nurmijärvi and, in the summer of 1953, Tromsö.

Since many of the oldest Finnish secular stations are located in the immediate neighbourhood of towns, some of them, during the past few years, had to be moved farther into the countryside. In this connection it is worth while to point out that the secular stations should preferably be placed at locations that are as inhospitable — but, of course, magnetically homogeneous — as practicable, not very far from the main roads, yet so far from the towns that the places have the chance to stay incolonized for at least many decades ahead.

D. *Auroral observations.*

Some photographs of auroral arcs have been taken in Sodankylä. Also visual observations are made there and on numerous climatological stations all over the country.

E. *Plans for ionospheric investigations.*

An automatic multifrequency ionospheric recording device is under construction and will be placed at Nurmijärvi. Another similar equipment is designed for Sodankylä and will probably be ready for use during the International Geophysical Year.

F. *Publications.*

Ergebnisse der magnetischen Beobachtungen des Observatoriums zu Sodankylä im Jahre 1940.
Ergebnisse .... im Jahre 1941.
Ergebnisse .... im Jahre 1942.
Ergebnisse .... in den Jahren 1933—1934 (in print).
E. Sucksdorff: Vom Polarlicht.
E. Sucksdorff: The Geophysical Observatory Sodankylä.
E. Sucksdorff: The Magnetic Observatory Nurmijärvi.
In collaboration with Danish, Norwegian and Swedish magneticians: The Variation of the Compass, Magnetic Declination 1950.0.

Finnish Meteorological Office

Helsinki, April 1954

FRANCE

Rapport National

Ce rapport est un inventaire sommaire des travaux intéressant la Section de Magnétisme et Electricité terrestres, exécutés en France pendant les années 1951, 1952, 1953. Un certain nombre de publications de l'année 1951, déjà mentionnées dans le rapport présenté à l'Assemblée de Bruxelles, ne seront pas rappelées.

I. — *Magnétisme Terrestre*

A. *Mesures géomagnétiques.*

— *Appareils.*

Divers dispositifs ont été mis au point, ou perfectionnés, pour l'étude des pulsations magnétiques. En Algérie, G. Grenet a développé les variomètres à aimant mobile inducteur dont il avait proposé le principe ; deux de ces appareils sont en fonctionnement continu (D et H) à l'observatoire de Tamanrasset (46). A Paris, un variomètre utilisant le même principe a été mis au point par I. Özdogan pour la composante verticale ; l'aimant-balance utilisé, nécessairement volumineux avec ce procédé, est suspendu par de minces lamelles évidées (144). H. Dürschner a imaginé et construit un magnétomètre photoélectrique, à compensation, avec enregistrement plume-papier du courant de compensation (77).

A l'observatoire de Chambon-la-Forêt, en plus d'un enregistrement La Cour rapide ordinaire à 3 composantes, fonctionne en service régulier un enregistrement (La Cour rapide aussi), d'un magnétomètre de H construit par G. Gibault (99). D'autre part, ont eu lieu les premiers essais d'un variomètre pour D, construit par G. Dupouy et A. Cecchini, utilisant une très longue barre de métal à grande perméabilité coupée par un entrefer magnétophonique ; on réalise ainsi, sur ruban magnétique, un enregistrement direct des variations du champ terrestre.

En ce qui concerne la mesure des éléments du champ terrestre, un nouveau type de sonde a été imaginé et construit par H. Gondet (101) ; c'est un appareil de zéro constitué par un long noyau droit entouré d'une bobine et coupé par un entrefer dans lequel tourne à grande vitesse un noyau dont la longueur est presque égale à celle de l'entrefer. En principe, la f.e.m. induite dans la bobine est nulle lorsque la composante du champ suivant l'axe du noyau est exactement annulée. Des essais sont en cours pour effectuer des mesures magnétiques en avion au moyen de cette sonde.

— *Observatoires.*

Durant l'expédition antarctique française 1951—1952 en Terre Adélie, P. Mayaud a pu effectuer des enregistrements magnétiques (D, H, Z) s'étendant sur 9 mois, à la base de Port-Martin (137).

L'installation, par l'O.R.S.T.O.M., d'une station magnétique permanente à Bangui (A.E.F.) est en cours. Une nouvelle station magnétique est en voie d'équipement en Algérie, à Médéa, à 100 km au Sud d'Alger.

— *Réseaux magnétiques généraux.*

Les stations du réseau français de répétition ont été réoccupées pendant l'été 1952 par E. Selzer.

Le réseau magnétique de la Corse, prélude probable à la reprise du réseau magnétique de la France, a été exécuté pendant l'été 1953 ; il a comporté 99 stations (E. Selzer, A. Cecchini, G. Jobert et Mme N. Jobert).

Un certain nombre de stations magnétiques ont été occupées en A.O.F. et A.E.F. par les géophysiciens de l'O.R.S.T.O.M. qui devront peu à peu exécuter le réseau magnétique de ces régions. D'autres mesures ont été effectuées par P. Mayaud sur la côte et l'inlandsis de la Terre Adélie, par G. Bidault au Maroc oriental et, en divers points des côtes de l'Union française, par le Service Hydrographique de la Marine.

— *Réseaux de prospection.*

Des mesures à la balance de Schmidt, souvent appuyées sur un réseau à grande maille à la B.M.Z., ont été effectuées par les géophysiciens de l'O.R.S.T.O.M. ; en particulier, Melle Crenn a fait une étude magnétique, en même temps que gravimétrique, très détaillée de la Nouvelle-Calédonie (58) ; d'autre part, les équipes de la Compagnie Générale de Géophysique (C.G.G.) ont effectué des réseaux étendus, principalement en Aquitaine, au Sahara et au Maroc. E. Le Borgne a étudié en Bretagne centrale trois anomalies magnétiques dont l'une est du type inversé (122) ; R. Godefroy a donné les résultats d'une prospection magnétique (100).

B. *Etudes sur les variations du champ terrestre.*

— *Variations régulières et irrégulières du champ instantané.*

J. Denisse, J. Steinberg et S. Zisler, distingant entre les taches solaires celles qui sont fortement émettrices de bruit radio-électrique, observent que leur passage au méridien central se marque statistiquement par une augmentation de l'activité magnétique avec un retard de un à deux jours (67) ; J. F. Denisse poursuivant cette étude remarque que les orages magnétiques correspondants sont surtout à début brusque (65) et il tente une explication du phénomène (66).

P. Bernard a étudié la relation éruption chromosphérique-crochet magnétique en insistant sur les très grandes éruptions dites "blanches" (29).

E. Selzer a étudié de grandes oscillations observées pendant certains orages magnétiques. Le phénomène n'est pas strictement local, mais il ne se présente avec une grande amplitude que dans une portion limitée du globe et dans un intervalle étroit d'heures locales ce qui conduit l'auteur à le relier à une instabilité accidentelle de l'ionosphère (159).

G. Gibault a signalé des pulsations rapides au cours d'un orage magnétique (98) et il a étudié les pulsations régulières, de courte période, qui sont observées de jour presque quotidiennement (99).

Les enregistrements effectués à Tamanrasset pendant les années 1950 et 1951 avec des variomètres de Grenet ont été analysés: G. Billaud a étudié pour ces deux années les perturbations du type p.s.c. (39) ; J. Castet a étudié l'amplitude et la période des pulsations régulières de jour (57) ; G. Grenet enfin a comparé des oscillations qu'il désigne par la notation Pu enregistrées à la fois à Tamanrasset et Chambon-la-Forêt (103).

M. Matschinski développe des calculs relatifs à la propagation des perturbations magnétiques dans le "trifeuille" auquel il assimile l'atmosphère terrestre comprise entre les conducteurs sol et haute atmosphère ; il est amené à discuter les opinions émises sur la simultanéité mondiale des phénomènes magnétiques brusques (134).

— *Variations du champ moyen.*

P. Bernard a étudié la variation undécennale de la composante H sur le globe; il considère que l'explication habituelle par l'effet de post-perturbation est insuffisante et il propose une explication à partir des vents généraux de la haute-atmosphère (27, 28).

P. Mayaud utilisant les résultats de ses observations (135) et des observations antérieures dans l'antarctique a cherché une localisation du pôle magnétique sud actuel (136) ; il a ensuite tenté de décrire les variations des pôles magnétiques nord et sud depuis un siècle, d'après l'ensemble des observations faites dans les régions polaires (138).

N. Stoyko a émis l'hypothèse d'une relation entre les variations de la vitesse de rotation de la Terre et les variations du champ moyen. Sa démonstration appuyée d'abord sur des faits magnétiques trop locaux (162) a été reprise avec un caractère plus mondial, la variation de l'intensité totale du champ en un certain nombre de stations (163). Poursuivant ses déductions, l'auteur croît pouvoir expliquer les inversions du champ terrestre dans le passé géologique (164).

— *Champ terrestre fossile.*

Melle J. Roquet a poursuivi sur des corps définis (sesquioxyde de fer et magnétite en grains dispersés) l'étude des propriétés qui sont à la base des recherches en paléomagnétisme ; elle a étudié dans une échelle de champs très étendue l'acquisition des aimantations rémanente isotherme et thermorémanente et les propriétés de ces aimantations, trop souvent méconnues des utilisateurs (158). E. Le Borgne ayant observé que le sol, dans sa couche tout à fait superficielle, est souvent beaucoup plus magnétique que le sous-sol qu'il recouvre, a entrepris une étude approfondie de pédologie magnétique qui se relie aux problèmes des latérites magnétiques et de l'altération magnétique des roches (123) ; avec S. Hénin il a émis l'hypothèse que le constituant magnétique des sols était le sesquioxyde de fer γ (110).

A. Roche a poursuivi son étude de l'aimantation rémanente de nombreuses formations volcaniques d'Auvergne, soit par prospection magnétique, soit par prélèvement d'échantillons. Il a rencontré de sérieuses difficultés venant de l'instabilité des aimantations de beaucoup d'échantillons et des possibilités d'aimantation par les courants de la foudre, dont il a fait d'ailleurs une étude préliminaire intéressante. Admettant que certains échantillons portent encore leur aimantation originelle, il conclut à des renversements du champ terrestre à certaines époques géologiques (154, 155, 156).

Pour la période historique, les terres cuites offrent un matériel d'étude beaucoup plus sûr que les roches. E. Thellier et Mme Thellier ont pour la première fois utilisé des parois de fours restées en place, ce qui donne la déclinaison et l'inclinaison du champ passé. Les résultats actuellement publiés portent sur des fours puniques et romains à Carthage (168) et sur des fours romains dans la région de Trèves (169).

L. Néel a continué à s'intéresser à la théorie des phénomènes fondamentaux du paléomagnétisme. Observant l'incompatibilité des conclusions obtenues à partir des roches sédimentaires et des roches volcaniques pour le lointain passé géologique, il envisage la possibilité pour certains minéraux d'acquérir des aimantations thermorémanentes de sens opposé au champ inducteur et il en montre la possibilité au moins théorique (141). Le fait ayant été observé expérimentalement au Japon, L. Néel discute ce phénomène paradoxal de l'aimantation inverse (142, 143).

II. — *Electricité tellurique*

L. Cagniard a publié la partie théorique de la nouvelle méthode de prospection qu'il a proposée et qui a fait l'objet de demandes de brevets en différents pays. Cette méthode dite magnétotellurique s'appuie sur la relation qu'il a étudiée entre les variations du champ électrique tellurique et les variations du champ magnétique horizontal mesurées au même endroit. Cette relation dépend des propriétés électriques du sous-sol, la couche pratiquement intéressée étant d'autant plus épaisse que la fréquence de la composante périodique que l'on considère est plus faible.

L'auteur souligne que sa méthode doit permettre une investigation très profonde (53).

Dans une étude sur la géophysique de la mer, Y. Le Grand et ses collaborateurs étudient les courants telluriques en mer et les f.e.m. induites par le déplacement de l'eau de mer dans le champ terrestre (126).

La Compagnie Générale de Géophysique a poursuivi d'importantes campagnes de prospection électrique tellurique en diverses régions (Bresse, Aquitaine, Algérie, Maroc, Sahara, Gabon, Madagascar). Mais cette compagnie a d'autre part participé activement à des études de recherche pure sur les courants telluriques; par exemple, à l'occasion de l'éclipse solaire de Février 1952, elle a fait procéder à un enregistrement continu, à grande vitesse de déroulement, pendant 24 heures, simultanément en Aquitaine, Sicile, Sahara, Gabon, Vénézuela et Louisiane. Le fait important découvert par M. Schlumberger et G. Kunetz d'une corrélation entre les variations telluriques (et évidemment aussi magnétiques) très rapides en des points éloignés du globe a été précisé par de nouvelles études de G. Kunetz et H. Richard (121), Melle Beaufils (25), et Melle Beaufils, G. Gibault et G. Kunetz (26) et enfin G. Kunetz (118).

Des discussions sur les méthodes de prospection électrique ou des exemples de prospection ont été présentés par A. Roger et Chereau (157), par la S.N.R.E.P.A.L. et R. Bouchon (160), par G. Kunetz et J. Chastenet de Gery (119, 120), par J. Breusse (45) et par M. Guerrier (104).

III. — *Electricité troposphérique*

A. Dauvillier a effectué un enregistrement continu du gradient de potentiel atmosphérique à Khartoum au moment de l'éclipse totale de soleil (59). Au Groënland, P. Pluvinage et P. Stahl ont effectué des observations sur la conductibilité électrique de l'air avec un appareil à deux tubes permettant la mesure directe de la différence des conductibilités positive et négative (146). En Terre Adélie, M. Barré a fait des observations étendues sur les charges électriques apportées par le blizzard sur des antennes horizontales (19). M. Sourdillon poursuivant ses recherches sur la foudre a étudié des éclairs entre nuage et air, soit isolés, soit accompagnant un coup de foudre à cime horizontale (161). R. Guizonnier a cherché une explication de la variation diurne du gradient de potentiel (105).

En ce qui concerne la radioactivité de la troposphère, H. Garrigue a poursuivi son étude des anomalies du contenu radioactif de l'air libre au sommet du Puy-de-Dôme et en avion (90, 91, 93, 94, 95); et M. Abribat et J. Pouradier ont suivi l'évolution des radio-éléments artificiels de l'air de la région parisienne (1); d'autre part, R. Lecolazet et Mme A. Hée ont étudié la mesure en avion de la radioactivité de l'air au moyen d'un gammamètre (124).

IV. — *Radioélectricité de la haute atmosphère*

— *Parasites atmosphériques*

Au L.N.R., à Bagneux, la cadence de succession des atmosphériques est enregistrée sur les longueurs d'ondes suivantes: 60 m, et en km: 1,6; 5; 11; 24; 35; 57 et 70; le champ électrique moyen des atmosphériques défini par F. Carbenay est enregistré en permanence sur 11; 35 et 50 km. Le radiogoniomètre pour très longues ondes est maintenant réglé sur 57 km.

Au point de vue technique et théorique, l'action des atmosphériques sur un récepteur a été analysée par F. Carbenay (54) et d'une façon étendue par E. Fromy (86, 87, 88) et G. Foldès (84, 85) ; R. Bureau et R. Bost ont décrit une méthode permettant la localisation des atmosphériques avec un seul goniomètre et ils ont analysé les résultats obtenus (48, 49). F. Carbenay a observé la correspondance entre le niveau moyen des atmosphériques et le degré d'intelligibilité d'une liaison radioélectrique sur ondes longues (55) et étudié les méthodes d'étalonnement dans l'enregistrement des atmosphériques (56).

Au cours de ses croisières antarctiques le navire polaire "Commandant Charcot", équipé par le L.N.R., a effectué l'enregistrement du niveau moyen des atmosphériques sur 11.000 m et, durant la campagne 1950—1951, des observations au goniomètre cathodique. Les résultats des observations et leur analyse ont été donnés par M. Barré pour la campagne 1948—1949 (18) et par R. Bureau et J. Vaury (50) et J. Vaury et R. Bost (170) pour celle de 1950—1951. M. Barré a rendu compte d'autre part de la longue série d'observations qu'il a faites pendant la campagne 1951—1952 à Port-Martin où il a pu assurer le fonctionnement d'un enregistreur de niveau moyen et d'un radiogoniomètre cathodique (20). Au symposium mondial sur les parasites atmosphériques (Zurich 1953), R. Bost a présenté des observations sur la mise en application du nouveau code des atmosphériques (42) et R. Bureau sur les messages A.T.M.O.S. (47).

— *Sondages ionosphériques*

La France entretient un nombre relativement important de stations de sondage en fonctionnement continu ou en installation: stations du Bureau Ionosphérique Français de Poitiers, Casablanca, Tamanrasset, et Bangui, avec la station expérimentale de Domont (et une station provisoire en Terre Adélie); stations du Service de Prévisions Ionosphériques militaire de Fribourg, Dakar, Djibouti, Tananarive, Kerguelen et Nha-Trang (et une station provisoire sur le Commandant Charcot). Les résultats des observations sont diffusées dans les Bulletins d'information du B.I.F. et du S.P.I.M. Au point de vue technique, on peut signaler la réalisation d'un simulateur d'échos ionosphériques par S. Estrabaud, H. Chazenfus et R. Grosjean (80), l'amélioration des sondeurs du S.P.I.M. par E. Harnischmacher (106) et K. Bibl (36). Dans une étude étendue J. Doublet a discuté le problème du passage des hauteurs virtuelles de réflexion aux hauteurs réelles et proposé une technique simple d'application de la méthode de Rydbeck (68).

Des résultats d'observations ont été analysés par F. Delobeau, E. Harnischmacher et F. Oboril pour Dakar (64), par J. Le Gall, B. Mongin et H. Munier pour les Kerguélen (125). Des résultats détaillés ont été donnés dans des mémoires étendus par A. Haubert pour un an et demi d'observations à Casablanca (109) et par J. Bouquin pour un an d'observations en Terre Adélie (44).

— *Les régions ionosphériques et leurs variations*

R. Eyfrig a analysé l'influence des orages magnétiques sur F_2 et montré que la diminution d'ionisation n'est pas mondiale (81) ; il a étudié une période de forte absorption ionosphérique (83) ; M. Barré et K. Rawer ont décrit les anomalies observées dans des sondages effectués devant la Terre Adélie (21, 22) ; l'effet dit de longitude sur l'ionisation de F_2 a été analysé à nouveau par K. Rawer (147). R. Rivault a fait une discussion étendue sur les stratifications des régions E et F d'où il conclut à la nécessité d'une révision de la nomenclature (152). F. Delobeau a effectué des sondages à Gao, pendant l'éclipse du 25 Février 1952 (63) et il a étudié une stratification fréquente dans les régions tropicales entre F_1 et F_2 (62). K. Bibl a observé des phénomènes transitoires d'ionisation se propageant de haut en bas sur des films d'ionogrammes projetés en accéléré (37). S. Estrabaud a étudié d'après ses observations de Bangui l'effet d'une éclipse solaire sur la région F_2 équatoriale (78) et sur la région E (79) ; K. Rawer a décrit la structure de la couche E_S dans les régions équatoriales magnétiques (148) ; E. Theissen est revenu sur l'étude des caractéristiques de la couche F_1 (167). R. Eyfrig a montré une variation lunaire de l'altitude du centre de la région F_2 à Huancayo (82) ; K. Bibl a étudié la variation diurne de la fréquence critique de E (35). Melle J. Ardillon a entrepris une étude étendue sur les perturbations ionosphériques; ses premiers résultats portent sur les effets diurnes (heures locales de début des chutes de fréquences critiques et variation diurne de l'amplitude des perturbations sur les fréquences critiques et les hauteurs virtuelles) (2), puis sur les orages ionosphériques (3).

P. Lejay et D. Lepechinsky proposent une explication remarquablement simple des propriétés de la région F_2 en examinant, dans le cadre de la théorie de Chapman de la formation des régions ionisées, l'effet de changements de température (129, 130). K. Rawer et E. Argence ont discuté de l'origine de l'ionisation de la région E (149, 150) et K. Rawer, K. Bibl et E. Argence ont tenté de déduire le nombre des chocs dans les régions E et F de l'amplitude des échos multiples (151). J. Gauzit a discuté de la température de la haute atmosphère (96, 97) et R. Gallet a proposé une interprétation de la couche E_s (89). R. Michard a étudié l'effet du rayonnement ultra violet solaire sur l'ionosphère (140). R. Jancel et Th. Kahan reprennent la théorie des propriétés d'un gaz ionisé soumis à un champ électrique oscillant, en présence d'un champ magnétique, et appliquent leurs résultats au cas de l'ionosphère (113, 114, 115, 117, 116) ; le même problème a été examiné par M. Bayet, J. L. Delcroix et J. F. Denisse (24).

— *Propagation radioélectrique*

Différents aspects de la théorie de la propagation des ondes radioélectriques dans l'ionosphère (géométrie des rais et absorption) ont été traités par K. Bibl (34), E. Argence (4, 5, 6, 7), E. Argence, K. Rawer et K. Suchy (8) et G. Dupouy (76).

N. Stoyko et Mme Stoyko ont essayé de concilier les observations faites sur les variations de fréquence et de vitesse apparente de propagation des signaux radioélectriques (166, 165) ; E. Harnischmacher et K. Rawer ont étudié le problème des liaisons antipodes et proposé une explication des faits expérimentaux (108) ; K. Bibl, K. Rawer et E. Theissen ont fait une étude étendue du phénomène de l'occultation des ondes décamétriques par la région E (38) et E. Harnischmacher a montré l'importance des trajets mixtes pour les propagations à très grande distance (107).

P. Lejay, Melle Ardillon et G. Bertaux ont comparé l'intensité du champ reçu de l'émetteur WWV avec l'agitation magnétique et ionosphérique (127, 128). Melle Pillet a comparé aux prévisions du B.I.F. les résultats d'écoute continue des émetteurs WWV et WWVH, faites en France et en Terre Adélie (145). J. Bouchard a rendu compte d'écoutes faites dans les régions arctiques (43) et R. Busch a comparé prévisions et observations pour la liaison Paris-Alger (51). M. Barré, K. Rawer et E. Argence ont suivi les variations de la propagation entre Nouméa et la Terre Adélie (23). J. Maire, enfin, a établi et discuté des résultats d'observations, portant sur plus d'un cycle solaire, faites dans l'exploitation des grandes liaisons radioélectriques intercontinentales (131, 132).

V. — *Optique de la haute atmosphère*

— *Aurores polaires*

Mme R. Herman a interprété et reproduit des bandes nouvelles infra-rouges de Meinel (111, 112) ; D. Barbier et Miss Pettit ont fait en Alaska des observations sur la brillance du ciel auroral, au moyen d'un photomètre photoélectrique automatique de Roach (17).

— *Lumière du ciel crépusculaire*

J. E. Blamont et A. Kastler ont construit un photomètre photoélectrique pour l'étude de la raie D crépusculaire et l'ont utilisé pour déterminer la répartition en altitude des atomes émissifs (41) et J. E. Blamont a proposé une nouvelle méthode d'analyse de la raie D atmosphérique, dans laquelle le rayonnement observé est filtré par une cuve à résonance optique où l'on provoque un déplacement Zeeman variable au moyen d'un champ magnétique (40). M. Dufay a observé et interprété une raie interdite de l'atome neutre d'azote dans les spectres du ciel crépusculaire et nocturne (73, 74) ; il s'est livré d'autre part à une étude étendue de l'émission crépusculaire des bandes de la molécule d'azote ionisée et de la raie 5199 Å de l'atome neutre d'azote (75). R. Robley a tenté le calcul de la polarisation de la lumière du ciel crépusculaire au zénith et a comparé les résultats calculés et observés (153). R. Grandmontagne trouve dans les observations de la température de la haute atmosphère faites au moyen de fusées une confirmation d'une de ses hypothèses antérieures (102). P. Berthier a étudié la dissymétrie des crépuscules du matin et du soir pour les raies rouges de l'oxygène et confirmé l'existence d'un faible renforcement, au crépuscule du soir, des bandes infra-rouges de O_2 et OH (31, 32).

— *Lumière du ciel nocturne*

M. Dufay a observé une nouvelle bande de la molécule OH dans le spectre infra-rouge (72) ; J. Dufay montre que les radiations observées entre 9.000 et 11.000 Å s'interprètent par une émission de la molécule OH découverte par Meinel (69).

H. Garrigue a décrit un photomètre visuel qui est un perfectionnement d'un appareil antérieur (92) ; G. Déjardin, J. Janin et M. Peyron ont fait des observations au laboratoire sur les bandes de vibration-rotation de la molécule OH (60, 61). D. Barbier a donné de nouveaux modes de calcul des corrections de diffusion et discuté le problème de la détermination de l'altitude des couches émettrices (10) et M. Mayot a établi des tables facilitant l'application de la méthode de Barbier dans le calcul des corrections de diffusion (139) ; avec J. Dufay et D. Williams, D. Barbier a effectué, et discuté d'une façon très poussée, des mesures photométriques relatives aux radiations 5577 et 5180 Å (16) ; enfin, il a poursuivi l'étude de la région UV de la lumière du ciel nocturne au moyen d'un photomètre photoélectrique automatique construit à l'Institut d'Astrophysique (12, 13, 14). Ce photomètre a été décrit par A. Baillet, D. Barbier, F. Bosson, A. Lallemand et J. Maguery (9).

P. Berthier a étudié le rapport des intensités des composantes du doublet du sodium (30) et déterminé l'altitude d'émission des bandes infrarouges de O_2 et OH (33) ; J. Dufay, P. Berthier et B. Morignat ont fait par photométrie photographique de nouvelles déterminations de l'altitude d'émission de la raie verte de O_2 (71). Des mises au point sur diverses questions ont été données par J. Cabannes (52), J. Dufay (70) et D. Barbier (15, 11).

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GERMANY

BUNDESREPUBLIK DEUTSCHLAND

A. Fachgebiet Erdmagnetismus

von F. Errulat

1) In den Observatorien Fürstenfeldbruck und Wingst wurden die erdmagnetischen Registrierungen fortgesetzt; das Geophysikalische Institut in Göttingen nahm sie in dem von Gauss begründeten Observatorium wieder auf. Alle 3 Observatorien arbeiteten sowohl mit hochempfindlichen Variometern als auch mit Sturmvariometern.

Vom Observatorium Wingst wurde für 1952 erstmalig die

Reproduktion der Magnetogramme in einem Sonderheft veröffentlicht, um den Vergleich der Registrierungen spezieller Effekte mit denen anderer Observatorien zu ermöglichen. Über die Beobachtungsergebnisse in München (1841—1926), Maisach (1927—32), Fürstenfeldbruck (1939—53) gab *F. Burmeister* eine Zusammenfassung; von Wingst liegen die Jahrbücher bis 1950, die Monats- und Jahresberichte bis 1953 vor (*F. Errulat* und *O. Meyer*).

Zur Sicherung der Basiswerte von H wurden mit Unterstützung der IATME mittels drei QHM Vergleichsmessungen zwischen Rude Skov, Fürstenfeldbruck und Wingst durchgeführt. Es ergab sich eine Basisdifferenz Wingst—Rude Skov = 4,7γ und Fürstenfeldbruck—Rude Skov = 5,8 γ (vgl. *Laursen*, Jahr. d. Obs. Wingst, Nr. 6, 1953).

Vergleichsmessungen Wingst—Fürstenfeldbruck gaben bisher folgende Werte: 1939,7 (Methode v. Lamont): 0 γ; 1941 (QHM): + 3 γ; 1949,9 (Lamont u. QHM): — 1 γ; 1950,2 u. 1952,2 (QHM): — 1 γ; 1952,6 (3 QHM der IATME): — 1 γ.

J. Bartels (Göttingen) fand eine bemerkenswerte Formänderung des winterlichen S_q in Potsdam im Verlaufe eines Sonnenfleckenzyklus; die zusätzliche Wellenstrahlung W, die von der fleckenreichen Sonne ausgeht, scheint tiefer in die Ionosphäre einzudringen, als diejenige der fleckenfreien Sonne (vgl. Zeitschr. der Meteorologie, 5, 236—239. 1951). Im Report des Committee Nr. 13 wird von ihm über die Neuberechnung von S und L für H in Huancayo 1922—1947 berichtet.

2) Eine wesentliche Ergänzung erfuhr die Registrierung von Pulsationen sowie deren Auswertung durch den Einsatz von Induktionsvariographen verschiedener Typen in Göttingen, Fürstenfeldbruck und Wingst. *G. Angenheister* (jun.) fasst die Göttinger Ergebnisse in einer Dissertation zusammen (1953). Nach den Registrierungen in Wingst kann man eine allgemeine Tagesunruhe mit Perioden unter 30 sec und Maximalwerten der Amplitude bei ca. 9—10 Uhr MOZ, von Pulsationen mit Perioden von 30—60 sec unterscheiden, die nachts ihr Maximum haben und mit P-Strahlung zusammenhängen müssen.

Für Fürstenfeldbruck berichtet *K. Burkhart* im wesentlichen ähnliche Ergebnisse; er machte weiter darauf aufmerksam, dass der Tagesgang der ersten Gruppe (10—30 sec) dem Tagesgang der Grenzfrequenz in E und F_1 gleicht. Da die Maxima dieser Gruppe scharf und ohne Übergänge auftreten, bringt er sie in Zusammenhang mit Resonanzeffekten in den E- und F-Schichten.

U. Fleischer (Göttingen) schloss auf Grund von Registrierungen von Baystörungen mit dem transportablen Askania-Variographen auf einen induzierten Erdstrom im tieferen Untergrund Norddeutschlands (Naturwissenschaften, Bd. 41, 114, 1954). Eine umfassende Verarbeitung des Problems der natürlichen Erdströme ist von *R. Bock* aufgenommen worden.

3) Die Potsdamer 3-stündigen Kennziffern und die aus ihnen abgeleiteten Werte wurden von den drei genannten Observatorien laufend mitgeteilt. Die Auswertung und Sammlung von planetarischen Kennziffern Kp betreute *J. Bartels* (Report IATME, Committee 9). Zehntägige Ionosphärenberichte, vom Deutschen Wetterdienst und der Arbeitsgemeinschaft Ionosphäre gemeinsam herausgegeben, ermöglichten die schnelle Bekanntgabe der täglichen Beobachtungen über Sonnentätigkeit, Ionosphäre, erdmagnetische Aktivität, Ultrastrahlung und Längstwellen. Ihr Zweck ist die eventuelle Prognose der 27-tägig wiederkehrenden Erscheinungen.

Besondere Beachtung fanden die speziellen magnetischen Effekte: s.c., s.f.e., und p.s.c.; auf die letzteren machte *O. Meyer* besonders aufmerksam (Deutsche Hydrogr. Zeitschr., Bd. 4, 1951, S. 61).

Über die Fachsparte Ionosphärenforschung gibt *W. Dieminger* einen Sonderbericht (vgl. B).

Im Meteorologischen Institut Köln untersuchte *H. Berg* in mehreren Veröffentlichungen die Korrelationen zwischen erdmagnetischen Daten und biologischen Vorgängen sowie die Struktur des erdmagnetischen Störungscharakters. (Vgl. Zeitschr. f. Geophysik, Sonderband 1953, S. 12—20).

4) Vermessungen und Kartographie: *R. Bock* ergänzte die Karte der magnetischen Deklination in den Niederlanden durch die deutschen Messungen aus dem Jahre 1944 in den Niederlanden wie im deutschen Grenzgebiet und berichtete über deutsche D-Messungen in Frankreich 1940—44 (Annales de l'Institut de Physique du Globe, Bd. XXVI, 1952). Er veröffentlichte eine Karte der Deklination in Hessen für 1922,5 (Notizblatt des Hessischen Landesamts für Bodenforschung, Bd. 81, S. 43—45—47, 1953). Über den Mitteleuropäischen Anteil am paneuropäischen Normalfeld von Z erschien eine Arbeit desselben Verfassers im Geologischen Jahrbuch 66, S. 671, 684, 1952, über den französischen Anteil in Ann. de l'Inst. de Phys. du Globe, Bd. XXVI, S. 66—69, 1952.

Die magnetische Vermessung II. Ordnung von Bayern durch *F. Burmeister* machte weitere Fortschritte, das Gebiet südlich der Donau, d. h. etwa 1/3 von Bayern ist mit mehr als 300 Messpunkten fast abgeschlossen. Es wurden die drei Elemente D, H (mit einem QHM) und Z (mit der Feldwaage) gemessen.

Eine neue Missweisungskarte $1:10^6$ für 1954,0 wurde von *F. Burmeister* bearbeitet; Karten von D, H, Z für 1950,5 von Westdeutschland gab *F. Errulat* im Jahrbuch Nr. 3 des Observatoriums Wingst. Im Auftrage des Deutschen Hydrographischen Instituts bearbeitete *J. Saldukas* das Normalfeld und die Anomalien der Vertikalintensität im Ostseegebiet (Jahrbuch Wingst, Nr. 4).

5) Angewandte Magnetik: Das Institut für angewandte Geophysik in München (*H. Reich*) berichtet über folgende Arbeiten:

1. Erdmagnetische Untersuchungen im Nördlinger Ries von *W. Horrix.* Z- und H-Messungen.
   Ergebnis: Feststellung anormal magnetisierter Basalte im Untergrund des Rieskessels und Feststellung eines Schlotes dieser anormal magnetisierten Basalte.

2. Erdmagnetische Untersuchungen in der Rhön durch *R. Dixiux.* Einige 1000 Stationen mit Z- und H-Messungen wurden dazu benutzt, um die anormale Magnetisierung der Basalte und die Magnetisierungsrichtung in verschiedenen geologischen Epochen festzulegen. Die Magnetisierung der verschiedenen Basalte in der Rhön wurde an geeigneten Proben auch bei hohen Temperaturen (Curie-Punkt) untersucht.

3. Durch einige 100 magnetischer Z- und H-Messungen wurden Züge magnetischer Gesteine im Bayerischen Wald in der Gegend von Bodenmais und Zwiesel im Anschluss an die bekannten Magnetkies-Lagerstätten durch *R. Paulus* untersucht.

4. Das Gebiet der grossen regionalen Störung in der Gegend von Reichenhall wurde durch *R. Gaenger* mit einigen 100 Stationen in Z vermessen.

Bei allen diesen Untersuchungen wurde Anschluss an das Vermessungsnetz I. Ordnung durchgeführt.

Das Amt für Bodenforschung in Hannover liess folgende magnetische Aufnahmen durchführen:

1. Regionalmessungen (Stationsabstand 1—3 km) im Hohen Venn, im Rheinischen Schiefergebirge rechts des Rheins und im Knüllgebirge (Hessen) (1092 Stationen unter 1 km Stationsabstand).

2. Spezialmessungen (Stationsabstand bis 1 m) im Siegerländer Eisenerzbezirk (über und unter Tage), im Hohen Venn (350 Messpunkte), im Fichtelgebirge (600 Messpunkte) und im Hessischen Eisenerzgebiet (15000 Messpunkte). Nach Mitteilung von *K. Jung* gelang es, im Dillgebiet, mit sehr engmaschigen Messungen die geologische Kartierung wesentlich zu unterstützen. Es wurde damit der Magnetik ein Arbeitsgebiet eröffnet, in dem sie bisher wegen der sehr komplizierten geologischen Verhältnisse nicht Fuss fassen konnte.

Vom Deutschen Hydrographischen Institut wurden im Jahre 1952 die Versuche zur Vermessung der Vertikalintensität auf See wieder aufgenommen. Dabei wurde eine Förstersonde in einer Tauchkugel oder im getaucht geschleppten Stromlinienkörper verwandt. Bei den Schleppversuchen betrug infolge häufiger Kabelbrüche die Sicherheit von Z etwa $\pm 100\ \gamma$, in der getauchten Kugel wurden $\pm 50\ \gamma$ erreicht. Die Versuche werden fortgesetzt.

6) Über luftelektrische Arbeiten gibt Herr *Mühleisen* einen Sonderbericht (vgl. C).

H. Israël legt für die gemeinsame Sitzung der erdmagnetischen und meteorologischen Association einen Sonderbericht mit Vorschlägen für das Internationale Geophysikalische Jahr vor, welche die luftelektrische Synopsis, apparative Verbesserungen, Atmospherics und Weltgewittertätigkeit betreffen.

7) *J. Bartels* zeichnete als Herausgeber für den Teil Geophysik des Werkes Landolt Börnstein: Zahlenwerte und Funktionen aus Physik usw., 6. Aufl. Bd. 3, 1952 und bearbeitete mit *F. Burmeister* die erdmagnetischen Abschnitte; die magnetischen Eigenschaften von Mineralien, Erzen, Gesteinen wurden von *M. Rössiger* dargestellt. *H. Israël* bearbeitete den Artikel über Luftelektrizität. *W. Dieminger* den über die Ionosphäre. Über die magnetischen Arbeiten des Deutschen Hydrographischen Instituts einschliesslich Observatorium Wingst vergleiche die Jahresberichte Nr. 6, 7, 8 (1951 bis 1953) dieses Instituts.

Die Deutsche Geophysikalische Gesellschaft gab aus Anlass ihres dreissigjährigen Bestehens einen Sonderband unter Redaktion von *B. Brockamp* heraus.

B. *Fachgebiet Ionosphäre*
von W. Dieminger

I. *Forschungsstellen und Arbeitsgebiete.*

Die Bundesrepublik verfügt nur über eine voll ausgerüstete Ionosphärenstation, die vom Institut für Ionosphärenforschung in der M.P.G. in Lindau am Harz betrieben wird.

Ausserdem befassen sich mit Problemen der Ionosphärenforschung folgende Stellen:

Fernmeldetechnisches Zentralamt in Darmstadt (Dr. *Beckmann*).
Ionosphärenforschungsgruppe Köln (Dr. *Krautkrämer*).
Elektrophys. Institut der T. H. München (Prof. *Schumann*).

1) Das Institut für Ionosphärenforschung führt folgende Routinebeobachtungen durch:

a) Echolotungen mit veränderlicher Frequenz bei senkrechtem Einfall. Frequenzbereich 1—16 MHz, Leistung 10 kW, Messungen in ½ stündlichem Abstand.
b) Echolotungen auf 1,65 MHz bei senkrechtem Einfall.
c) Registrierung der Feldstärke von Funksendern auf 2,6; 2,9 und 3,6 MHz.
d) Registrierung der Horizontalkomponente des erdmagnetischen Feldes.

Die Routinebeobachtungen werden ergänzt durch Echolotungen bei schrägem Einfall über eine Entfernung von 450 km. Frequenzbereich 1—16 MHz.

Die Aufnahme regelmässiger Absorptionsmessungen ist für Mitte 1954 vorgesehen.

Ausserdem werden in Zusammenarbeit mit dem NVDR Reflexionsmessungen auf 971 kHz bei schräger Inzidenz durchgeführt.

Die Arbeit des Instituts konzentriert sich z. Zt. auf Ionosphärenstürme, Echos aus der D-Schicht und Feinstruktur der Ionosphäre.

2) Das FTZ beschäftigt sich in erster Linie mit den Zusammenhängen zwischen dem Zustand der Ionosphäre und dem Funkverkehr. Es unterhält eine Abteilung Funkwetterdienst, deren Aufgabe es ist, Prognosen der Funkausbreitungsbedingungen aufzustellen. Diese werden als Monats-, Wochen- und Halbtagesprognosen ausgegeben. Die Langfristvorhersagen werden auf Grund der Periodizitäten in der Ionosphäre, die Kurzfristprognosen nach synoptischen Methoden aufgestellt. Dazu werden Beobachtungen der Sonne, der kosmischen Ultrastrahlung, des erdmagnetischen Feldes, der Ionosphäre und des Funkverkehrs herangezogen, die täglich beim Funkwetterdienst zusammenlaufen (pro Tag etwa 1000 Werte).

3) Die Forschungsgruppe Köln führt im Rahmen internationaler Verabredungen Windmessungen in der Ionosphäre nach der Methode von *Krautkrämer — Mitra* durch. Theoretische Arbeiten der Gruppe befassen sich mit der Deutung der Beobachtungen und mit Fragen der Wellenausbreitung in der Ionosphäre.

4) Im Elektrophysikalischen Institut der T. H. München wird vor allem der Einfluss der Ionosphäre auf die Ausbreitung sehr langer Wellen ($\lambda > 10$ km) untersucht. Hierzu werden laufend Feldstärkeregistrierungen von entfernten Längstwellensendern durchgeführt. Die Ergebnisse werden mit den Echolotungen und mit anderen geophysikalischen Daten verglichen. Theoretische Arbeiten befassen sich mit dem Verhalten des Systems Erde—Atmosphäre—Ionosphäre bei Anregung durch sehr lange Wellen. Für die Berechnung von Strahlwegen bei der Ausbreitung von Kurzwellen in der Ionosphäre wurde ein graphisches Verfahren entwickelt.

II. *Ursigramme.*

Auf Grund einer Vereinbarung, die im April 1951 in Paris getroffen wurde, beteiligt sich die Bundesrepublik am europäischen Ursigrammdienst. Die Ursigramme werden in Paris aus Beobachtungen deutscher, französischer und niederländischer Institute zusammengestellt und über den Sender Pontoise mehrmals täglich auf verschiedenen Frequenzen ausgestrahlt. Die Sammlung und Weiterleitung der deutschen Beiträge hat der

Funkwetterdienst der Bundespost übernommen. Diese Stelle übermittelt auch die Ursigramme täglich auf dem Drahtweg den daran interessierten deutschen geophysikalischen Instituten.

III. *Organisation.*

Die deutschen Institute und Wissenschaftler, die an der Ionosphärenforschung interessiert sind, haben sich zu der "Arbeitsgemeinschaft Ionosphäre der deutschen geophysikalischen Institute" zusammengeschlossen. Diese Arbeitsgemeinschaft bildet seit der Aufnahme der Bundesrepublik in die URSI im Jahre 1952 den Grundstock des deutschen URSI-Landesausschusses und hält gleichzeitig mit diesem einmal im Jahr eine Arbeitstagung ab.

C. Fachgebiet Luftelektrizität

von R. Mühleisen

Es besteht seit langem der Wunsch, auf dem Weg über luftelektrische Dauerregistrierungen die Stärke der Weltgewittertätigkeit zu verfolgen, und so den täglichen und jährlichen Verlauf zu erhalten. Dies schien möglich, nachdem man erkannt hatte, dass der Ursprung des elektrischen Feldes in der Atmosphäre bei Schönwetter in der elektrischen Ladungstrennung in den Gewitterwolken zu suchen ist, und dass sich diese Ladungen in Schichten über 40—60 km Höhe und in der Erdoberfläche in kürzester Zeit über den Erdball verteilen. So ist die Tatsache zu verstehen, dass wegen der zeitlich fast konstanten elektrischen Leitfähigkeit der Luft über den Ozeanen dort der Gang des luftelektrischen Potentialgradienten parallel zum Gang der Gewittertätigkeit ist.

An den luftelektrischen Untersuchungsstellen auf dem Kontinent wurden aber Tagesgänge registriert, die einen Zusammenhang mit der Weltgewittertätigkeit nicht mehr erkennen liessen. Das hat seine Ursachen einmal in den starken Leitfähigkeitsschwankungen der kontinentalen Luft der unteren Troposphäre, die wiederum von dem täglichen Gang der Dichte der Kondensationskerne abhängt. Deren Verteilung richtet sich stark nach dem vertikalen Luftmassenaustausch. Wenn dadurch Leitfähigkeitsänderungen eintreten, so verändern sie damit nur den untersten Teil des Säulenwiderstandes, und es dürfte eine Änderung des vertikalen Leitungsstromes nur im geringen Umfang eintreten. Weil dieses aber an den meisten Stationen nicht gefunden wird, sondern der Tagesgang des Vertikalstromes ebenfalls starke Schwankungen aufweist, mussten über Land noch weitere Ursachen als Quellen für luftelektrische Felder vermutet werden.

An der Entdeckung dieser Ursachen haben wir gearbeitet und schon eine grössere Anzahl Ergebnisse erhalten. Zu diesem Zweck sind von uns einmal zuverlässige und leicht transportable, also mechanisch unempfindliche Messgeräte entwickelt worden zur Messung des Potentialgradienten, des Vertikalstroms, der elektrischen Raumladungsdichte und der Zahl der Kleinionen. Mit diesen Geräten wurden nun luftelektrische Messungen dort angestellt, wo die grössten Störungen der luftelektrischen Elemente erwartet wurden, nämlich in der Grossstadt, an Verkehrsknotenpunkten der Eisenbahn, der Kraftwagen und in Industriebezirken.

Das wichtigste Ergebnis all dieser Untersuchungen ist, dass neben der starken Kernproduktion dieser Gebiete eine Menge geladener Teilchen, nämlich Grossionen, in die Luft gesandt werden, die zu beträchtlichen, grösstenteils positiven Raumladungen führen, weil sie positives Vorzeichen haben. Sie erhöhen so das vom Potential der Ausgleichsschicht herrührende Feld am Erdboden und führen ausserdem zu starken Schwankungen des Feldes am Erdboden. Negative Raumladungen wurden ebenfalls gefunden. Ihr Ursprungsort ist z. T. in den chemischen Fabriken und Laboratorien zu suchen oder an Stellen bei ungenügender Verbrennung.

Die Raumladungen haben grosse Beständigkeit und Lebensdauer in der Grössenordnung von Stunden und werden deshalb vom Wind weit fortgetragen.

Quellen solcher Raumladungen sind auch ausserhalb der Grossstädte, Verkehrszentren u. a. zu erwarten, bis jetzt aber erst zum Teil bekannt. So verursachen Hochspannungsleitungen sehr unregelmässige, aber weitreichende Störungen mit grossen Amplituden. Andere Störungen werden vermutlich von Stellen ausgehen, an denen die Ionisierungsstärke örtlich oder zeitlich stark wechselt, z. B. an der Grenze von Ackerland, Wäldern und Seen.

Diese Untersuchungen sollen fortgesetzt werden. Schon mit den bisherigen Erfahrungen lassen sich viele frühere Registrierungen, insbesondere in der Nachbarschaft von Grossstädten, erklären. Die hohen Werte der Feldstärke am Vormittag zwischen 6 und 8 Uhr Ortszeit entstehen, weil um diese Zeit viele Öfen in Wohnungen und Industrie angeheizt oder geschürt werden, der Kraftverkehr stark einsetzt usw. Im Winter zeigt die Mittagszeit wieder hohe Werte wegen der Herdfeuerungen, während im Sommer die gerade über der Grossstadt kräftig aufsteigende Luft die Raumladungen wegschafft. Mit dem Ende der menschlichen Tätigkeiten am Abend fällt das luftelektrische Potential stark ab.

Bei bestimmten Wetterlagen sind die geschilderten Störungen fast verschwunden. Dies tritt ein, wenn kräftiger Wind über 3 m/s bei wolkenlosem oder nur teilweise bedecktem Himmel weht und die entstandenen Kerne und Raumladungen schnell wegführt, also keine nennenswerte Konzentration der Kerne und Grossionen zulässt. Abgesehen von einem kurzen Anstieg am Morgen ist das Potential auch am Tage niedrig und sein Verlauf lässt schon einen Vergleich mit den ozeanischen Werten zu.

Das Ziel all dieser Untersuchungen ist, Erfahrungen zu sammeln und Messgeräte zu entwickeln, mit denen man die Registrierungen luftelektrischer Elemente an beliebigen Orten einwandfrei deuten kann. So muss es dann auch möglich werden, Orte ausfindig zu machen, an denen Registrierungen erhalten werden, die weitgehend nur von der Spannung der luftelektrischen Ausgleichsschicht und damit von der Elektrizitätsproduktion aller Gewitter der Erde abhängen. Von *Israël, Kasimir* und *Wienert* ist dies schon auf Bergspitzen, auf dem Jungfraujoch, der Zugspitze u. a., versucht worden. Wegen der Raumladungen, die durch Schneewehen entstehen, sind aber solche Registrierungen ebenfalls während langer Zeiten bei Schönwetter gestört. Wir suchen deshalb nach Messstellen, die tiefer gelegen sind, die aber ihrer Geländebeschaffung nach weitgehend ungestörte Registrierungen zulassen.

Das Kriterium für ungestörte Registrierungen luftelektrischer Elemente ist der parallele Gang an mehreren mit diesem Ziel ausgesuchten und weit auseinanderliegenden Orten. Wir werden versuchen, diese Messstellen in unserer Nachbarschaft zu finden und haben vorgeschlagen, im *Geophysikalischen Jahr* dieses Netz über die Grenzen auszudehnen. Dazu ist aber notwendig, dass die ausländischen Stationen in gleicher Weise an ausgesuchten Orten eingerichtet werden.

Als zweites luftelektrisches Thema zum Geophysikalischen Jahr ist von uns vorgeschlagen worden, die luftelektrische Leitfähigkeit der Luft mit Ballonaufstiegen zwischen 5 und 25 km Höhe zu messen. Es sind uns 2 Arbeiten bekannt, aus denen Hinweise auf sehr unregelmässige Leitfähigkeitsverläufe mit der Höhe zwischen 10 und 20 km Höhe vermutet werden. Nur eine Reihe von Aufstiegen zur Leitfähigkeitsuntersuchung wird hier praktische Ergebnisse bringen. Wir haben die Absicht, in diesem und im nächsten Jahr Versuche zu unternehmen, um dann sicher für das Geophys. Jahr eine einfache Aufstiegsapparatur, wahrscheinlich mit einer Radiosonde gekoppelt, vorschlagen zu können.

GREAT BRITAIN

British National Report on Terrestrial Magnetism, Electricity and Aurora 1952—54

A. Terrestrial Magnetism and Electricity

1. Royal Greenwich Observatory.

During the period 1952—54 the routine work of the Abinger Magnetic Observatory has continued. Some trouble was experienced when observing with the Dye vertical intensity coil magnetometer due to the alternator employed in supplying A/C to the oscillating coil. In consequence of this the alternator has been replaced by an electronic oscillator.

A number of tubular compasses have been tested at the observatory prior to their being issued to H. M. Ships for the purpose of making declination observations upon land.

On the suggestion of Professor Chapman an analysis of the bi-hourly values of D, H and Z recorded since 1916 at Greenwich and Abinger has been undertaken. Hollerith Cards, covering the period 1916—1949, have been punched, but the analysis has been held in abeyance in consequence of the large amount of work involved in the preparation of the Admiralty World Magnetic Charts for the epoch 1955.0.

The work of preparing these charts has been carried out during the period under review. This work has included the preparation of the initial D and H charts, which have been subjected to a preliminary spherical harmonic analysis. Revised versions of the charts have then undergone a second analysis, following which the final D and H charts have been drawn up.

The constants obtained from the second analysis have been employed in the synthesis of a basic Z chart, which has been slightly modified in places where observational data have made this seem necessary. In general, however, the observations have been in satisfactory agreement with the synthetic values.

Finally, charts of Inclination and Total Field have been drawn up, together with secular variation charts of all these elements: and the X and Y charts are in course of preparation.

A paper entitled "The Distribution of Great and Small Geomagnetic Storms in the Sunspot Cycle" is in course of publication. The Greenwich data come from the seven sunspot cycles 1879—1953.

Annual lists of geomagnetic storms recorded at Abinger have been published for the years 1951—53 in "The Observatory".

A start has been made on the compilation of an Appendix to the *Greenwich Observations* that will contain Greenwich sunspot and geomagnetic-storm data from 1874 (when the sunspot observations began) to 1954. It is proposed to include (1) monthly values of the mean daily area of sunspots: (2) a list of sunspots with mean daily area during disk passage of $\geqq$ 500 millionths of the Sun's hemisphere: (3) complete lists of great and small geomagnetic storms, 1874—1954 with appropriate sunspot data. A list of the greater storms recorded at Greenwich from 1840 to 1874 might also be added.

The results of the harmonic analysis of the Earth's magnetic field, as depicted on the Admiralty World Magnetic Charts for epoch 1942.0, which were prepared at the Royal Observatory, together with a discussion, have been published in the Geophysical Supplement of the Monthly Notices, 6, 409—430, 1953.

The Royal Greenwich Observatory has commenced the continuous recording of the general cosmic ray flux. The recording of the rare high energy showers is also to be undertaken.

2. *Observatories of the Meteorological Office, Lerwick, Eskdalemuir and Kew, and investigational work at Meteorological Office, Edinburgh.*

La Cour magnetographs working on the ordinary time scale of 15 mm. to the hour and also similar quick-run instruments continued in operation at Lerwick and Eskdalemuir. Any small gaps in these records were completed from the records of supplementary less-sensitive magnetographs. At both observatories the orientation of the magnet systems has been checked.

Absolute measurements at Eskdalemuir were made twice or thrice weekly, or more frequently, by means of the Schuster-Smith coil for H, the Kew unifilar magnetometer for D and the Schultze inductor for I; Q.H.M. and B.M.Z. magnetometers were also in use. At Lerwick similar instruments were used for H and D, but a B.M. instrument was used for Z until 1953 when it was refashioned into a B.M.Z. instrument in Denmark. Some intercomparison between the two observatories has been effected by means of Q.H.M. and B.M.Z. instruments.

Recalibration, at the National Physical Laboratory in 1953, of the potentiometer used with the Smith coil at Lerwick revealed that a change had taken place in the value of the standard resistances. The change is of a magnitude to alter the value of H by about 7 γ. The potentiometer used at Eskdalemuir is being recalibrated at the time of writing this report.

Measurement of the magnetograms and the allocation of daily magnetic character figure (C) and three-hourly indices (K) has been undertaken at the observatories. Further computational work and the preparation of copy for the Observatories' Year Book was done in the Meteorological Office, Edinburgh. Publication of the Year Book, with the volume for 1938, is to be resumed in the near future.

Daily character figures and K indices along with particulars of solar flare effects, sudden commencements, sudden impulses and $3K_s$ figures have been supplied regularly to De Bilt in accordance with international agreement. The K indices have been published in the Journal of Atmospheric and Terrestrial Physics. Various magnetic information and copies of magnetograms have been supplied regularly or on request to journals, individuals or institutions concerned with mining or ionospheric research.

An auroral watch was maintained at Lerwick during the night hours, except in a period around the summer solstice when the twilight intensity prevents visual observation.

Investigational work continued in the Meteorological Office, Edinburgh. The following publications on geomagnetic subjects, or on topics which have arisen in the course of geomagnetic studies, may be mentioned —

D. H. McIntosh — Geomagnetic solar flare effects at Lerwick and Eskdalemuir. J. Atmos. Terr. Phys., London, 1, p. 315 (1951).
R. P. Waldo Lewis and D. H. McIntosh — Geophysical and meteorological changes in the period January to April, 1949. Nature, London, 170, p. 488 (1952) and 171, p. 968 (1953).
R. P. Waldo Lewis and D. H. McIntosh — Atmospheric pressure and geomagnetic disturbance. Nature, London, 169, p. 1059 (1952).
R. P. Waldo Lewis and D. H. McIntosh — Some effects of the coherence of meteorological time series. Met. Mag., London, 81, p. 242 (1952).
R. P. Waldo Lewis and D. H. McIntosh — Diurnal and storm-time variations of geomagnetic and ionospheric disturbance. J. Atmos. Terr. Phys., London, 3, p. 186 (1953).
R. P. Waldo Lewis and D. H. McIntosh — Geomagnetic and ionospheric relationships. J. Atmos. Terr. Phys., London, 4, p. 44 (1953).
R. P. Waldo Lewis and D. H. McIntosh — A universal time component in geomagnetic disturbance. J. Atmos. Terr. Phys., London, 4, p. 78 (1953).
D. H. McIntosh — Solar and terrestrial relationships. Met Mag., London, 82, p. 11 (1953).
R. P. Waldo Lewis and D. H. McIntosh — Statistical analysis of geophysical time series. Met. Mag., London, 82, p. 239 (1953).
R. P. Waldo Lewis and D. H. McIntosh — Recurrence tendencies in Kew surface pressure. Met. Mag., London, 82, p. 301 (1953).

Other papers recently prepared for publication deal with the relation between the geomagnetic field and range disturbance in various latitudes, and the geomagnetic post-perturbation effect.

At each observatory continuous records of the electric potential at a fixed point have been made. Necessary observations are made to reduce these records to potential gradient over a level surface. The electrical potential gradient at Kew is greatly affected by local atmospheric pollution: there are considerable periods of negative gradient in the absence of rain. At Kew simultaneous measurements of potential gradient and air-earth current have been made at about 1500 G.M.T. on undisturbed days.

B. Aurora

Abridged from Report by Mr. Paton

1. Photographic Work.

Stations equipped with auroral cameras and linked by telephone have been maintained at Abernethy, Blairgowrie and Rosneath. During 1952 and 1953, auroral forms visible in Central Scotland have been almost invariably diffuse glows and weak low arcs, which have yielded no measurable parallactic photographs. However, photographs have been taken at Abernethy to provide a record of the nature of current auroral activity.

2. Visual Observation: The Aurora Survey.

As the new director of the Aurora and Zodiacal Light Section of the British Astronomical Association, Mr. Paton has arranged for the thirty observers in the Section to make nightly observations of the sky and to record whether aurora was present or absent or if cloud or bright moonlight made observations doubtful or impracticable. During displays an accurately timed log of auroral forms and changes is kept. Promising results have been obtained and the network of observations is being extended. The voluntary observers include flying officers of British civil airlines and the Royal Air Force: arising out of the interest and co-operation of British Overseas Airways Corporation, regular observations made on transatlantic flights are providing fruitful.

By arrangement with the Chief Scientist, observations have been made by the British North Greenland Expedition, 1952—54. The first winter's observations, made in remarkably clear weather, reveal a quite unexpectedly high frequency of occurrence of aurora within ten degrees of the geomagnetic axis pole. In addition, two observers are situated in Iceland.

The Marine Superintendent of the Meteorological Office has arranged that selected ships should make observations according to a scheme outlined in the "Marine Observer" August, 1953.

Finally, the Director of the Meteorological Office has granted permission for observers at certain northern stations of the Meteorological Office to make brief auroral reports on specially prepared forms at each observing hour during the night.

All these reports have contributed to the success of the Survey and it now seems certain that only on very few occasions during the occurrence of very widespread cloud or bright moonlight or twilight can an aurora remain unobserved over the region from Iceland to the English Channel.

3. *The Combination and Analysis of Observations.*

Most of the observations are made within the zone lying between geomagnetic longitude lines 70° and 90°. They are therefore assembled in groups, each of which comprises the observations made within ½° of each geomagnetic latitude. Each group is then examined one day at a time and the synthesis of the information contained in them entered on the chart for the day. The graph entry is a horizontal line, its ordinate giving the latitude of the zone and its range of abscissae, the period of time to which the observations refer. A wavy pencil line indicates that cloud or some other obscuring factor makes observation impossible; a blue ink line shows that aurora is absent and a red line that it is present. In the latter case, symbols show which forms are present and their intensities and elevations throughout the night in this latitude. Observations in each latitude are similarly plotted so that the final diagram provides a synoptic picture of the aurora and its development during the night. The time scale extends through the 24 hours of the day so that solar and ionospheric events may also be entered. The time scale is so chosen that easy comparison may be made with magnetograms from the magnetic observatories.

One would wish to plot also a diagram showing only the position of overhead auroras, the need for which has been emphasised by Professor Chapman. Approximate diagrams of this kind may be prepared from the present daily charts using the observed elevations of lower borders and assuming them to be at 100 km. When aurora comes southwards over our network, it will become possible to prepare such diagrams from direct observation.

Preliminary analyses for 1952 and 1953 have appeared in "The Observatory" of February 1953 and February 1954. Some interesting series of 27-day recurrence sequences of long duration, associated with solar M-regions, have been found. It is hoped to continue the preparation of these daily charts during a complete solar cycle, i.e. until 1964.

C. British Theoretical Researches

Report by Professor V. C. A. Ferraro and Professor A. T. Price

1. The earth's main field and its secular variation.

In a paper entitled "A negative experiment relating to magnetism and the earth's rotation", P. M. S. Blackett (1952, Phil. Trans. A *245*, 309) has described a laboratory experiment carried out to test the Schuster-Wilson hypothesis that the earth's magnetism might be due to some fundamental relation between rotation and magnetism, which would only become important for massive bodies. The experiment involved examining whether a heavy body (actually 10×10 cm. cylinder of gold), at rest in the laboratory and so rotating with the earth, would appear to an observer, also rotating with the earth, to produce a weak magnetic field of order 10^{-8} gauss. That such a field might exist is a plausible deduction from a particular form of the Schuster-Wilson hypothesis considered in some detail by Chapman and Runcorn. The experiment showed that no such field exists. This confirms the independent refutation of the hypothesis based on the measurements made by S. K. Runcorn, A. C. Benson, A. F. Moore and D. H. Griffith (1951, Phil. Trans. A, *244*, 113) of the variation with depth below the earth's surface of the main geomagnetic field. Blackett's experiment involved the construction of a very sensitive astatic magnetometer which has since proved particularly suitable for the measurement of the remanent magnetisation of weakly magnetised geological specimens.

The remanent magnetism of rocks and the history of the geomagnetic field has been discussed by J. Hospers (1951, Nature (Lond.) *168*, 111; see also A. T. Price, 1953, Nature (Lond.) *172*, 786). Hospers has made a series of measurements of the natural permanent magnetisation of lava flows and sediments found in Iceland and he has found that a proportion of these are polarised in a direction opposite to that of the present field. The mechanism of magnetisation of these Icelandic lavas differs from that of the reverse thermoremanent magnetisation of certain lavas in Japan, described by T. Nagata, and Hospers concludes that his results can only be satisfactorily explained on the assumption that the earth's field has been reversed at least three times since the Miocene era. Some of the statistical problems involved in the evaluation of Hospers' data have been discussed by Sir Ronald Fisher (1953, Proc. Roy. Soc. A *217*, 295).

A dynamo theory of the earth's main field, which attributes the field to electric currents generated in the earth's liquid metallic core by the interaction of fluid motions in the core with the internal magnetic field of the currents themselves, was proposed by E. C. (now Sir Edward) Bullard in 1949, and described in our 1951 report. A doubt has existed as to whether there is not some general principle, such as an extension of Cowling's theorem, which would prohibit the existence of such a terrestrial dynamo. An elaborate mathematical investigation designed to settle this point has recently been completed by E. C. Bullard and H. Gellman (1954, Phil. Trans. A, in press February, 1954). The main problem discussed in this paper is whether Maxwell's equations, together with the relevant boundary conditions, for a sphere of electrically conducting fluid, in which there are fluid motions of *specified form*, possess solutions which are steady in time. It resolves itself into the question of the existence or non-existence of real values of a certain parameter V, which would permit the homogeneous differential equations for the magnetic field $\underline{H}$, namely $\nabla^2 \underline{H} + 4\pi K \operatorname{curl} (V \underline{v} \wedge \underline{H}) = 0$ with $\operatorname{div} \underline{H} = 0$ and the relevant boundary conditions, to have non-trivial solutions. The vector $\underline{v}$ specifies the form of the fluid motions, the parameter V determines their magnitude; K is the conductivity in e.m.u. Thus the problem is to determine the eigenvalues V of the above equation, and the corresponding characteristic functions for $\underline{H}$. The prescribed velocity field $\underline{v}$ and the required magnetic field $\underline{H}$ are each expressed in terms of surface spherical harmonics multiplied by functions of the distance r from the centre of the sphere. This leads to an infinite set of simultaneous linear ordinary differential equations in r, in which the dependent variables are the radial functions associated with the various harmonics in the magnetic field. Various numerical methods of investigating these equations and of determining the characteristic values of V are developed.

Some simple cases involving only one or two differential equations are treated analytically by E. C. Bullard in another paper (1954, to be published probably in Proc. Camb. Phil. Soc.), and in these cases it is proved that solutions exist when certain conditions are satisfied by the imposed velocity distribution. But in order to establish the existence of the terrestrial dynamo it is necessary to treat the above infinite system of equations.

Following Elsasser's earlier work, Bullard and Gellman develop "selection rules" for investigating the nature of the reactions between the various harmonics in the velocity and magnetic fields. They show that there are only three velocity fields, out of those obtained by combining motions corresponding to surface harmonics of degrees one and two, which are likely to produce dynamo effects of the type required to explain the earth's field. These are denoted by $T_1 S_1^c$, $T_1 S_2^{2c}$, where T_1 indicates a toroidal field of the form curl $\{\underline{r}\ T(r)\ P_1(\cos\Theta)\}$ and S_m^{mc} denotes a poloidal field of the form curl curl $\{\underline{r}\ S(r) P_n^m(\cos\Theta)\cos m\}$.

The infinite set of equations for the magnetic field associated with the particular motion $T_1 S_2^{2c}$ is considered in detail for various simple polynomial forms of the radial functions $T(r)$ and $S(r)$. It is shown that, when alle the harmonics in the magnetic field above degree four are ignored, non-trivial solutions exist for the set of twelve equations which remain. These twelve equations are used to determine the lowest critical value V and the corresponding characteristic radial functions in a number of cases. This incidentally involved considerable numerical work, requiring some two hundred and forty hours of operating the A.C.E. electronic computer.

An elaborate investigation was then made of the orders of magnitude of the modifications which would be made in the solution by taking additional equations. The results afford a strong indication, though not a complete proof, that V tends to a finite value as the number of equations tend to infinity and that consequently a solution of the required type does exist. Bullard and Gellman have thus succeeded in removing any serious doubt that a self-existing terrestrial dynamo is a mathematically possible mechanism.

They then show that this mechanism can probably provide a satisfactory explanation of the earth's observed dipole field, and they obtain rough estimates of the various quantities involved. These estimates are of course affected by the forms of the fluid motions, S_2^{2c} and T_1, specified in their mathematical problem. These motions may not correspond very closely to those actually existing in the earth's core, but they are thought to exhibit some of the likely features of those motions, and they are adjusted so as to satisfy roughly one dynamical requirement, namely, the conservation of angular momentum. The resulting magnetic field, as determined by their mathematical solution, contains not only the poloidal field S_1, which is identified with the observed dipole field, but also a much larger toroidal field T_2, which is confined within the core.

The magnitude of the S_2^{2c} motion required for the steady dynamo is independent of the absolute magnitude of the magnetic field, and is determined by the characteristic value V and the assumed value of the conductivity K. Taking this as 3.10^{-6} e.m.u, the corresponding maximum radial velocity of the fluid is estimated to be 0.013 cm./sec. This S_2^{2c} motion, which is probably generated by thermal effects, would, in a rotating sphere, involve a continuous flow of angular momentum radially inwards and lead to the T_1 motion. In a steady motion this transfer of angular momentum must be balanced by electromagnetic couples which transfer it back again to the outer part of the core. These couples are principally due to the interaction of the known S_1 field with the currents which produce the T_2 field. Hence the angular momentum balance can be used to estimate T_2. This is found to be large, the maximum value of the field being 860 gauss, but this would be reduced if K were larger. The strength of the T_2 field can be used to estimate the T_1 velocity; the maximum value of this velocity is 0.041 cm./sec. Bullard and Gellman emphasise that all these estimates are very rough, but they do not regard them as unreasonable.

A new spherical harmonic analysis of the main field for the epoch 1942—5 has been published by Sir Harold Spencer Jones and P. J. Melotte (Mon. Not. R.A.S., Geophys. Suppl. *6* 409, 1953). This shows that within the limits of experimental error the field is entirely of internal origin, there being no evidence of a dipole field of external origin greater than 0.1 per cent of the field of internal origin. Comparison with earlier analyses indicates that the intensity of the dipole field has decreased by nearly 5 per cent during the last century. It has however been pointed out by E. C. Bullard (1953, Journ. Geophys. Research *58*, 277) that this decrease appears to have stopped about 1936, and the field is now increasing.

A. T. Price and H. Vestine (paper to appear probably in Journ. Geophys. Research) call attention to the fact that the rate of decrease of the dipole field has been more rapid than the rate of free decay of simple current systems in the core, if the conductivity there is taken as 3.10^{-6} e.m.u. Hence either the conductivity is less than this, or the current generator responsible for the dipole field has, during the last century, been operating in reverse. They also discuss some effects of the mantle on the secular variation and obtain an estimate of 10^{-9} e.m.u. for its mean conductivity from a study of the apparent phase difference between fluctuations in the rate of the earth's rotation and in the rate of the westward drift of the secular variation field.

S. K. Runcorn (1954, Trans. Amer. Geophys. Union and papers in preparation) has studied the effects of thermo-electric potential differences between the silicate mantle and the metallic core.

He has shown that, if temperature differences caused by heat convection exist on the surface of the core, electric currents will be set up giving rise to a toroidal magnetic field, which may interact with motions in the core to produce the observed external field. Some of the implications of this hypothesis have been considered by F. J. Lowes (1953, Nature *172,* 786). The importance of these thermo-electric effects would greatly depend on the electrical conductivity of the lower part of the mantle and Runcorn and his associates have undertaken several investigations relating to this, some of which are referred to below. The results lead Runcorn to estimate that the conductivity may be as high as 10^{-8} e.m.u.

H. Hughes and A. F. Moore (unpublished, Feb. 1954) have analysed the frequency spectrum of the secular variation and find that their results can be explained in terms of electromagnetic screening by the mantle. Runcorn (paper shortly to be published) has investigated the electromagnetic torques exerted on the earth's mantle by the magnetic field of currents in the core, and has shown that, in order for these to be large enough to explain the irregular changes in the length of the day, a considerable toroidal magnetic field must exist in the lower part of the mantle.

H. Hughes (1953, Nature *172,* 786 and paper in preparation) has studied both experimentally and theoretically the electrical conductivity of the mantle, the main constituent of which is probably some form of olivine. From laboratory experiments he deduces that, at temperatures well above 1000°C olivine behaves like an ionic semi-conductor, so that the conductivity may be expressed in the form $K = K_0 \exp(-A/kT)$. This affords an explanation of the increase of conductivity with depth in the mantle, which was inferred by Chapman, Price and Lahiri from studies of the short time variations of the geomagnetic field. Using Price and Lahiri estimates of K at depths down to 900 km. he derives values of K_0 and T, which are of the same order of magnitude as those obtained experimentally. He therefore uses the above formula to obtain an estimate of K at the base of the mantle. This is of order 3.10^{-8} e.m.u.

A. T. Price and L. B. Slichter (1953, Proc. Roy. Soc. A, *216,* 434) in a short note point out that the method previously proposed by Slichter for determining experimentally the distribution of K within the earth by an electromagnetic induction method, would fail for certain special simple distributions of the exiting field.

Some experiments which may throw light on the types of convection which can occur within the earth's core have been made by R. Hide (1953, Quart. J. R. Met. Soc. *79,* 161 and paper in preparation). He has investigated the thermal convection in a liquid between two concentric cylinders at different temperatures, rotating with the same angular velocity. If the Coriolis forces are strong, a jet stream is produced, and long cyclonic waves are also observed. The wave system rotates slowly with respect to the cylinders. The Coriolis forces appear to be nearly balanced by the pressure forces. This suggests that motions inside the earth may be mainly two-dimensional. At higher angular velocities the two-dimensional pattern, which is otherwise stable, oscillates between a form in which the jet stream is continuous and a form in which the streams form closed eddies. It is suggested that the rapid changes in the secular variation may perhaps originate in such instabilities in the earth's core.

S. Chapman (1951, Arch. f. Meteor. A. *4*, 368) has discussed the equatorial electrojet as detected from the abnormally large range of the daily variation of the horizontal component of magnetic force at Huancayo and elsewhere near the magnetic equator. He has made illustrative calculations in order to show what data it is desirable to obtain in order to estimate the height, intensity, width and return current flow of the electrojet. The importance of measuring the daily variation of the vertical force at stations north and south of the electrojet is emphasized.

2. *Magnetic storms.*

The discovery that the quiet day solar daily variation S_q was abnormal at Huancayo naturally raised the question as to whether the same was true of geomagnetic disturbances there. Chapman (Geofis. Pura e Applicata *19,* 1951) has shown that it is in fact normal, that is, comparable with that shown elsewhere in similar latitudes. The normality is manifested by both the disturbance daily variation S_D and by the storm-time variation D_{st}. In the latter case this normality is in accord with the Chapman-Ferraro theory of magnetic storms, but the normality of S_D is less easy to explain.

In another paper dealing with the morphology of geomagnetic storms Chapman (Ann. di. Geofisica, *5,* 481, 1952) reconsiders the part of the disturbance field which has a simple form relative to the meridian passing through the Sun. In the case of weak or moderate storms this reveals itself as an addition to the solar daily variation S and is denoted by S_D (disturbance daily variation). But during the storms with definite commencement the average march of the part of the D field can be followed not only from one day to the next, as has been done in the past, but also for over shorter periods (as for storms whose duration is less than one day). When this is done it is not a daily variation that is found but a disturbed field changing in form and intensity with storm-time. Chapman denotes this by D_S (disturbance local time inequality). Its variation with storm-time differs from that of the D variations developing more quickly than the main phase of D_{st}.

The theory of the first phase of a geomagnetic storm has been further elaborated by V.C.A. Ferraro (J. Geophys. Res. *57,* 15,

1952) by considering the advance of a semi-infinite ionised corpuscular stream in a unidirectional and variable magnetic field parallel to the plane boundary of the stream. It is found that the unaccelerated ions and electrons from the back of the stream (which is shielded from the earth's magnetic field by induced surface currents) overtake the ions and electrons in the surface layers so that the surface of the stream is constantly reformed by new particles. In this way the particles in the stream are able to penetrate further into the field than would be the case if they were alone in it. The sudden increase in the horizontal force produced outside the stream by the induced currents near the earth is identified with the sudden commencement (SC) of a magnetic storm. The earlier calculations of Chapman and Ferraro on the reduction of velocity of the front surface of the stream agree well with the new calculations made in this paper.

H. W. Newton and A. S. Milson (1954, to appear in June issue of Journal of Geophysical Research) have discussed the distributions throughout the sunspot cycle of (i) great magnetic storms, (ii) small storms with sudden commencements (SC's) and (iii) small non-SC storms. A close accordance was found between the averaged sun-spot curve for the past seven cycles and the averaged curves for the storms of types (i) and (ii). There is also good correlation of these storms with the occurrence of giant sunspots, solar flares of great magnitudes and notable auroral displays. The distribution of the small non-SC storms throughout the solar cycle is of a different form and the relationship with sunspots at storm onset is also different. The broad division of small storms into those with and without SC's appears therefore to be of intrinsic significance and probably related to their solar origin. This is also supported by other characteristics, including a difference in the tendency to recur at intervals of a synodic rotation.

3. *Aurorae.*

In a paper dealing with the few aurorae reported as visible from India, S. Chapman (Proc. Indian Acad. Sc., *37*, 175, 1953) draws attention to the fact that whilst the *isochasmic* diagrams of Fritz and Vestine map the distribution of frequency of auroral visibility from any point of the earth, there is need for a new type of *isoauroral* diagram showing the lines of equal frequency of currents about its terrestrial point. The practical difficulties involved in drawing such *isoaurores* and means of overcoming them, such as those suggested by J. Paton, are discussed in detail.

The geometry of radio echoes from aurorae has been discussed by S. Chapman (J. Atmosph. Terr. Physics, *3*, 1, 1952). The case considered by him is that of discrete echoes assuming the reflecting unit to be an auroral ray situated along a line of force of the geomagnetic field (taken to be the field of the equivalent dipole) and that an echo is received at the transmitting station Q only when the beam between Q and the echo point on the ray is perpendicular to it. In this case Chapman has shown that Q lies on a cubic surface (the echo surface). There is an echo surface for each point Q and the geometry of the surface is discussed in detail. A northern station Q can receive echoes not only from the Aurora Borealis but also, above the atmosphere, from the stream of primary particles producing the Aurora Australis. Because of the low density of the primary stream it is considered uncertain whether such extra terrestrial echoes can be observed. The results of the analysis are discussed in the light of Jodrell Bank auroral radio echo observations. Lowell, Clegg and Ellyett interpreted the echoes they observed as coming from above by reflection from an auroral ionised layer with electron density of about 5×10^7 per c.c. though Herlofson has proposed a different interpretation.

In the first of a series of notes on auroral geometry and optics S. Chapman (J. Geophys. Res. *58*, 347, 1953) gives a simple graphical method for the determination of height and location of a point of an aurora from its elevation from two base points on the earth surface in the same diametral plane as the auroral point.

The valuable contribution made by D. F. Martyn to the theory of the aurora has led to a revived interest in this field. S. Chapman (Ann. Géophys., *8*, 205, 1952) reviews in detail the neutral corpuscular stream hypothesis in relation to magnetic storms and aurorae, with special reference to Martyn's extension of the Chapman-Ferraro theory of magnetic storms, and especially to the fact, to which Martyn first drew attention, that ions and electrons may be accelerated in the neighbourhood of the earth by local electric fields to speeds exceeding the speed of travel of the stream from the Sun to the earth. The estimated speed is in accord with the findings of A. B. Meinel from his observation of the Doppler shifted Hα line in an auroral spectrum taken in the direction of the local geomagnetic field.

An expository article on the aurorae (V. C. A. Ferraro, Phil. Mag. Supp., *2*, 265, 1953) deals with their general characteristics, their topography and spectrum and contrasts the theories of the aurora put forward by Alfvén and Martyn. Ferraro points out that the former rests on the now doubtful existence of an appreciable solar magnetic field.

The excitation processes in aurorae and airglow have been discussed in two recent papers. In the first by D. R. Bates and A. Dalgarno (J. Atmosph. Terr. Phys. *4*, 112, 1953) the claims that the spectrum of the airglow, other than the Meinel hydroxyl bands, originates at levels of several hundred kilometres are questioned. The authors consider various excitation mechanisms which might be operative but they conclude that even under the most favourable assumptions none appears to be sufficiently effective at such altitudes.

M. J. Seaton (J. Atmosph. Terr. Phys. *4,* 285 295, 1954) has also discussed the excitation processes in the aurorae and airglow and in the first of two papers he discussed the observed intensities and electron densities in high altitudes. From radio and optical evidence he concludes that the electron densities are of the order of 10^7—10^8 electrons per c.c. in bright high latitude aurorae. The second paper is mainly concerned with excitation mechanisms of forbidden atomic lines in high latitude aurorae.

4. *Sudden movements in Geomagnetism.*

The analysis of the hourly frequency of sudden commencements (SC) of magnetic storms and sudden impulses (SI), that is, movements simulating an SC but not followed by geomagnetic disturbance, was carried out by V. C. A. Ferraro, W. C. Parkinson and H. W. Unthank (J. Geophys. Res., *56,* 117, 1951) for the records at Cheltenham (Md), Tucson, San Juan, Honolulu, Huancayo and Watheroo. They showed that the smoothed local time hourly frequencies for SCs has a shallow minimum around 6h and that this differs from the corresponding smoothed local time hourly frequencies of SIs. The latter is a roughly semi-diurnal curve with minima at 8h and 20h and maxima at 03h and 15h respectively. The hourly frequencies of SC*s and SI*s (that is, SCs or SIs in which there is a preliminary movement opposite to the main impulse) at these stations exhibit a local time effect. They tend to occur most frequently during the local afternoon hours. The annual means of the number of SCs and SIs combined and the curve giving the annual mean sunspot numbers were found to show striking similarities.

The "sudden commencements" at Lerwick for the period 1934—49 have been studied by D. H. McIntosh (J. Atmosph. Terr. Phys., *1,* 223, 1950). The form of the SC there is found to bear little relation to the following disturbance there, but the SCs which are followed by large disturbances have an apparently higher amplitude in the horizontal force. The author also corroborates the fact first noted by McNish that the average effect of the Lerwick SCs is mainly opposed to that of the main disturbance field.

The "diurnal variation" in the amplitude of sudden commencements and sudden impulses in geomagnetism were examined by V. C. A. Ferraro and H. W. Unthank (Geofis. Pura e Applicata, *20,* 1951). "Corrected" mean amplitudes for SCs and SIs for the five stations Cheltenham, Tucson, San Juan, Honolulu and Watheroo showed that the mean amplitudes had a minimum around 8h local time. This is also approximately the time of occurrence of the minimum in the hourly frequencies of SCs.

At Huancayo the daily variation of the amplitude of the SCs was found to differ markedly from that at the other five stations considered. The amplitudes were found to be greatest during the period from about 08h to 15h, the maximum impulse being considerably greather than at other stations. In this respect the effect was noted to resemble the abnormal S_q variation at Huancayo which suggest that, unlike geomagnetic disturbance, the SC impulse at Huancayo must in part be atmospheric in origin.

W. Jackson (J. Atmosph. Terr. Phys., *2*, 160, 1952) has drawn attention to world wide magnetic fluctuations lasting for several hours and often dissociated from large disturbance. By considering the traces of magnetograms at several stations, Jackson concludes that in their terrestrial effects these fluctuations have characteristic features which are indistinguishable from those of accepted SCs. The most important difference seems to be that these movements are prolonged in time and are not closely related to storms, whereas a normal SC is usually the precursor of a storm. These SC-type movements, as Jackson calls them, and the normal SCs are discussed in relation to the Chapman-Ferraro theory of magnetic storms, especially as regards the consequences of the first impact of the stream, the formation of the ring-current and the entry of particles in the atmosphere.

E. R. R. Holmberg (1953, Mon. Not. R. A. S., Geophys. Suppl., *8*, 467) has discussed the nature of periodic and quasi-periodic variations of the geomagnetic field in the range of periods between 10 and 100 seconds. He has analysed the set of recordings of variations of current flowing in a large loop made at Eskdalemuir in 1926 and 1927. Some interesting features of these variations are found. The daytime fluctuations have a spectrum with a definite fine structure. At sunset there is a change of type from a continuous flux of disturbance to a comparatively quiet phase punctuated by short damped wave trains. The characteristics of these fluctuations indicate that their origin is ionospheric and not extra-terrestrial.

5. *Solar corpuscular stream and Cosmic Rays.*

F. D. Kahn has continued his studies on the emission and possible spectroscopic detection of solar streams of corpuscles. In a paper on emission of such streams (M.N.R.A.S., *110*, 477, 1950) he first calculates the minimum momentum density of the stream which can be emitted from a solar flare and cause a magnetic storm to be 4×10^{-7} dynes/sq. cm. He then shows that resonance radiation from the flare or ionization of the atoms by the flare are insufficient to expel a stream dense enough for a storm of observed intensity. In a second paper (M.N.R.A.S., *110*, 483, 1950) Kahn re-examined the possibility of detecting the presence of a solar corpuscular stream by spectroscopic methods.

Assuming two different abundances of elements in the stream, namely Unsöld's and Stromgren's, Kahn shows that the Ca II content of the stream must be lower than that found in a previous paper (M.N.R.A.S., *109,* 324, 1949). He concludes that even for dense clouds with an emission particle density as high as 10^{12}, the chance of observing the absorption appears to be very small.

Variations of cosmic ray intensity with geomagnetic and solar activity are discussed by H. Elliott in an article in Progress in Cosmic Ray Physics (Ed J. G. Wilson, North Holland, 1952). As is well known, there appears to be some correlation between geomagnetic storms and variations in cosmic ray intensity, but this appears to be complex and not yet understood. Thus, whereas for the magnetic storm of Jan. 16, 1938, Forbush found a good correlation between changes in the horizontal force H and cosmic ray intensity D. W. N. Dolbear and H. Elliott (Nature, *159,* 58, 1947) found no detailed correspondence between H and the changes of cosmic ray intensity for the storm of July 26, 1946. In this case, as sometimes happens, the largest changes in cosmic ray intensity was *delayed* relative to the corresponding large changes in H. As Elliott points out, it seems difficult to account for the changes in cosmic ray intensity during magnetic storms on the basis of an associated ring current, since decreases in the cosmic ray intensity would require the radius of the ring to be far smaller than seems warranted by geomagnetic considerations. Elliott also casts doubt on Alfvén's suggestion that changes in cosmic ray intensity may arise as a result of the polarisation electric field of the corpuscular stream by a solar magnetic field.

The evidence of a 27-day "recurrence tendency" in the cosmic ray intensity is now definitely established but there are differences between this and the recurrence tendency in geomagnetism. The former is rather suggestive of a gradual sinusoidal variation, whereas the geomagnetic variation shows sharp peaks at intervals of 27 days with flat portions between them. The amplitudes of the successive peaks decreases rapidly whereas the cosmic ray "pulses" persist with the same amplitude for at least four periods of 27 days.

The increase of cosmic ray intensity associated with solar flares, first discovered by Forbush and Lange in 1942, is of interest in this connection. The variation of neutron intensity obtained at Manchester during the solar flare of November 19, 1949 shows an increase about six times its normal value (N. Adams, Phil. Mag., *41,* 503, 1950). The cosmic ray intensity increased by only about 11 % on this occasion. There appears to have been a delay of about half an hour between the beginning of the flare and the increase in cosmic ray intensity and this is interpreted as pointing to the fact that on this occasion the charged primaries were protons of energies between 2 and 5 Bev.

These large increases in intensity are of particular interest since they represent occasions when particles may acquire energies up to 5 Bev in or near the neighbourhood of the Sun and has a direct bearing on the theory of the origin of cosmic rays.

6. *Ionosphere.*

A simple and quick method by which (H′, f) records can be analysed to give information about the vertical distribution of electron density in the ionosphere has been given by J. A. Ratcliffe (J. Geophys. Res. *56,* 463, 1951). Assuming a parabolic distribution of electron density he constructs a series of curves, similar to those of Booker and Seaton, on a transparent scale and in such a way that they can be matched directly to the photographic records. Important parameters, such as height and thickness of the layer, can then be read off from the scale. The method is based on the assumption that the earth's magnetic field is zero and the effect of removing this limitation is discussed.

In a second paper, Ratcliffe (J. Geophys. Res. *52,* 487, 1951) applies the method to determine some regular characteristics in the F2 region. The parameter studied, in particular, is the total number, n, of electrons below a level of maximum electron density in a column of unit cross-section in this region and the analysis is carried out for the records obtained at Watheroo, Huancayo and College (Alaska) for two magnetic quiet days per month for a year of sun spot maximum and in a year of sun spot minimum. Ratcliffe finds that n behaves in a regular manner and is closely related to the sun's zenith angle χ unlike the maximum electron density which shows no simple relation to this angle. Ratcliffe also finds a relation between the thickness and height of the F2 region and discusses its possible bearing on ionospheric forecasting.

Sir Edward Appleton (J. Atmosph. Terr. Phys., *1,* 106, 1950) has considered the seasonal variation of the noon equivalent height of the F2 layer at a number of stations characteristic of the northern and southern hemispheres. The change from one type of variation to the other appears to occur over a region which is approximately nearer to the magnetic than the geographic equator.

A theoretic discussion of the temperature of the upper atmosphere has been given by D. R. Bates (Proc. Phys. Soc. B, *64,* 805, 1951) by considering the thermal equilibrium in the F region for a number of simple model atmospheres. The rate at which energy is gained by photoionization is estimated and the various dissipated processes examined. Bates concludes that it is difficult to explain why the upper atmosphere is as hot as it is generally supposed to be. Various other sources of energy are considered and Bates is forced to the conclusion that heat must be supplied to the upper atmosphere mainly by non-observed ionization.

Geomagnetic and ionospheric relationships have been investigated by R. P. Waldo and D. H. McIntosh (J. Atmosph. Terr. Phys. *4,* 44, 1954). They consider variations of several geomagnetic and ionospheric parameters, on and around a chosen day on which the three hour Kp index is markedly above or below those of adjacent days. The analysis shows that there is a time-lag of the minimum of the horizontal force about 18 hours after the maximum amplitude variation of the 3 hour range. They found that the relationship between geomagnetic and ionospheric parameters is usually an inverse one; for instance expansion and contraction of the F2 layers is usually associated respectively with the increasing and decreasing magnetic disturbance. Seasonal and non-cyclic variations are also discussed.

C. W. Allen (J. Atmosph. Terr. Phys. *4,* 53, 1953) has discussed world-wide variation in the F2 critical frequency and virtual heights as a function of phase of sun spot cycle, season, and geomagnetic and geographic co-ordinates. He shows that this can be described in terms of certain anomalies namely a sun spot minimum anomaly, the sun rise anomaly and the diurnal range anomaly.

M. A. Ellison (J. Atmosph. Terr. Phys. *4,* 226, 1953) confirms his earlier work (1950) that an average time-lag of 7 minutes is found between the maximum of the solar flare and the maximum of the resulting sudden enhancement of the atmospherics (SEA).

7. *Winds in the Upper Atmosphere.*

Winds in the upper atmosphere have been investigated by radio methods by A. Maxwell and C. J. Little (Nature, *169,* 746, 1952) at the Jodrell Bank Experimental Station of the University of Manchester using extraterrestrial radiation from the intense radio sources in Cygnus and Cassiopeia. This radiation indicates fluctuations in intensity due to the presence of irregularities in the F region. The effect is one of diffraction of the incoming radiation (see in particular M. Ryle and A. Hewish, M.N.R.A.S., *110,* 181, 1950). The observations were made at night and the results indicate that the F region irregularities move horizontally, preferentially towards the west, with speeds of the order of 350 kilometres per hour. One interesting result they find is that near midnight the wind direction changes by more than 140° within an hour. This reversal of wind velocity is of interest in connection with the striking findings of Meinel and Shulte who have observed a reversal of the motion of auroral features also around midnight.

In a paper on the scintillation of radio stars during the aurorae and magnetic storms Little and Maxwell (J. Atmosph. Terr. Phys. *2,* 356, 1952) found that the amplitude of the fluctuations of the intensities of the radiation received is relatively unaffected during aurorae but that the scintillation *rate* is considerably faster during an aurora than under normal conditions (about four to eight times as fast). Likewise the scintillation rate is faster during times of magnetic activity. Little and Maxwell ascribe the increase in the scintillation rate during aurorae and magnetic storms to the change in the velocity of the diffraction pattern and to the changes in its dimensions and stability. Moreover the scintillation rate and velocity of the ionospheric irregularities are approximately proportionate to the K index of geomagnetic activity.

Finally in an early investigation by G. J. Phillips (J. Atmosph. Terr. Phys. *2*, 141, 1952) based on ionospheric echoes at several receiving ground stations, the rate of fading was used to measure the horizontal movement in the ionosphere. Using observations covering a period of two years on frequencies of 2.4 mc/sec. Phillips interprets the results to imply the motion of the air to be at heights in the range of 100—120 km.

A. Hewish (Proc. Roy. Soc. *A, 209*, 81, 1951) in a paper dealing with the diffraction of radio waves from radio stars in the ionosphere concludes that ionospheric irregularities causing diffraction have a lateral extent of the order of 5 km and that these are sufficient to cause a phase deviation of from one to two radians for a wavelength of 6.7 m.

D. *Oceanographic Survey. (R.R.S. Research).*

The General Assembly of the International Union of Geodesy and Geophysics, held in Brussels in August 1951 passed a resolution urging that efforts should be made to obtain, through the United Nations Organisation, UNESCO or other appropriate international organisation, funds for fitting out and operating the non-magnetic ship, the *Research,* as the British Admiralty, in view of the changed conditions arising from the war, was not in a position to do this.

The possibilities of obtaining the necessary funds for completing and operating the *Research* were being investigated when it was learnt that effect was about to be given to the Admiralty's earlier decision to dispose of the ship. Efforts were made to have this final step postponed once more so that it could first be ascertained whether the ship could be completed and operated through an international organisation. However the prospect of the latter was not considered sufficiently firm, and the *Research* has now been broken up.

HUNGARY

Rapport sur les travaux de magnétisme terrestre et les prospections électriques effectués en Hongrie Présenté par le Comité Géodésique et Géophysique de l'Académie Hongroise des Sciences

Changement dans l'organisation.

Les recherches concernant le magnétisme terrestre en Hongrie, se sont développées dans deux directions. Les problèmes théoriques et ceux de l'observatoires, ainsi que les questions du champ magnétique du pays faisaient partie du rayon d'activité de l'Institut National Hongrois de Météorologie et de Magnétisme Terrestre, tandis que l'Institut Géophysique "Eötvös Lóránd" s'occupait surtout des prospections de pétrole et de minerais. En septembre 1950, l'Institut Météorologique passa son rayon d'activité, lequel ne s'y était développé que pour des raisons historiques, à l'Institut Géophysique, en lui cédant également l'observatoire de Budakeszi avec tout son équipement instrumental, et depuis ce temps les deux domaines de recherche sont subordonnés à la section de magnétisme terrestre de l'Institut Géophysique.

Le travail de l'observatoire.

Les observations magnétiques interrompues après la guerre furent reprises en 1948 à Budakeszi, à l'observatoire provisoire établi à la station de recherche de l'Institut Scientifique Forestier. C'est la sixième année qu'on y enregistre les variations du champ magnétique terrestre.

Au cours de cette année nous commencerons le travail dans un nouvel observatoire que nous venons de construire à Tihany, où les variations de la force magnétique pourront être enregistrées libres de toute influence perturbatrice, avec la précision exigée par les recherches modernes.

Les nouvelles mesures magnétiques générales en Hongrie.

Les dernières mesures magnétiques générales furent effectuées en Hongrie de 1890 à 1894 par I. Kurländer. Depuis ce temps, vu le changement séculaire, l'image magnétique normale de notre pays a subi des changements considérables, c'est pourquoi le nouvel établissement en fut-il très urgent. Au cours des mesures générales effectuées de juillet 1949 jusqu'à décembre 1950, nous avons déterminé la valeur absolue des éléments magnétiques à 300 points répartis d'une manière assez uniforme.

Les travaux de mesure et d'élaboration ont été dirigés par Gy. Barta.

Mesures comparatives internationales.

A l'aide d'instruments QHM et BMZ, de fabrication danoise, I. B. Haáz et Gy. Barta ont déterminé en juillet les différences entre les éléments magnétiques de l'observatoire de Budakeszi d'une part et des observatoires de Pruhonice et Ógyalla /Hurbanovo/ d'autre part. Les différences selon leurs mesures étaient les suivantes :

$$
\begin{aligned}
D_B - D_{Pr} &= +\,1^\circ 32{,}6' && \pm\,0{,}2' \\
Z_B - Z_{Pr} &= -\,979\,\gamma && \pm\,0{,}8\,\gamma \\
H_B - H_{Pr} &= +\,1335\,\gamma && \pm\,0{,}7\,\gamma \\
D_B - D_O &= +\,0^\circ 14{,}7' && \pm\,0{,}3' \\
Z_B - Z_O &= -\,133\,\gamma && \pm\,0{,}7\,\gamma \\
H_B - H_O &= +\,153\,\gamma && \pm\,0{,}5\,\gamma
\end{aligned}
$$

Mesures magnétiques régionales sur la Plaine Hongroise.

En vue d'étudier la structure des couches couvertes, nous déterminons les variations de l'intensité verticale du champ magnétique terrestre depuis 1951 par des mesures régionales d'une espace de 1,5 km sur la Plaine Hongroise. Jusqu'à maintenant nous avons effectué les mesures sur la partie située vers le Nord de la ligne Budapest—Debrecen de la Plaine. Selon des rapports de I. B. Haáz et M. Dér, non publiés encore, les anomalies obtenues jusqu'ici, indiquent des roches éruptives couvertes en plusieurs endroits.

Mesures magnétiques et électriques pour la prospection de minerais.

Dans l'intérêt de la prospection de minerais nous avons effectué à différents endroits du pays des mesures régionales d'une espace de 500—200 m, ainsi que des mesures plus détaillées d'une espace de 50—20—10 m ou encore plus petite.

Des mesures régionales d'une espace de 500 m — à certains endroits moindres — furent effectuées sur la péninsule de Tihany. Nous avons démontré que l'endroit choisi à l'aide de mesures préalables dans la partie du Sud de la péninsule convient parfaitement aux fins de l'observatoire déjà presque achevé, car quoiqu'il soit absolument calme, dans sa proximité, au milieu de la péninsule, des variations assez grandes, de l'ordre de 1000 γ sont à disposition pour les mesures d'expériences et comparatives.

Aussi la Communauté de Travail Géophysique de Sopron de l'Université Technique et la Chaire de Géophysique de l'Université "Eötvös Lóránd" ont également effectué au cours des vacances d'été des mesures détaillées du magnétisme terrestre.

Le but des prospections magnétiques de la Chaire de Géophysique et de la Communauté de Travail Géophysique de Sopron était de montrer la possibilité de mettre à jour des minerais de bauxite. Les mesures de susceptibilité effectuées par la Chaire de Géophysique ont fourni les bases aux prospections de bauxite de la Communauté de Travail. Les mesures ont démontré la présence de la bauxite jusqu'à une profondeur des gisements de 8 à 10 m ; au delà de cette profondeur les prospections magnétiques n'étaient plus applicables.

Les recherches géoélectriques se sont limitées également à la découverte de minerais. Les prospections de bauxite et de manganèse ont conduit à de beaux résultats.

La Chaire de Géophysique a étudié le comportement des courants telluriques et leur effet sur d'autres phénomènes, comme par ex. le magnétisme terrestre. On a trouvé des relations très intéressantes entre les variations rapides des champs magnétiques et les courants telluriques. Les résultats sont en train d'être élaborés. L'étude des deux phénomènes et de leur relation semble pouvoir fournir des indications précieuses sur les hypothèses relatives à l'origine du champ magnétique terrestre.

La Communauté de Travail désire appliquer les résultats des recherches telluriques générales de la Chaire de Géophysique à l'étude de la structure en profondeur.

Littérature.

Györgi Barta: Les lois de la variation de la force magnétique terrestre en Hongrie. A. Magyar Tudományos Akadémia Müszaki Tudományok Osztályának Közleményei Tom. V. Nr. 1—2. Budapest 1952.

Sur la période de 44 ans de la variation séculaire de la force magnétique terrestre. /12 figures, résumés russe et anglais/. Geofizikai Közlemények Tom. III Nr. 1. 1954.

Les variations de la force magnétique terrestre en Hongrie. /Texte hongrois, russe et allemand/. Publication de l'Académie Hongroise des Sciences, Budapest 1954.

Györgi Barta et Miklós Dér: Mesures magnétiques pour la désignation de la nouvelle entrée de la grotte Béke. /Résumés russe et anglais/. Geofizikai Közlemények Tom. II. Nr. 8. 1953.

István Béla Haáz: Détermination de la situation, les dimensions et la nature d'une couche oblique d'un effet gravitationnel et magnétique. /Résumés russe et anglais/. Geofizikai Közlemények Tom. I. Nr. 5. 1952.

László Egyed: The Determination of an Infinite Inclined Dike from the Results of Gravity and Magnetic Surveys. Geophysics, Vol. 13. July 1948. pp. 437—442.

Károly Kántás: La base théorique des méthodes de recherche électriques de la géophysique et les possibilités de les développer. Magyar Tudományos Akadémia Müszaki Tudományok Osztálya Közleményei Tom I. Nr. 1. 1950.

Recherches géoélectriques en Hongrie. Magyar Tudományos Akadémia Müszaki Tudományok Osztálya Közleményei Tom V. Nr. 1—2. 1952.

Résultats et perspectives des recherches telluriques en Hongrie. Conférence en 1953. /A paraître dans Bányászati és Kohászati Lapok/.

Procédés géophysiques servant à démontrer l'existence d'eau carstique. Magyar Tudományos Akadémia Müszaki Tudományok Osztálya Közleményei Tom. VIII/1.

E. Annau — A. Erkel — L. Szabadváry: Les relations entre les variations rapides du champ magnétique terrestre et les courants telluriques. Conférence en 1953. / A paraître dans Bányászati és Kohászati Lapok/.

P. Egerszegi — E. Takács: La pratique des recherches telluriques. Conférence en 1953. / A paraître dans Bányászati és Kohászati Lapok/.

Károly Sebestyén: Un appareil simple pour la détermination de la susceptibilité magnétique des roches. /Résumés russe et anglais/. Geofizikai Közlemények Tom. II. Nr. 2. 1953.

Études comparatives relatif à l'évaluation des courbes de sondage électriques verticales. Geofizikai Közlemények Tom. III. Nr. 3. 1954.

Compensateur destiné à la mesure du potentiel naturel. Geofizikai Közlemények Tom. II. Nr. 10. 1953.

Antal Tárczy-Hornoch: Sur le calcul de la déclinaison magnétique. A Magyar Tudományos Akadémia Müszaki Tudományok Osztályának Közleményei, 1951.

Über die Berechnung der magnetischen Deklination im Karpathenbecken. Acta Technica Tom. III. Fasc. 1—2. Budapest 1952.

INDIA

Note on Activities in Geomagnetism and Atmospheric Electricity in India (1949—54)

Systematic magnetic observations were started in India at Colaba (Bombay) in 1846. With the introduction of electric tramways, a magnetic observatory was started in 1904 at Alibag (18 miles SSE of Colaba). At the end of two years of comparative measurements, the whole magnetic work was shifted from Colaba to Alibag in 1906. With the shut down of the magnetic observatory at Dehra Dun in 1943, Alibag was for a few years the only primary magnetic observatory in India.

The Watson magnetographs have now been in operation for 50 years. La Cour declination magnetograph was installed in 1936 and the La Cour horizontal and vertical magnetographs in 1946. The variometer records are standardized by the absolute measurements, once a week, of horizontal force and of declination and, on most days, of the inclination. Dr. S. K. Banerji's method using the running correction is employed for the magnetogram measurements.

Quick-run records by Watson magnetographs were obtained on selected occasions during the last five years at Alibag. A study of these magnetograms is being made. An addition of La Cour QHM and BMZ instruments has been made to the Colaba and Alibag Office.

The old magnetic observatory at Kodaikanal which had been closed down in 1923 was restarted at the same site after re-conditioning the instruments (Watson for the variometers, Ind. Trigonometric Survey Pattern Magnetometer and Schulze Earth Inductor). La Cour magnetographs with all elements on the same sheet of paper have been functioning from the middle of 1951. A visual recording Askania magnetic balance is being used from the end of 1952. The absolute magnetic observations are taken as at Alibag.

At the instance of IATME, the field investigations of large diurnal range in the horizontal force near the geomagnetic equator had been entrusted to the Geodetic Branch of the Survey of India. It took H observations at five places in S. India with Kodaikanal as base station using the three QHM instruments loaned by IATME. The values of H were determined at 13 places in India and a revised isogonal chart for S. India south of Lat. 16°N was prepared. Individual officers of the India Meteorological Department also undertook more detailed observations near the magnetic equator in 1951 and 1953.

Measurements of atmospheric electricity at ground level continued to be recorded uninterruptedly at Colaba from its inception nearly 25 years ago. The recording at Poona was resumed after a short break at the Meteorological Office. A rain electrograph for measuring electricity carried by rain has been installed near the potential gradient instrument at Poona.

Measurement of potential gradient in upper air has been made with success using the HL 23 valve as an electrometer after Koenigsfeld and sending these up in the Fan type and Friesz type radiosondes.

Measurements of atmospheric electrical conductivity have also been made at Poona at higher levels of the atmosphere. The drop in voltage due to conductivity of the surrounding air of a Gerdian condenser is transmitted by the radiosonde to the ground for recording. The cylinder is periodically charged to a known voltage by a simple switching arrangement.

As in most Geophysical Observatories, the magnetic, electrographic and meteorological data collected at Alibag and Colaba are published in an annual volume. Due to war and its attendant circumstances, the publication has lagged behind for some time. However the magnetic character figures are being published in the Journal of Geophysical Research and Ind. Jour. Met. & Geophys. and transmitted to the sections of the UGGI needing them. An advance circular of the same is also exchanged with other interested organisations. The character figures of Kodaikanal are published along with relevant solar data in Ind. Jour. Met. & Geophys. The hourly values at Kodaikanal are published in the half-yearly bulletins of the Kodaikanal Observatory.

The magnetic observations made by the Survey of India are published in part 3 of its annual reports (Technical Section). Recently (January 1954), it has brought out the isoporic charts for 1953.

The Geophysical Laboratory of Bengal Engineering College conducted studies in the geomagnetic field variations (particularly the diurnal variations) and the effect of atmospheric oscillations at high altitudes on these variations and developed an analysis for calculating the diurnal field on the basis of the dynamo theory.

The papers published in the above subjects from India are listed below.

Publications

1. K. S. Raja Rao: Geomagnetic Equator — Curr. Sci., *18*, 1949, 121.
2. A. K. Das and K. S. Raja Rao: The brilliant Solar Flare of 1949 January 23 and the Great Magnetic Storm of Jan. 24—26 — Observatory, *69*, 1949, 147.
3. A. K. Das and R. Ananthakrishnan: Existe-t-il une correlation entre les protubérances à disparition brusque et les perturbations géomagnétiques ? — L'Astronomie.
4. K. S. Agarwala: Rate of atmospheric Ionization and Air Earth current at Poona — Ind. Jour. Met. Geophys., *2*, 1951, 224.
5. A. K. Das: Solar noise burst of 11th April 1952 and associated Ionospheric and Magnetic disturbances — Ind. Jour. Met. Geophys., *3*, 1952, 236.
6. S. K. Pramanik: Secular variation of Magnetic field at Colaba & Alibag — Jour. Geophys. Res., *57*, 1952, 339.
7. S. K. Pramanik and S. Yegnanarayanan: Diurnal Magnetic variations in Equatorial Regions — Ind. Jour. Met. Geophys., *3*, 1952, 212.
8. M. V. Sivaramakrishnan: Recurrence feature of some of the great Magnetic Storms recorded at Kodaikanal — Ind. Jour. Met. Geophys., *3*, 1952, 231.
9. M. V. Sivaramakrishnan: Geomagnetic field variations at Kodaikanal — Nature, *169*, 1952, 409.
10. S. L. Malurkar: Transients of Magnetographs and instantaneous values from recordings — Ind. Jour. Met. Geophys., *4*, 1953, 190.
11. M. V. Sivaramakrishnan: Changes of Atmospheric Electric Potential Gradient at Poona during disturbed weather — Ind. Jour. Met. Geophys., *4*, 1953, 62.
12. V. V. Sohoni, S. K. Pramanik, S. L. Malurkar and S. P. Venkiteshwaran: Effect of Electric Current on Magnetic instruments at Alibag — Ind. Jour. Met. Geophys. *4*, 1953, 45.
13. S. P. Venkiteshwaran, N. C. Dhar and B. S. Huddar: The measurement of the electrical Potential Gradient in Upper Air over Poona — Proc. Ind. Acad. Sci., *38*, 1953, 260.
14. S. K. Pramanik and P. S. Hariharan: Diurnal Magnetic variations near Magnetic Equator — Ind. Jour. Met. Geophys., *4*, 1953, 353.
15. B. N. Bhargava: A new early morning Ionospheric phenomenon — Nature, *171*, 1953.
16. A. K. Das and K. Sethumadhavan: Eruptive prominence of 1953 February 26 and associated radio noise burst — Nature, *172*, 1953, 446.
17. R. Ananthakrishnan: Geomagnetic activity and the Sunspot Cycle — Nature, *172*, 1953, 854.
18. S. K. Chakrabarty: Sudden Commencements in Geomagnetic Field Variations — Nature, *167*, 1951.
19. S. K. Chakrabarty and R. Pratap: On the Dynamo Theory of Geomagnetic Field Variations — Journal of Geophys. Res., March, 1954.
20. R. Pratap: Atmospheric Oscillations at high altitudes and their relations to Geomagnetic Field Variations — Proc. Nat. Inst. Sciences., Jan. 1954.
21. R. Pratap: The effect inclination of the Geomagnetic Axis on the Sq Variations — Bulletin, Cal. Math. Soc., December 1953.

INDONESIA

National report on the activities in the field of terrestrial magnetism and electricity in Indonesia 1951—1953

Earth magnetism.

1) Our pre-war apparatus, consisting of self-recording magnetometer and H-absolute, have been destroyed during the Japanese occupation. In 1950 we started registrations in Lembang (W-Java) in one of the buildings of the Astronomical Observatory with the following La Cour recording instruments:

Declinometer de Copenhagen No D 69
Variometer de Copenhagen No H 66
Balance de Godhavn No 84
Paper speed: 15 mm/hour
Timing: breaks every hour; clock controlled by time-signals

Because of very strong disturbances caused by the electrical apparatus, the results were not satisfying and the registrations were stopped 6 months later.

We transferred the instruments to *Kuyper,* our pre-war station, situated in the Bay of Djakarta (6° 2′ S, 106° 44′ E), after restoration of the building.

In July 1952 we started our experiments with the La Cour instruments. Till the present we are rather satisfied with the results and hope to publish the data in 1955.

At present we use for our absolute measurements of H a pre-war field instrument type Eliot, for D and I resp. an observatory model declinator and earth inductor. All these instruments are not yet standardized after the last war.

2) The Geophysical Department of our observatory is in possession of 1 QHM and 1 BMZ, type la Cour.

In 1952 and 1953 we have made magnetical field observations in Celebes and Borneo. Due to lack of personnel, observations could not be made regularly.

The BMZ has been returned to the factory in Copenhagen a few months ago for rechecking and modification, because by our experience it was not fully adjusted for northern latitudes for example Menado, Tarakan etc.

For the future we have made a 5 year plan involving the acquisition of complete magnetical instruments for a modern observatory, field work and registrations.

Atmospheric Electricity.

As a consequence of the measures taken at the outbreak of the Pacific war in December 1941, the observations in Atmospheric Electricity in Bandung (Java) on the grounds of the

"Bosscha laboratory", belonging to the former Technical University at Bandung, had to be stopped. Not earlier than at the end of 1949 the work of reestablishing could be taken up.

In the beginning of 1950 a part of the scheme of observational work in Atmospheric Electricity, that had been carried out at the Bosscha laboratory before December 1941, was recommenced and continuous Benndorf recordings of the normal and of the disturbed potential of the earth's electrical field have since been made and are still being made on the grounds of the Bosscha laboratory together with Benndorf continuous recordings of the positive and of the negative conductivity of the air (according to Schering's method) and with Benndorf continuous recordings of the electricity on rain.

It is hoped to publish the results of the observational work in Atmospheric Electricity at the Bosscha laboratory during the period August 1937 up to December 1941 and during that of the observations resumed in 1950.

The construction of new buildings and laboratories, needed for the extension of the University of Indonesia, and also on the grounds directly adjacent to that of the Bosscha laboratory, made it urgent to look for another site, where the observational work in Atmospheric Electricity could be displaced to.

It is hoped that in the course of this year the establishing of a new station for Atmospheric Electricity, which is now in progress, will have been effected.

The observation-plan includes the full scheme of the observations of the previous period up to December 1941 (continuous simultaneous recordings of the important factors of Atmospheric Electricity in connexion with meteorological recordings) and in addition some new continuous recordings will be taken up.

IRELAND

Report of Work in Terrestrial Magnetism and Electricity 1951—1953

(a) *Meteorological Service.*

A set of three new La Cour type magnetic variometers for recording the Horizontal Field (H), Declination (D), and Vertical Field (Z) have been installed in a specially constructed hut at Valentia Observatory. The building is provided with double walls and roof for insulation against outside temperature variations. In addition thermostatically controlled heaters are fitted to the inner wall to provide a uniform internal temperature.

Observations are performed three times weekly in order to supply the necessary data for the computation of the Base Values using the following instruments:

(1) A La Cour Quartz Horizontal Force Magnetometer (QHM) for measuring Horizontal Force, (2) a Kew Magnetometer for measuring Declination and (3) a La Cour Magnetometric Zero Balance (BMZ) for measuring the Vertical Component. An Earth Inductor by Askania Werke, Berlin has been obtained and routine observations will be commenced shortly. The ordinary programme of work described in the previous Report has been continued.

(b) *Dublin Institute for Advanced Studies, School of Cosmic Physics.*

A magnetic re-survey at 37 of the 44 stations measured in 1891 and 1915 has been carried out. Observations of Declination, Horizontal Intensity and Inclination were made using the Carnegie Institution of Washington Magnetometer-Inductor C.I.W. 13. The results, reduced to Epoch 1950.5, are given in the maps published in Geophysical Memoirs No. 4 (see below).

Interpolated values of the Vertical Intensity have been obtained with a field balance at 750 stations over an area of 6,700 sq. km., that is, 1 station/9 sq. km.

Publications

Geophysical Memoirs

No. 4: *Thomas Murphy,* The magnetic Survey of Ireland for the Epoch 1950.5; Dublin 1953.

Geophysical Bulletins

No. 2: *Thomas Murphy,* Provisional Values for Magnetic Declination in Ireland for the Epoch 1950.5; Dublin 1951.

(c) *Ordnance Survey.*

The Ordnance Survey cooperated with the School of Cosmic Physics, Dublin Institute for Advanced Studies, on the Magnetic Survey of Ireland during the years 1950—51, and a full report has already been published by that body.

(d) *Geological Survey of Ireland.*

The Survey has undertaken some investigations of magnetic effects in the vicinity of certain mineralised areas.

JAPAN

Japanese National Report on Terrestrial Magnetism and Electricity

National Committee for Geodesy and Geophysics, Science Council of Japan

Terrestrial Magnetism.

Magnetic Observatories. The standing magnetic observatories, Kakioka ($\varphi = 36° 14' N, \lambda = 140° 11' E$) and Aso ($\varphi = 32° 53' N, \lambda = 130° 01' E$), have continued their regular observations. A new magnetic observatory was established in 1951 at Memambetsu ($\varphi = 43° 55' N, \lambda = 144° 12' E$), where regular observations were started from January 1952. Eight other temporary observatories have continued magnetic observations for their respective special purposes.

Magnetic Surveys. Regular magnetic surveys for the purpose of finding the secular variations in Japan and its neighbourhood were carried out by the Geographical Survey Institute and the Hydrographic Department during 1948—52. Second-order surveys, in which the net-works of magnetic points are much closer than in first-order surveys, were started in 1953 by the Geographical Survey Institute.

Instruments. A new electromagnetic magnetometer for measuring the three components of the geomagnetic field was completed by I. Tsubokawa. This magnetometer was proved in field surveys to be satisfactorily useful for measuring the three components with sufficient accuracy within 10 minutes.

Origin, Secular Variation and Palaeomagnetism. Theoretical studies on the origin of the geomagnetic field have been extended with promising results by H. Takeuchi and Y. Shimazu along the self-exciting dynamo theory first proposed by Elsasser and Bullard. In relation to palaeomagnetism, a number of reversely magnetized rocks were found in Japan also. Among these rocks, T. Nagata, S. Akimoto and S. Uyeda found particular rocks which show the self-reversal of thermo-remanent magnetization by cooling in a geomagnetic field. Stability of rock-magnetism has been examined in detail by N. Kawai and others.

Regular Transient Variations. Attempts for detecting the anisotropy of the ionospheric electric conductivity were made by M. Hasegawa and H. Maeda by analyzing the world-wide distribution of geomagnetic daily variations. The anomalously large value of *Sq* around the geomagnetic equator was theoretically interpreted by M. Hirono as due to anomalously high electric conductivity of the ionosphere caused by the Hall-effect on and near the geomagnetic equator in daytime.

Magnetic Disturbances. Ever-changing aspects in the course of development of magnetic storms and bays were investigated in detail by T. Nagata and N. Fukushima by analyzing the Second Polar Year data, with the conclusion that instantaneous aspects of the polar magnetic disturbances are generally partial appearances of the so-called S_D-field, the average of a number of these instantaneous fields composing the S_D-field. The dynamo-theory of the S_D-field was extended by N. Fukushima and S. Matsushita by taking into account the anisotropy of the ionospheric conductivity. Magnetic pulsations accompanying magnetic storms and bays were studied by Y. Kato et al, whereas the characteristics of distribution of SC* and local anomalous behaviour of Z-component of SC were examined analytically and theoretically by T. Nagata and T. Rikitake respectively.

Publications. Other works published during the period from November 1950 to December 1953 concerning general topics in geomagnetism, geomagnetic effect of solar eclipse, magnetic instruments, magnetic surveys, local magnetic anomalies, and magnetic phenomena in the earth's crust and interior are summarized in (A)—(F) in the attached list of publications.

Ionosphere and Upper Atmosphere Physics.

Observations. The routine hourly observations of the ionosphere have been continued at Wakkanai, ($\varphi = 45° 24' $ N, $\lambda = 141° 41'$ E), Akita ($\varphi = 39° 44'$ N, $\lambda = 140° 08'$ E), Kokubunji ($\varphi = 35° 42'$ N, $\lambda = 139° 29'$ E) and Yamagama ($\varphi = 31° 13'$ N, $\lambda = 130° 38'$ E).

Observation Technique. Apparatus for almost continuous recording of h' and fc of the ionosphere was constructed by Y. Nakata, M. Kan and H. Uyeda. Measurements by means of these instruments, called respectively a sweep-frequency h'-t measurement and a sweep-frequency fc-t measurement, have given fairly detailed information about stratifications, anomalies and disturbances in the ionosphere, their travel, the intensity of reflected wave, the absorption of wave energy and behaviour of multiple reflexion.

Anisotropic Conductivity of the Ionosphere. The anisotropic character of ionospheric electric conductivity was pointed out by M. Hirono and its study has been extended by him and K. Maeda. The results of their studies were further applied by M. Hirono, K. Maeda, N. Fukushima, S. Matsushita and others to the problems of ionospheric and geomagnetic variations.

Ionospheric Storms. The morphology of disturbances in the electron density and the layer height of the $F2$ region were made fairly clear by K. Sinno, T. Nagata and T. Oguti, the results showing that the $F2$-region storms consist of the Dst- and the S_D-variations and both change with the storm-time and seasons. A theoretical interpretation of this phenomenon was attempted by K. Maeda with some promising results.

Sporadic E-layer. In regard to the sporadic *E*-layer, its latitudinal distribution, lunar tides and its correspondence to geomagnetic variation, especially the S_D-component on magnetically disturbed days, were found and examined in detail.

Physical Processes in the Ionosphere. It was derived by T. Yonezawa from various observed data that the diminishing rate of electron density in the *F2*-region takes an apparent form due to the attachment process. Y. Inoue has proposed a theory of formation of the ionosphere by considering the ionosphere as a scattering medium for photons in place of the ordinary conception of the absorbing medium.

Publications. Publications on ionosphere physics and the night sky are summarized in (J) in the attached list.

Cosmic-Ray.

Observations. Continuous observations of the μ-meson component of the cosmic-ray have been carried out at Itabashi ($\varphi = 35°\ 45'$ N, $\lambda = 139°\ 43'$ E), Mabashi ($\varphi = 35°\ 43'$ N, $\lambda = 139°\ 40'$ E) and Nagoya ($\varphi = 35°\ 10'$ N, $\lambda = 136°\ 58'$ E) by means of counter telescopes. Several other observations for special purposes have also been continued at these places by using either counter telescopes or ion chambers.

Cosmic-Ray Storms. The morphology of cosmic-ray storms derived by Y. Sekido and S. Yoshida indicates that the distribution of cosmic-ray storms associating magnetic storms is composed of *Dst*-variation (a world-wide decrease in intensity) and S_D-variation (an increase in amplitude and an advancement in phase of the anisotropy), their magnitude depending on latitude and altitude. K. Nagashima showed theoretically that these phenomena can be satisfactorily explained by assuming an increase in electrostatic potential in the vicinity of the earth.

Other Works and Publications. The atmospheric effect on the cosmic-ray, location of cosmic-ray sources on the celestial sphere and other works were also made, their publications being given in (K) of the attached list.

Terrestrial Electricity.

Observations. Routine observations of the potential gradient of atmospheric electric field have been continued at Kakioka, Memambetsu, Kanoya and Honjo, whereas a continuous observation of atmospherics has been made as a routine work at Toyokawa. Routine observations of the earth-currents have been continued at four places, Kakioka, Memambetsu, Kanoya and Haranomachi.

Atmospheric Electricity. The distribution of daily variations in the potential gradient over Japan Islands, disturbances in the atmospheric electric field owing to the fog and volcanic smoke, and the correlation between daily variations in electric field, conductivity and space charge in the atmosphere were chiefly studied.

Atmospherics. Location of the sources of atmospherics associated with typhoons and the studies of wave forms of atmospherics have chiefly been made.

Earth-Currents. Regular daily variations and disturbances in the earth-currents were studied in relation to both geomagnetic variations and the electric properties of the uppermost part of the earth.

Publications. Scientific articles concerning atmospheric electricity, atmospherics, and earth-currents are listed respectively in (G), (H), and (I) in the attached list.

Solar and Terrestrial Relationship.

Observations. Observations of visual solar phenomena have been continued at Tokyo Astronomical Observatory at Mitaka (φ = 35° 40′ N, λ = 139° 30′ E), whereas the observation of corona by means of a coronagraph has been conducted on Mt. Norikura (φ = 36° 07′ N, λ = 137° 33′ E).The solar radio emissions from 60 MC/s to 3000 MC/s in frequency have been continuously observed at Mitaka, Toyokawa (φ = 34° 50′ N, λ = 137° 22′ E) and Ōsaka (φ = 34° 42′ N, λ = 135° 30′ E).

Solar Flare. It was concluded by Z. Suemoto from analyses of spectroheliograms of solar flares that their temperature is less than 30,000°K.

Solar Radio Emission. Locations of sources of radio emission on the sun's disk were carried out with the aid of interferometers, the results showing especially the limb brightening of the solar radio emission. Statistical characteristics of the directivity of lower frequency radio emission, relations between noise storms and the central meridian passage of sunspots, and the dependency of long-period variation of radio emission upon the electron density of corona were obtained.

Publications. Other works are listed, together with the above works, in (L) of the attached list.

LIST OF PUBLICATIONS

(Nov. 1950—Dec. 1953)

Abbreviations

BERI Bulletin of the Earthquake Research Institute.
BGSI Bulletin of the Geographical Survey Institute.
BRIA Bulletin of the Research Institute of Atmospherics, Nagoya University. (in Japanese)

GN Geophysical Notes, Tokyo University.
HB Hydrographic Bulletin. (in Japanese)
JGG Journal of Geomagnetism and Geoelectricity.
JGR Journal of Geophysical Research.
JMS Journal of the Meteorological Society, Japan. (in Japanese)
JPE Journal of Physics of the Earth.
JSRI Journal of the Scientific Research Institute.
JSTU Journal of the Faculty of Science, University of Tokyo. Section II.
MENU Memoirs of the Faculty of Engineering, Nagoya University.
MMO Memoirs of the Kakioka Magnetic Observatory. (in Japanese)
PASJ Publications of the Astronomical Society of Japan.
PJA Proceedings of the Japan Academy.
PMG Papers in Meteorology and Geophysics.
PRIA Proceedings of the Research Institute of Atmospherics, Nagoya University.
PTP Progress of Theoretical Physics.
RIRJ Report of Ionosphere Research in Japan.
RSEC Report of the Solar Eclipse Committee.
SRTU The Science Reports of the Tohoku University, Fifth Series.

(A) Terrestrial Magnetism

1. Fukushima N. Progressive Change in the Current System of the Bay Disturbance. GN, *3*, No. 22 (1950).
2. —. Preliminary Report of the Magnetic Storm on Aug. 3, 1949. RIRJ, *4*, 222 (1950).
3. —. Current System for S_D-Field and the Bay Disturbance. JGG, *2*, 103 (1950).
4. —. Some Characteristics of Magnetic Storms (I) (The Magnetic Storm on Aug. 3, 1949). RIRJ, *5*, 85 (1951).
5. —. Geomagnetic Variation during the Initial Phase of the Magnetic Storm on Jan. 24, 1949. RIRJ, *5*, 191 (1951).
6. —. Development and Decay Processes of the Bay Disturbances in Geomagnetic Field. JGG, *3*, 59 (1951).
7. —. Constitution of Polar Magnetic Storm (II). RIRJ, *6*, 185 (1952).
8. —. Geomagnetic Condition before the Occurrence of Bays. RIRJ, *6*, 211 (1952).
9. —. Polar Magnetic Storms and Geomagnetic Bays, JSTU, *8*, 293 (1953).
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NEW ZEALAND

Christchurch Geophysical Observatory Report for 1951—54

by J. W. Beagley

Instrumental recording and data distribution.

Ionosphere.

Routine ionospheric recording has been maintained at Christchurch, Rarotonga and Campbell Island. Owing to increasing noise level at the Lincoln site the station was closed and Godley Head became the main recording station for Christchurch on 10th December, 1953.

Modifications have been made to improve the efficiency of all recording instruments and multi-wire delta type aerials built at Christchurch and Campbell Island. The good vertical directivity of the new aerial system at Christchurch has resulted in the continuous recording of D-region echoes.

Two minute frames were obtained from the Lincoln ionosonde during the solar eclipse of 7th March, 1951.

Summarized information from all stations has been forwarded monthly to the Radio Research Board, Sydney; the Central Radio Propagation Laboratory, Washington; Radio Research Station, Slough, England; Telecommunications Research Laboratory, Johannesburg, South Africa; Ionosphere Station, Graz, Austria, full data being distributed at a later date. I-Indices, times of ionospheric storm occurrence and storm intensities at Christchurch as well as median values at Campbell Island, Rarotonga and Christchurch have been published monthly in the Radio Research Office Bulletin of the Dominion Physical Laboratory, N. Z. Department of Scientific and Industrial Research.

Geomagnetism.

During the years covered by this report a further reorganisation of observatory activities in Christchurch was carried out. The Magnetic Survey Branch has now become responsible for all routine magnetic work at Christchurch and Apia, leaving Geophysical Observatory staff free to concentrate on ionospheric and cosmic radiation research. Before transfer of responsibility for magnetic work, publication of Amberley data to the end of 1950 and Apia data to the end of 1951 was completed. A list of Amberley mean values of magnetic elements, D, H, I, X, Y, Z, T 1902—1950 was included in the Amberley 1950 publication, and a similar list is being prepared for Apia when results of all intercomparisons are to hand enabling appropriate corrections to International Magnetic Standard to be applied.

Cosmic Radiation.

The C. I. W. Compton Bennett Ionization Chamber has operated continuously and results have been sent out regularly to the Carnegie Institution of Washington and other interested organisations.

The Blackett M.U.2. Intensity Recorder was maintained in operation and although equipment faults caused much loss of record it was possible to gain sufficient data to complete the investigation of diurnal variation in the North-South direction. The circuitry was then redesigned to overcome the various difficulties so that operation would be more efficient and trouble free.

A vertical intensity recorder was built using spare M.U.2. trays and is now in operation at Apia Observatory.

Examination of nuclear research plates exposed at different altitudes in New Zealand was discontinued on account of staff shortage in 1952. For this reason also work on the wide-angle recorder for measuring cosmic ray showers was discontinued.

Research investigations.

Changes in intensity of ionization during the solar eclipse of March 7th, 1951, were investigated. Ionization in the E layer decreased 52 % during the optical eclipse, the minimum being reached 12 minutes after the maximum of the optical eclipse. There was some evidence for a decrease in F2 ionization also, but an ionospheric storm in progress at the time made confirmation of this difficult.

Further investigations into magnetic ionospheric storm relationships were carried out. Diurnal and seasonal variations of sudden commencement occurrence at Amberley 1939—1949 inclusive, were examined as well as their frequency variations with sunspot cycle. It was found that Amberley data do not support Parkinson and Ferraro's suggestion that frequency occurrence of their type II sudden commencement may be a function of geomagnetic longitude. A detailed analysis of geomagnetic crochets occurring at Amberley and Apia 1947—51 simultaneous with solar flares and Dellinger fadeouts was made and the relation to following magnetic and ionospheric disturbances discussed. The relationship between magnetic storm commencement times and ionospheric storm ion density decrease onset in the F2 layer was examined using Amberley K-Indices and Lincoln I-Indices. Decreases in ion density of the F2 layer followed closely the commencement of severe magnetic storms and high correlation of indices occurred at these times. With less intense storms the decrease in ion density of the F2 layer lagged behind the magnetic storm commencement, the lag varying from a few hours to a day and more.

Analyses of the lunar variations in D, H and Z at Amberley for the years 1931—35 were made. The lunar semi-diurnal variations in D and H were found to agree with those expected from Chapman's analyses of northern hemisphere stations but the large amplitude of the Z semidiurnal lunar wave was found to be anomalous and the luni-solar variation almost non-existent in this element. The dependence of (foE2—foE1) at noon for the years 1947—53 on lunar age is undergoing preliminary examination.

An investigation of recombination and attachment processes in the F2 layer over Lincoln at night-time was undertaken. Intensive work has also been done in connection with the determination of the electron distribution with height in the ionosphere. This project developed from suggestions made by Mr J. A. Ratcliffe during his visit to the Observatory in 1952.

Analysis of data previously taken by the M.U.2. recorder has shown a N—S asymmetry greater than that found in other parts of the world.

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NORWAY

Report on auroral work by Professor Carl Störmer and his helpers during 1951, 1952 and 1953

by Carl Störmer

A. During the 3 years 1951, 1952 and 1953 the following photographic auroral stations were in action:

Oslo (triple station),
Lillehammer,
Askim,
Holmestrand,
Kongsberg,
Drøbak.

These stations were in action 27 nights. The results are seen in the following table, where the headings have the following meaning:

P	means	the number of successful photographs.
S	„	the number of sets among these, taken simultaneously from 2, 3, 4, or 5 stations.
Sm	„	the number of pairs measured out.
N	„	the number of resulting aurora heights.
St	„	the number of aurora stations in action.

		P	S	Sm	N	St
1951						
March	8—9	38				2
»	13—14	163	41	26	178	5
April	24—25	46	15	5	30	4
»	25—26	22	9	3	12	3
May	9—10	26	6	4	18	3
Sept.	19—20	26				1
Oct.	7—8	142	48	27	126	3
»	17—18	146	36	18	108	6
Nov.	28—29	73	12	5	22	4
1952						
Febr.	16—17	54	7			3
March	15—16	47				2
»	16—17	1				4
»	30—31	106				1
April	2—3	137	21	5	42	5
May	3—4	87	25	6	25	3
Aug.	29—30	177	52	25	142	4
Sept.	28—29	75	15	2	8	2
Oct.	11—12	10				1
1953						
March	8—9	276	69	33	136	6
»	9—10	35				1
»	14—15	2				1
»	19—20	72				1
Sept.	4—5	110				2
»	15—16	75				1
»	16—17	22				1
Oct.	18—19	31				2
Nov.	12—13	125	11	3	5	4
Total		2104	367	162	852	

By the work during these three years the number of successful aurora photographs taken in Southern Norway from my aurora stations amounts to approximately 40800, among these there are 9100 sets, of which 3200 pairs have been measured out giving height and geographical position of 18800 points selected on the aurora.

The work is still going on by subventions from the government and from scientific funds in Norway.

B. Visual observations of aurora have been continued parallel with the photographic work by my helpers and myself. Reports from each year can be found in Annuaire astronomique et météorologique Camille Flammarion, publié par l'Observatoire de Juvisy, for the last years.

C. As to the theoretical work, only one paper has been published namely: *Results of the observations and photographic measurements on aurora in Southern Norway and from ships in the Atlantic during the polar year 1932—33,* in Geof. Publ. Vol. XVIII, No. 7, 117 p. with 21 figures and 3 plates.

Most of the time has, however, been spent writing a book *The Polar Aurora* for the Clarendon Press, Oxford. The manuscript is now in the hands of the printer.

PAKISTAN

National Report for Pakistan

Magnetic Observatory Work in Pakistan

by S. N. Naqvi

Director Meteorological Service, Karachi

At the request of the Government of Pakistan a group of Geophysicists led by Dr. G. Nørgaard was sent by UNESCO early in 1951 to assist in the development of geophysical work initiated by the Meteorological Service and the Survey of Pakistan. K .A. Wienert arrived in Karachi on 29th April, 1951, to take up the position in geomagnetism.

After inspection of various sites it was finally decided that Quetta would be the most suitable. A magnetic observatory at this place would be able to provide variations for the largest part of West Pakistan. Moreover Quetta is not likely to grow within the near future and thus to render the observatory useless.

A vertical force survey of the site proper and the area around Quetta revealed that there exist no local anomalies within a distance of ten miles. The ultrabasic intrusions which start approximately ten miles north of Quetta are of a very local character and do not influence the magnetic field at Quetta.

In November, 1952, a Ruska magnetograph was installed in a building in Quetta. Although the building was not non-magnetic and the site was disturbed by traffic on a nearby road valuable conclusions could be drawn from the obtained records as to the choice of variometer sensitivities for the final installation in the permanent buildings. Moreover personnel could be trained in setting up and maintaining variometers.

The temporary observatory was operated until the end of

August 1953. No absolute observations were made due to the lack of instruments.

On 4th September, 1953, the Ruska magnetograph was shifted from the temporary observatory to the permanent building.

In the new variometer house provisions were made for installing the declination variometer at a distance of 3.5 meters from the recorder instead of 1.7 meters specified by the makers. This measure not only doubles the sensitivity of the declination variometer but also takes it off the disturbed area between the two force variometers. In the new position it is approximately 120 cm. away from the vertical force variometer.

The range of the declination variometer is much decreased since the two spare magnet mirrors are eliminated. In this arrangement the variometer can only record variations of approximately 50′ (475 gammas) to each side. Although at Quetta average magnetic storms have scarcely any influence on declination it is quite possible that during violent magnetic storms the trace can be lost. In such a case the Danish magnetograph with quick running recorder will give full coverage.

The two force variometers are temperature compensated by magnets, in order to prevent a seasonal shift of the base values. The diurnal temperature variations in the variometer houses are negligibly small.

A Danish magnetograph with a recording speed of 15 mm/h was installed for training purposes in a second variometer house at the end of November, 1953. This magnetograph was dismantled in February, 1954, and will be be sent to Chittagong (East Pakistan) where a second magnetic observatory is under construction.

The results of the Ruska magnetograph and of the Danish magnetograph were carefully compared over a period of two months. Both variometer sets were in good agreement.

The time marks are given by a Danish clock. The five minute time marks are a great help in the timing of magnetic phenomena like s.s.c., p.s.c., and s.i., and make extra time marks for absolute measurements quite unnecessary. However, the contacts of the clock which are meant to switch a current of 0.2 amperes at the utmost did not stand up to the heavy current requirements of two magnetographs. As it was not desirable to complicate the circuit with a relay the contact arrangement was slightly altered.

From 1st October, 1953 onward good records were obtained until the end of February, 1954, when high humidity in the variometer rooms due to seepage of water through the floors and the walls caused by exceptionally heavy rainfalls interrupted the work. Repairs were started immediately and the Ruska magnetograph was reinstalled on 15th April, 1954. During recent rainfalls the variometer rooms remained dry.

On 26th April, 1954, the installation of the Danish magnetograph with quick running recorder which will mainly serve for timing s.s.c., p.s.c., s.i., and for studying pulsations was completed. Since these phenomena show up mainly in horizontal force the horizontal force variometer was set to a scale value of 2 gammas/mm.

The two variometer sets have the following ranges:

	Ruska			Danish		
D	—50′	to + 50′		—200′	to + 200′	
	(—475	to + 475	gammas)	(—1900	to + 1900	gammas)
H	—1000	to + 800	gammas	—350	to + 350	gammas
Z	—1000	to + 1400	gammas	—500	to + 500	gammas

These ranges will be sufficient to record even violent storms without loss of trace except for the horizontal force. However, it will be easy to decrease the sensitivity of the Ruska horizontal force variometer with the increasing sun spot activity.

The base values of the variometers were controlled by means of 3 QHMs, 2 BMZs and an earth inductor. QHM and BMZ observations were made 2 to 3 times a week while dip was observed 3 times a month.

The BMZs are equipped with the adjustable type of compensation bar. The distance setting of the compensation bars repeats extremely well.

The values of the vertical force derived from horizontal force and dip measurements differ from those obtained from BMZ observations by only 3 gammas. This indicates that the constants of the QHMs and BMZs are in good agreement.

The stability of the declination and vertical force base values was excellent. The horizontal force variometer showed a fairly quick decrease of the base value for the first two months but kept almost constant for the rest of the time.

It is felt that some more equipment is needed for the absolute measurement of the declination, since the results obtained from QHM observations are not completely reliable. Therefore the purchase of a theodolite base and accessories for measuring declination by means of fibre suspended magnets has been taken into consideration.

A G.S.I. Precise Magnetometer as described by Tsubokawa is to arrive in the near future.

An ionospheric recorder has just arrived. This equipment will be installed at Quetta in the course of this summer.

Adequate staff for the observatory has been trained. For the time being 2 observers and 1 computor are able to cope with the current work. No uncalculated material is allowed to accrue.

Preliminary monthly means, character figures, s.s.c., p.s.c., and s.i., are published every 3 months. The scaling of K-indices is under preparation.

During 1951 and 1952 some prospecting surveys were made by means of vertical force field balances. About 2000 stations were observed in various parts of Pakistan. Good results were obtained on hematite and magnetite. The results obtained on deposits of chromite and manganese were unsatisfactory owing to the close association of ultra basic rocks.

The Magnetic Survey of Pakistan

by K. A. Wienert

1. At the request of the Government of Pakistan a group of Geophysicists led by Dr. G. Nørgaard was sent by UNESCO early in 1951 to assist in the development of geophysical work initiated by the Meteorological Service and the Survey of Pakistan. K. A. Wienert arrived in Karachi on 29th April, 1951, to take up the position in geomagnetism.

2. The first magnetic survey in the area of Pakistan was done between 1901 and 1920 by the Survey of India. (Records of the Survey of India, Vol. XIX, The Magnetic Survey of India 1901—20). When the Survey of Pakistan resumed magnetic work in 1952, it was decided that Pakistan should be resurveyed because it is no longer possible to derive reasonably accurate values for the magnetic elements from the old data.

3. In order to make the survey suitable for all practical and scientific purposes it was determined that the distance between the absolute stations should be of the order of 15 to 20 miles.

4. As many of the old stations as possible should be reoccupied in order to get a good picture of the regional distribution of the secular variations. Between the absolute stations the vertical force should be observed by means of a field balance every two miles so as to enable the observer to judge immediately the degree of disturbance of an absolute station, and thus to avoid local anomalies and especially spot anomalies.

5. In 1953 seven of the nine old repeat stations, which during the first survey had been marked by pillars, were reconnoitred. It was found that out of the seven repeat stations only two are undisturbed and fit for reoccupation. Of the other five stations three are disturbed by nearby buildings. At one station the stone has disappeared (silted up by river floods), and in one case the original pillar was extended by brickwork for the purposes of a local survey.

6. The rest of the stations are not marked. The Survey of India will supply the sketches and descriptions of these stations.

7. In order to make the survey economic it was decided to

use QHMs and BMZs to begin with. In autumn, 1954, a Japanese G.S.I. precise magnetometer will be available.

8. Azimuths are derived from sun observations. For these observations a Wild T2 theodolite is used together with a chronometer. The chronometer is controlled at every station with wireless time signals.

9. Field work commenced in November, 1953. However, the survey did not make good headway partly due to the lack of suitable transport and partly due to the difficult conditions at the observatory. Moreover the field party had often to return to the observatory because it shared the instruments with the observatory team.

10. Thus far complete observations have been made at 23 stations. The vertical force was observed at 150 stations.

11. Of the twenty-three stations three are old repeat stations. (in capitals in the table below). Four more stations are within 100 to 300 feet of other old stations. The table below gives the preliminary results of the stations together with the values for the epochs 1909 and 1920.

12. The results of these stations give a fairly good idea of the behaviour of the secular variations in the southern part of West Pakistan.

13. The repeat observations at the observatory indicate that no change in instrument constants took place. The relation between the constants of the QHMs and the BMZs could be controlled by dip observations. So far the agreement has been good.

14. The differences between the two QHMs and the two BMZs were used to judge the accuracy of the observations.

15. The standard deviations were:

D: 0.5′
H: 4 gammas.
Z: 4 gammas.

16. The comparatively large standard deviations in H and Z arise from the difficult temperature conditions.

17. It is planned to observe about 1000 stations. With the present equipment it is possible to observe two stations per day. Under the assumption that a field season contains about 130 working days, the work can be completed in four years.

18. Attention will have to be paid to the replacement of the old repeat stations which are all in cities. In future for each repeat station two different sites will be selected at which observations will be made every five years. It is planned to increase the number of the repeat stations from nine to twenty.

PAKISTAN

Magnetic Elements for 7 Stations for the Epochs 1909, 1920, 1946 and 1954

Name of Station	Latitude North	Longit. East	Height in ft.	Declination East				Horizontal Force in gammas				Vertical Force in gammas			
				1909.0	1920.0	1946.0	1954.0	1909.0	1920.0	1946.0	1954.0	1909.0	1920.0	1946.0	1954.0
Quetta Obs.	30°11′12″	66°57′00″	5800	—	—	—	1°31′.3	—	—	—	32 881	—	—	—	33 640
Sibi	29 32 39	67 51 40	435	2°46′.5	2°34′.8	—	1 17 .1	32 582	32 187	—	33 231	29 665	30 911	—	32 978
Belpat	28 59 40	68 00 20	307	2 30 .4	2 17 .6	—	0 59 .7	32 969	32 596	—	33 712	29 220	30 476	—	32 400
RUK	27 48 23	68 38 20	200	2 03 .4	1 46 .7	0°37′.3	0 30 .6	33 520	33 196	34 051	34 411	27 550	28 798	30 509	30 687
MIRPUR KHAS	25 31 19	69 01 40	50	1 54 .2	1 33 .6	—	0 17 .1	34 483	34 240	—	35 629	24 654	25 875	—	27 532
Hyderabad-Sind	25 22 25	68 22 30	70	1 48 .9	1 29 .4	—	0 15 .2	34 477	34 239	—	35 647	24 390	25 624	—	27 340
KARACHI	24 49 24	67 02 36	52	1 41 .7	1 26 .2	0 22 .8	0 12 .1	34 554	34 321	35 270	35 755	23 550	24 803	25 428	26 528
Quetta-Old	30 12 21	66 59 55	5500	2 58 .3	2 51 .0	1 36 .2	—	32 293	31 865	32 603	—	30 283	31 516	33 435	—
New	30 12 07	66 59 49	5500	—	—	1 37 .7	—	—	—	32 569	32 896	—	—	33 433	33 688

PERU

National Report to the IATME Meeting at Rome

by A. A. Giesecke

Geophysical work in Peru since the Brussels meeting continued to be the responsibility mainly of the Huancayo Geophysical Institute. Official support continued at a high level and the contract with the National Bureau of Standards of Washington, D.C. was maintained. Additional economic and material aid was received from the Carnegie Institution of Washington.

Special magnetic observations of daily variation were made for Committee No. 11 of the IATME — "To promote observations of daily magnetic variations in low latitudes" — finishing the work previously begun in 1949, with the occupation of six stations between Atico, Peru, (Lat. 16.2°S) and Victoria, Chile, (Lat. 21.8°S). Results of these observations of H made it possible to complete the curve of comparative ranges in H based on 19 stations along a chain about 2800 kms. long.

Intercomparisons were made with IATME's QHM's Nos. 17 and 18 and with the IAGS Ruska 3054C magnetometer and earth inductor. This was done between November 1952 and the end of 1953; it being possible to finally adopt IMS corrections for the Huancayo No. 10 magnetometer.

Throughout most of 1953 a magnetic survey was conducted with the occupation of 57 stations. Of these 20 were reoccupations for secular variation, 23 were new first priority stations and 14 were stations established solely for D. This work was made possible with the loan of the field instruments and a grant to cover all transportation costs donated by the Inter American Geodetic Survey (IAGS). Many of the new stations were established in the most remote parts of Peru's Amazon jungle area. Values of D were also obtained at provisional stations in the southern jungle area with a Wild T-O instrument. The data obtained will be published in charts for the epoch 1955.0.

A new Field Intensity laboratory was inaugurated in July, 1952; it was built exactly similar to that operated at Ft. Belvoir, USA, by the CRPL; it has been designed to measure absolute values of field intensity.

A special experiment to determine possibility of propagation of radio waves in the 50 Mc. band, between Huancayo and Washington, D.C., during magnetic storms was initiated with the Department of Terrestrial Magnetism but with little success.

On August 20, 1952, a total annular type solar eclipse was observed at Huancayo and special observations were made with continuous 16-mm movies taken with the ionosonde.

With the gift of a C-3 ionosonde by CRPL, and funds provided by the Department of Terrestrial Magnetism to cover transportation and certain installation costs, it was possible for the Institute to establish a new ionospheric laboratory in Talara, (Lat. 4° 37.8′ S and Long. 81° 30.7′ W) in a building donated by the International Petroleum Co. This new laboratory will facilitate predictions of optimum usable frequencies and will also be important to determine latitude variation in ionospheric parameters in the magnetic equatorial region.

In cooperation with the University of Chicago's Institute for Nuclear Studies a cosmic-ray laboratory was built in December, 1951, to measure changes in the primary spectrum of cosmic rays as a function of time using the nucleonic component generated in the atmosphere. This laboratory has functioned continuously since and will be expanded in accordance with already approved plans.

In 1952 another special cosmic-ray program was initiated and carried out in cooperation with the University of Amsterdam, Holland. Two Dutch technicians remained at Huancayo during most of a year to supervise the various experiments which were aimed at finding experimental evidence of the heavy mesons to improve the statistics on their characteristics, to obtain evidence of the pi-meson generating power of pi-mesons themselves in nuclear encounters, to establish a simultaneous relationship between cosmic ray intensity in Huancayo and Amsterdam with solar flares, and to make an investigation on the intensity, and contents, of extensive air showers.

Interest in meteorological work was increased at Huancayo with the transfer of the observatory belonging to the Ministry of Aeronautics. Pilot balloon observations were begun. A detailed climatological study of the Mantaro River Valley is contemplated with the installation of seven observatories in an area about 150 square kilometers. Radiosonde observations are also contemplated in cooperation with the Air Ministry. Reduction of thirty odd years of data was begun for publication purposes.

A new seismological station has been built in Iquitos (3° 46.8′ S. Lat. and 73° 12.5′ W. Long.); installation of the equipment is now in progress. Transfer was made to the Huancayo Institute of all the seismological work formerly done in Lima by the Geological Institute of Peru; this includes a teleseismic station and an accelerograph laboratory. This has meant the establishment of a permanent office in Lima.

San Marcos University of Lima was unable, due to economic reasons, to accept the gift of a coronograph from the University of Kyoto, Japan. Steps have been taken to negotiate such a transfer directly to the Institute at Huancayo.

Publications of the Institute have been kept current with the exception of the magnetic data. This latter is scheduled for publication by the end of this year.

The Institute sponsored an exchange policy between members of its technical staff and those of similar organizations abroad; the purpose was to provide the former with an opportunity for academic study and the latter with facilities to do special experimental work at the magnetic equator. This program has not yet materialized due to various difficulties, one of the main ones being the dearth of available technical personnel abroad.

The Institute has also proposed recently that a large international research center be created in Huancayo, similar in organization to Associated Universities, Inc., which functions in the United States. This proposal has met with uniform approval abroad and at present it is under consideration by the National Research Council in Washington, D.C. Peru would contribute materially to this project.

The above proposal is of special interest in connection with the forthcoming International Geophysical Year, since much very important work can be done at Huancayo and in Peru in general.

PHILIPPINES

Philippine National Report on Terrestrial Magnetism

by Andres O. Hizon, Director
Bureau of Coast and Geodetic Survey

Brief History.

Prior to the outbreak of World War II, the Manila Observatory under the direction of the Jesuit Fathers established a magnetic observatory in the Philippines, which was first located in Manila but later transferred to Antipolo, Rizal.

During the period from 1901 to 1941 the United States Coast and Geodetic Survey, Manila Field Station, made numerous observations of magnetic declination in the different islands, usually in conjunction with its hydrographic and topographic survey operations. In 1912—13 and again in 1924—25, many observations were made on the three magnetic elements: horizontal intensity, declination and dip, in the different islands. The results of these observations together with some field observations of the Manila observatory were published in 1930 in a volume entitled "Magnetic Declination in the Philippines in 1925".

The war operations during World War II in the Philippines resulted in the complete destruction of the Magnetic Observatory at Antipolo, Rizal, and some of the pre-war records of magnetic observations.

Geomagnetic Work of the Bureau of Coast and Geodetic Survey.

After World War II, the geomagnetic work in the Philippines was at first confined to the determination of magnetic declination at a few scattered stations where hydrographic survey operations were undertaken. In the later part of 1948, the Philippine Government appropriated funds for the construction of a magnetic observatory under the Bureau of Coast and Geodetic Survey. After inspecting various possible sites, an area of about four hectares was selected within the Insular Prison Reservation at Muntinlupa, Rizal. Construction work on three non-magnetic buildings, an office and quarters for the observatory personnel was started in October 1949. The non-magnetic buildings comprising a variation building, an absolute building and an auxiliary absolute building were patterned after similar buildings of the magnetic observatory at Barber's Point, Hawaii.

Initial operation of the magnetic observatory began in November 1950. The first set of instruments which was installed consisted of Eschenhagen-type variometers with a 20 mm/hr drum photo recorder, manufactured by the Ruska Instrument Corporation of Houston, Texas, and a field CIW magnetometer. These instruments were furnished by the U.S. Coast and Geodetic Survey and were tested by officers of the Philippine Bureau of Coast and Geodetic Survey at Cheltenham Magnetic Observatory, Maryland, U.S.A., before shipment to the Philippines. In 1952 a Ruska observatory type magnetometer with earth inductor and galvanometer and six QHM's as well as two BMZ's from the Danish Meteorological Institute were acquired.

Prior to the arrival of the Ruska observatory type magnetometer and the QHM's, a CIW field type magnetometer with earth inductor was used for absolute observations. Absolute observations were then made at least three times a week.

Starting from December 1952 when the observatory type instruments arrived, absolute observations were increased to four times a week using the Ruska observatory type magnetometer, the QHM and the BMZ instruments.

Continuous absolute observations and variometer records were maintained from October 1950 to the end of May 1953. On May 29, 1953, the observatory was struck by lightning resulting in the damage of the Z variometer. This variometer was sent back to the manufacturer through the United States Coast and Geodetic Survey, Washington, D.C., for repairs. Pending the return of the Z variometer, only one daily determination of Z is being made by the use of either the BMZ instrument or the earth inductor. The H and D variometers also suffered minor damage, but it was possible to resume the continuous recording on these instruments two weeks after the accident. Extensive lightning protection devices were also installed after the accident.

In the beginning a progressive negative drift of the H base line was experienced but it was finally stabilized by using a magnet of smaller moment. Preliminary hourly and mean values of the three magnetic elements have been compiled and tabulated for the years 1951 and 1952. These data as well as other details of the magnetic studies of the observatory are available at the Bureau of Coast and Geodetic Survey, Manila.

During the past few years field observations of magnetic elements were limited to declination observations in conjunction with hydrographic and topographic surveys so that at present the coverage of the Philippines is incomplete and distribution is uneven.

Work on an extensive magnetic survey of the islands by the Bureau of Coast and Geodetic Survey is presently underway. A field party using a Coast Survey motor vessel has been assigned exclusively on a two-year project of magnetic observations of H, Z and D in all bigger islands of the Philippines.

PORTUGAL

National Report
presented by the National Committee of Portugal

This report covers the work on terrestrial magnetism and electricity, auroral observations, ionospheric physics and cosmic rays. Below are given the reports on the work done in the period 1951—1954, as submitted by Serviço Meteorológico Nacional, Instituto Geofísico da Universidade de Coimbra and Instituto Geofísico da Universidade do Porto.

1. *Serviço Meteorológico Nacional, Lisboa.*
   Director: Prof. H. Amorim Ferreira.

Magnetic Observatory of San Miguel (Azores). The Magnetic Observatory was in continuous operation throughout the period. The instrumental constants were re-determined by comparison with the new La Cour magnetometers received for geomagnetic survey of Portugal.

We are trying to modernize the equipment of this Observatory and for that purpose geomagnetic equipment of La Cour type (special magnetic recording apparatus, QHM and BMZ instruments) was acquired.

The values of geomagnetic elements observed are being published since 1951 in the “Boletim Geomagnético Preliminar” of this Service. We are planning to publish the hourly values according to the recommendation of the I.A.T.M.E.

Geomagnetic surveys. In the year 1952, 5 repeat stations were occupied in the continental territory of Portugal in Europe, 1 in Azores Islands, 1 in the Madeira Island, 1 in the Cape Verde Islands and 2 in S. Tomé Island. During 1953 the 5 repeat stations in the continental territory of Portugal were reoccupied.

The geomagnetic survey of the Portuguese Territory in the Iberian Peninsula (Continental Europe) is presently being carried out. The geomagnetic survey corresponds to an average of 1 station for 288 square kilometers. The period chosen for the survey was 1952—57. The observations are to be made with Askania theodolites and La Cour magnetometers (QHM and BMZ).

The geomagnetic survey of the Portuguese Territory in Continental Europe will be followed by the survey of the North Atlantic islands (Azores, Madeira and Cape Verde).

The geomagnetic survey of S. Tomé and Principe Islands, in the Gulf of Guinea (Africa) was carried out in 1952, on the occasion of the solar eclipse of February 25.

The geomagnetic survey of the Portuguese territory in the Hindustani Peninsula is planned. The work to be done is consistent with the geomagnetic survey of the Peninsula (10 miles grid) and the observations are to be made with an Askania theodolite and La Cour magnetometers.

Due to the great area of the territories of Angola and Mozambique, before starting the geomagnetic survey, two geomagnetic observatories are presently being built and installed near Luanda (Port. West Africa) and Lourenço Marques (Port. East Africa), in accordance with recommendation 7 of the I.A.T.M.E (Brussels, 1951). It is expected that these two observatories will be in operation by the end of 1954, so that the geomagnetic survey of the territory may soon start.

At the first opportunity we shall have some geomagnetic observations taken in the 3 other oversea territories: Portuguese Guinea, Macao (China) and Timor (Australasia).

Atmospheric electricity and electric earth-currents. To improve our contribution to the knowledge of the geoelectric field, the establishment of a geoelectric station near Lisbon is under consideration.

Auroral observations. During the aurora of 28 October 1951 and 27 August 1953, only visual observations have been made at the climatological stations in connection with meteorological observations.

Other geophysical work. The present geophysical activities in the meteorological observatory of Macao were started in 1950. During the period 1951—54 the observatory has enlarged its activities: high atmosphere and ionospheric researches, radio noise observations and measurements of cosmic radiation are being carried out, while others are planned.

2. *Instituto Geofísico da Universidade de Coimbra.*
Director: Prof. J. Custódio de Morais.

Activity of the magnetic section in the period 1951—54. The Magnetic Observatory of the Geophysical Institute of the Coimbra University is on the suburbs of the town, at 1.000 meters from the electric tramways. The absolute observations were renewed at the beginning of 1951, and in October of the same year the photographic registrations of the variometers were resumed.

In 1952 we have received new material of the La Cour type, with

2 magnetometers QHM
1 magnetometer BMZ

At the beginning of 1955 we shall further have:

1 magnetometer QHM
1 magnetometer BMZ

For determinations of declination we have to-day the old Elliot, but we have also ordered one new Askania declinometer.

Our La Cour magnetometers have been compared with those of the I.A.T.M.E. in the summer of 1953, and they have proved very good, as will be published by the Association. To-day we work approximately with the mean error,

for H and Z $\pm$ 2 gammas;
for D $\pm$ 0′,1.

Every week we have two days for absolute observations (with the above mentioned sets) and the values obtained are used for the calculation of the values given by the variometers which are of the Eschenhagen type, made by Askania in 1929. On these variometers, with the time-scale of 20 mm per hour, the time signals are given by an independent watch, which allows us to obtain the time of the magnetograms with an error always inferior to 1 minute. The scale-values, obtained with the Helmholtz coils and with the magnetic method, are approximately:

for D 1′ per mm;
for H 4 γ per mm;
for Z 4,5 γ per mm.

The electric tramways of the town make constantly small oscillations on the needles, with the amplitude of 5 gammas, approximately, and for good measurements it is necessary to use the hours of the night, without electric traffic.

Every month we send to De Bilt the Bulletins with all the magnetic values of K, C and the perturbations of the magnetograms.

3. *Instituto Geofisico da Universidade do Porto.*
Director: Prof. A. Rosas da Silva.

Activity of the magnetic section in the period 1951—54. In the period 1951—54 the Institute has enlarged its activities on atmospheric electricity in the following ways:

1) During 1951 and 1952, some improvements in instrumental equipment have been made, especially for measuring atmospheric electric potential gradient.

2) Since 1953 the routine observations of potential gradient have been continued, while occasionally observations of atmospheric electric conductivity and ionisation have been carried out. The data for 1953 are already in the press and are expected to be published shortly; they will be followed by the data for the following years.

SPAIN

Commission Nationale de Géodésie et de Géophysique
Section de Magnétisme

Rapport National
par
José Rodriguez-Navarro de Fuentes

En exécution des accords de la Section, le soussigné, Secrétaire de la Section, a l'honneur d'exposer les activités se rapportant au Géomagnétisme et à la Géoélectricité, déployées en Espagne de 1951 à 1953 par les différents Centres Scientifiques qui s'occupent de ces études et de leur application pratique.

1. — *Institut Géographique et Cadastral*

Par sa Section de Géodésie, de Géophysique et de Météorologie, cet Institut est chargé aussi des Services de Magnétisme et d'Electricité Terrestres dont dépendent les travaux de campagne et les Observatoires détaillés ci-après.

1.1 — *Observatoires*

1.11 — *Observatoire Géophysique Central de Buenavista (Tolède)*

Situé à 4 km au N.W. de Tolède, il a, à l'endroit du pilier où est installé le magnétomètre magistral d'absolues, les coordonnées géographiques suivantes:

Latitude: 39° 52′ 58″ N.
Longitude: 4° 02′ 48″ W. Gr.
Altitude: 501 mètres.

Dans cet Observatoire fonctionnent les services de Géomagnétisme et de Géoélectricité, de l'activité desquels pendant les années de 1951 à 1953 nous allons nous occuper brièvement.

La description générale de l'Observatoire ainsi que la description des bâtiments destinés à ces services, a été faite dans le Rapport présenté par le soussigné à la IX Assemblée de la U. G. G. I. qui a eu lieu à Bruxelles en 1951. Comme les plans et les photographies nécessaires y figuraient, nous n'y revenons plus dans le présent Rapport.

1.111 — *Magnétisme Terrestre*

Le théodolite magnétique normal d'Askania Werke et l'inducteur terrestre avec galvanomètre *Edelmann* de la même firme, continuent à fonctionner comme magistraux. L'installation d'absolues a été complétée par des magnétomètres La Cour QHM numéro 218 et BMZ numéro 78.

Il y a deux équipements de variomètres, l'un d'Askania Werke avec des composantes D, H, Z, et enregistrement de 20 mm/h, d'une sensibilité normale et l'autre, qui enregistre depuis le 18 Janvier 1952, marque Topfer, aux mêmes composantes mais d'une sensibilité supranormale et une vitesse de 30 mm/h.

On fait les déterminations des valeurs absolues et les données nécessaires sont transmises aux centres internationaux.

On a fait une étude complète des constantes du théodolite normal de Schmidt et de ses aimants, ce qui a permis son emploi comme magistral pour la détermination de H à partir du premier Janvier 1952.

Avec les magistraux on a fait la vérification périodique des équipements des Brigades de campagne magnétiques du Service Espagnol, et nous avons eu aussi l'honneur d'une visite de nos collègues portugais dans le même but, ainsi que pour déterminer les coéfficients de leurs aimants.

Dans les variomètres on fait les corrections nécessaires dans l'orientation de leurs aimants et la compensation de température. On procède actuellement à l'installation d'un autre équipement La Cour avec enregistrement rapide de 180 mm/h.

Publications.

"Géomagnétisme, 1948". Valeurs journalières moyennes, variations diurnes, amplitudes journalières et index d'activité. Graphiques d'orages.

"Géomagnétisme, année 1949". Analogue à celui de 1948.

Sous presse.

"Annuaire de Géomagnétisme, 1950". Valeurs horaires moyennes, maximum et minimum journalier, moyennes journalières et mensuelles, variations diurnes, index et phénomènes d'activité. Graphiques d'orages.

"Annuaire de Géomagnétisme, 1951". Analogue à celui de 1950 complété de quelques données supplémentaires.
"Annuaire de Géomagnétisme, 1952". Idem.
"Annuaire de Géomagnétisme, 1953". Idem.

1.112 — *Électricité Terrestre*

Pendant les dernières années on a continué les travaux sur les courants telluriques avec l'installation décrite dans des travaux antérieurs. L'enregistreur rapide de 160 millimètres par heure a été une aide efficace dans l'étude des sauts brusques, des vibrations et en général de tous les troubles électrotelluriques dans lesquels la connaissance du temps a un grand intérêt. On a continué à employer l'enregistreur lent de 20 millimètres par heure, avec double enregistrement de chaque composante, l'un provenant de l'installation avec ligne aérienne et l'autre de l'installation avec câble souterrain. De cette façon on a obtenu une grande sécurité et une permanence dans les enregistrements.

Pour l'étude de l'ionisation atmosphérique on a apporté quelques modifications à un compteur d'ions, type Ebert, pour le changer en enregistreur automatique. Au moyen d'un interrupteur tournant, l'électromètre se charge chaque demi-heure, alternativement à potentiels positifs et négatifs pour le calcul du nombre d'ions des deux signes. La chute du potentiel de l'électromètre à cause du passage de l'air est enregistrée photographiquement, et les valeurs données par l'anémomètre totalisateur sont enregistrées sur la même bande. La décharge qui a une durée de quinze minutes est précédé d'une autre décharge de la même durée, sans passage d'air, afin de déterminer les pertes à cause des défauts d'isolement.

Le même mécanisme interrupteur contrôle le fonctionnement d'un appareil Gerdien, lui aussi avec enregistrement photographique, pour la mesure de la conductibilité électrique de l'air, en obtenant une valeur horaire de la conductibilité de chaque signe. Grâce à ces données on trouve aussi des valeurs horaires de la mobilité des ions.

L'enregistreur primitif de parasites atmosphériques a été remplacé par un autre plus moderne, à cinq passages, le premier pouvant être supprimé à volonté, lorsqu'on n'a pas besoin d'un tel agrandissement. L'antenne peut être connectée à volonté à un circuit apériodique ou à un circuit syntonisé à 20.000, 25.000 ou 30.000 mètres. Le dernier passage formé par deux lampes en contrephase attaque une lampe tiratron qui, en recevant un signal, agit sur l'électro-aimant de l'appareil enregistreur, où le nombre d'atmosphériques reçues par unité de temps est enregistré. Le même passage en contrephase est connecté à un oscillographe de rayons cathodiques, pour l'étude de la forme de décharge.

Comme l'enregistreur a une grande vitesse, 120 millimètres par minute, il ne fonctionne que pendant dix minutes chaque heure, d'où l'on déduit la valeur moyenne dans chaque intervalle horaire.

Publications.
"Corrientes Telúricas, 1950".
"Corrientes Telúricas, 1951".

Sous presse.
"Corrientes Telúricas, 1952".
"Contador automático de iones".

1.12 — *Observatoire Géophysique d'Alméria*

Il est situé aux environs d'Alméria dans la zone convenablement isolée des perturbations causées par le trafic et par des masses magnétiques. Le point géodésique placé sur le toit des pavillons de Magnétisme a les coordonnées géographiques suivantes :

Latitude: 36° 51′ 12″ N.
Longitude: 1° 13′ 43″ W. Gr.

L'altitude du plancher de la salle d'absolues est environ 65 mètres au-dessus du niveau de la mer.

Dans cet Observatoire fonctionnent depuis de nombreuses années des services de Sismologie et de Météorologie, et ceux de Magnétisme y ont été installés aussi. C'est seulement de ces derniers que nous allons nous occuper.

La description, les plans et les photographies des pavillons de Magnétisme figurent dans le Rapport que le soussigné a présenté à l'Assemblée de l'U. G. G. I. qui a eu lieu à Bruxelles en 1951. C'est pour quoi on n'en parle pas dans le présent Rapport. Nous voulons seulement faire remarquer que les précautions prises dans le pavillon de variomètres pour éviter les changements de température brusques ont donné de très bons résultats, ayant obtenu que les changements diurnes soient pratiquement insensibles et que les annuels n'arrivent même pas à dix degrés centigrades.

Dans le pavillon de variomètres, il y a deux salles pour les magnétographes. Dans l'une de ces salles fonctionne déjà un équipement La Cour, construit à Charlottenlund (Danemark) sous la direction du professeur V. Laursen par "Det Danske Meteorologiske Institut". Il comprend :

1 Déclinomètre de Copenhague n° 66
1 Variomètre de Copenhague pour la composante H, n° 90
1 Balance de Godhavn pour la composante Z, n° 109
1 Enregistreur des trois composantes avec une vitesse de 15 mm/h.

Au pavillon d'absolues on a installé un équipement de magnétomètres pour la détermination de D et H, et un inducteur terrestre pour l'angle d'inclinaison. Tout a été construit dans les ateliers de l'Institut Géographique et Cadastral en utilisant des éléments de magnétomètres de Sartorius Werke ; on a monté un QHM de La Cour, numéro 217, pour des déterminations de H.

On a déjà fait des observations d'absolues et les variomètres fonctionnent avec entière efficacité. Nous espérons que l'Observatoire Magnétique pourra bientôt commencer à fonctionner normalement.

1.13 — *Observatoire Géophysique de Logroño*

Situé à 4 km. au W de la ville, ses coordonnées géographiques approximatives sont les suivantes :

Latitude : 42° 27′ 27″ N.
Longitude : 2° 30′ 12″ W. Gr.
Altitude : 460 m.

Dans cet Observatoire seront installés les services de Magnétisme, de Sismologie et de Météorologie.

Les pavillons de Magnétisme sont terminés et leur description et les plans figurent dans le Rapport National présenté à L'Assemblée de Bruxelles, déjà citée.

On a acquis pour cet Observatoire un équipement de variomètres La Cour, exactement le même que celui d'Alméria et construit, lui aussi, à Charlottenlund sous la direction du professeur V. Laursen. L'équipement de magnétomètres pour les absolues est aussi égal à celui que l'on emploie à Alméria.

On commencera bientôt l'installation de tous les instruments pour que l'Observatoire fonctionne au plus tôt avec normalité.

1.14 — *Observatoire Géophysique de Santiago de Compostela*

Le dernier des Observatoires qui forment le plan de l'Institut Géographique et Cadastral dans le Territoire Métropolitain, est celui de Santiago de Compostela, dont la construction a déjà commencé et où seront installés des services de Magnétisme et de Sismologie avec le complément nécessaire de Météorologie.

Il se trouve aux environs de la ville de Santiago de Compostela et sa situation géographique est à peu près la suivante :

Latitude : 42° 53′ 16″ N.
Longitude : 8° 33′ 06″ W. Gr.
Altitude : 245 mètres.

1.2 — *Travaux de campagne*

Pour les Brigades de campagne, qui dépendent du Service de Magnétisme on a acquis quatre équipements de magnétomètres Askania, construits à Berlin-Friedenau.

Pendant les années 1951 à 1953, on a continué l'observation de stations séculaires sur notre territoire péninsulaire.

En 1952 et pour contribuer à l'étude de l'éclipse de soleil qui eut lieu le 25 février et qui fut totale dans les Territoires Espagnols du Golfe de Guinée, les Brigades de campagne s'y rendirent et établirent un Observatoire Magnétique provisoire à Eviayong (Guinée Continentale) dont l'emplacement approximatif était le suivant :

Latitude : 1° 26′ 16″ N.
Longitude : 10° 33′ 40″ E. Gr.

En prenant comme base cet Observatoire on fit un relèvement de la carte magnétique de ces Territoires et de l'île de Fernando Poo, en observant des stations séculaires de même que des stations normales. Les grandes anomalies que présente ce terrain permettront seulement d'avoir une carte utilisable sur de petites échelles et qui servent d'avant-projet pour un relèvement postérieur, fait avec plus de temps et plus d'éléments.

En divers points du Territoire et de l'Ile on fit aussi des déterminations des variations de H, d'accord avec les indications données par le Comité 11 de l'A. I. M. E. T. que préside le professeur Egedal, pour étudier les amplitudes anormales de cette variation à proximité des équateurs géographique et magnétique.

Enfin, pendant l'année 1953 on a fait des observations de stations normales dans les provinces de Jaen et de Cordoue, pour l'étude des anomalies magnétiques et leur rapport avec la faille tectonique du Guadalquivir où des tremblements de terre à foyer profond ont eu lieu récemment.

Au cours de cette année 1954 on commence un relèvement de la Carte Magnétique de la Péninsule Ibérique en collaboration avec le Service Météorologique National Portugais, d'après le projet présenté à Bruxelles par le professeur H. Amorim Ferreira et par l'ingénieur soussigné. En Espagne on fera les zones qui ont comme base les Observatoires de San Fernando et de Coimbra et on commencera celle de l'Ebre.

2. — *Observatoire de l'Ebre (Tortosa)*

Cet Observatoire, bien connu pour la qualité et la quantité de ses travaux, dirigé par les P. P. Jésuites et fonctionnant depuis le début du siècle, a réalisé en ce qui concerne le Magnétisme et l'Electricité Terrestes les travaux suivants :

Dans les trois années qui séparent la Réunion de l'U. G. G. I. à Bruxelles et la prochaine Assemblée de Rome, la section magnétique et électrique de l'Observatoire de l'Ebre a continué sa marche normale et on a réalisé quelques travaux extraordinaires.

On a continué l'enregistrement ininterrompu des composantes magnétiques H, Z, et D, des composantes N et E des courants telluriques et du potentiel atmosphérique.

On a réduit les valeurs des courbes et on a intensifié la réduction des valeurs des années antérieures où le manque de personnel ne permettait pas de le faire.

On a continué la collaboration avec le Comité 9 de l'A. I. M. E. T. pour la caractérisation des perturbations magnétiques, avec un envoi mensuel à De Bilt et à Washington des caractères trihoraires K, et des psc, ssc, si et sfe, et on a continué la composition du catalogue de baies magnétiques.

L'installation d'un nouvel enregistreur La Cour avec des aimants plus sensibles que les antérieurs, touche à sa fin et on a donné au papier une vitesse de 30 mm/h pour que les empreintes horaires données chaque minute soient parfaitement lisibles. Les premiers résultats obtenus sont franchement encourageants.

On a envoyé au Danemark deux Q. H. M., 109 et 110, pour leur étalonnage, et on en a acquis un autre, le 229.

Suivant les indications du Comité 11, dont le P. Romañá est membre, on a fait des déterminations de l'amplitude de la variation diurne près de l'équateur. A cet effet on instruisit, à l Observatoire, MM. Sanchez-Martinez et Capuz du Service Météorologique National, qui, munis de Q. H. M. de l'Observatoire même et suivant les indications rédigées par le P. Romañá, effectuèrent diverses déterminations de l'amplitude diurne de la composante H à Santa Isabel (Fernando Poo) et sur le continent, pendant les années 1949 et 1950. En 1951, le P. Cardús profita de son séjour en Guinée pour faire de nouvelles déterminations à Bata et finalement les P. P. Romañá et Cardús, à l'occasion de l'éclipse de soleil totale le 25 Fèvrier 1952, établirent un Observatoire magnétique provisoire à Niefang pour la détermination de l'amplitude de la variation diurne dans les trois composantes H, Z, et D.

Le P. Cardús, comme membre de la Commission mixte pour l'étude de l'influence lunaire sur les phénomènes météorologiques et magnétiques a continué à s'occuper de ces problèmes et a presque terminé la détermination de la variation L de la déclinaison à Tortosa. En même temps il a travaillé, d'après les indications données par le professeur Chapman, à l'étude des différences trouvées dans la valeur des angles de phase en calculant par la méthode décrite et par la méthode Chapman-Miller. Avec les données aimablement prêtées par l'Institut Géographique et Cadastral, le P. Romañá a terminé une première détermination de l'influence de la lune sur la composante horizontale à Moka (Fernando Poo) pendant la deuxième Année Polaire.

Dr. D. Constantino Gaibar Puertas, a publié sa thèse doctorale sur la "Variation séculaire du champ géomagnétique" ainsi qu'une grande monographie sur "Géomagnétisme Pyrénéen" dans le compte-rendu du Premier Congrès International d'Etudes Pyrénéennes. Il publia dans *Geofisica Pura e Applicata* une autre monographie sur "Increase of the Earth magnetization" et une note sur "Caractéristique de la variation séculaire du signe et de l'intensité de l'aimantation moyenne du globe" dans *Ciel et Terre.* Le P. Cardús de son côté a publié dans *Urania* un travail sur "L'Influence de la position héliographique des fulgurations cromosphériques dans la production de crochets géomagnétiques".

3. — *Institut et Observatoire de Marine de San Fernando (Cadix)*

Dans les années 1951 — 52 — 53, on a vérifié des observations absolues périodiques des trois éléments (déclinaison — force horizontale — inclinaison), d'après le plan suivant :

Force horizontale	= Tous les 10 jours
Déclinaison, Inclinaison	= Tous les 5 jours

L'enregistrement continu de la force horizontale et de la déclinaison a été maintenu par le variographe Adie, sans autres interruptions que celles causées par le manque de courant dans le réseau.

La perturbation causée par la ligne électrique qui passe à quelque 500 mètres de la station, rend l'enregistrement des indications de la balance impossible et affecte aussi un peu les enregistrements de la force horizontale et de la déclinaison, quoique sans importance excessive.

Pendant les trois années indiquées ci-dessus, aucune exploration ni travail géomagnétique extraordinaire n'ont été faits.

4. — *Institut Géologique et Minier*

Depuis 1951 ce Centre n'a fait aucune investigation par la méthode magnétique.

En ce qui concerne les méthodes électriques il a employé celles de courant continu et alternatif-carré dans les prospections suivantes du sous-sol :

Investigation électrique à Torrevieja (Alicante) 1952

On effectue à présent une prospection géophysique à Torrevieja à l'aide du gravimètre. Mais ce dont nous allons parler ici, c'est d'un petit complément de cette prospection réalisé par des sondages électriques. Il s'agissait de ce que les eaux souterraines de la région étaient salées dans certains lieux relativement éloignés de la grande lagune salée de Torrevieja. Une étude de résistivités nous borna la zone dans laquelle toute trouvaille d'eau souterraine avait les plus grandes probabilités d'être de l'eau saumâtre.

Investigation hydrologique par la méthode électrique à Alméria

Chargé par l'Institut de Colonisation, notre Section effectua une grande étude géologique-géophysique entre Dalias et Vicar, à l'aide de la méthode électrique.

Le travail offre de grandes difficultés, mais on borne les bonnes zones pour essayer de futures prospections ainsi que celles de peu d'intérêt hydrologique ; un cas curieux à signaler c'est que les zones considérées, avant notre étude, comme intéressantes, ont été marquées par nous comme de peu d'intérêt et vice-versa. Plusieurs travaux de forage pour la recherche d'eau souterraine ont été proposés, dont l'un a été commencé déjà.

Investigation hydrologique par la méthode électrique à Nijar (Alméria) 1953

Région à caractéristiques pareilles à l'antérieure, on délimite dans celle-ci, par la même méthode électrique, plusieurs failles cachées par des couches modernes et qui peuvent être autant d'autres cas d'eau souterraine. En outre, à peu de mètres de profondeur, on détermine un contact argileux, sous un horizon sablonneux, ce qui est du plus grand intérêt hydrologique.

Investigation électrique à Hernani (Guipúzcoa) 1953

Les villages d'Espagne qui ne disposent pas de bonne eau en quantité suffisante pour couvrir leurs nécessités domestiques, sont bien nombreux. La quantité disponible par personne, diminuera encore si on tient compte de l'augmentation continue de la population et de la consommation d'eau par habitant à mesure que le niveau de vie moyen s'élève. Comme exemple, quoique non caractéristique, il y a celui d'Hernani, qui, bien que situé dans une région très pluvieuse, manque de l'eau en été, et surtout on ne peut pas couvrir les prévisions pour les années futures, si l'on considère les projets d'agrandissement de ses industries.

Un supplément d'eau potable d'origine souterraine serait d'un énorme intérêt pour l'avenir. C'était là les raisons de notre étude que nous avons faite plutôt dans le but d'investigation et de preuve de méthodes et de procédés que dans l'espoir d'obtenir des résultats immédiats de type économique.

Avec le travail électrique on confirme qu'on peut déterminer les contacts de terrains hydrologiquement intéressants malgré les couches modernes de basse résistivité et leur structure tectonique compliquée.

SWEDEN

Report on work in terrestrial magnetism and atmospheric electricity since the Brussels Assembly

by Harald Norinder

In the Swedish report to the Brussels Assembly there was given an account of the erecting of a new geophysical research institute in the far northern parts of Sweden. The institute was to be erected in an open region not far from the Swedish town of Kiruna (67° 50′, 27° 26′) where the local conditions were favourable both for general geophysical investigations and meteorological observations.

While awaiting a definite establishment of the planned institute a temporary organization of a geophysical observatory has been started at Kiruna. This enterprise has been economically supported by the town of Kiruna, by the Swedish State, and by the Royal Swedish Academy of Science.

During the spring of 1954 a special commission under the auspicies of the Royal Swedish Academy of Science has visited Kiruna. The main aim was to investigate the local conditions in relation to the designs worked out for a new central building for the planned institute.

In the last report it was mentioned that a temporary ionospheric observatory had been erected at Lurbo in the vicinity of Uppsala under the auspicies of the Royal Research Institute of National Defence in Sweden. The locality for this observatory has shown to be very fitted for its purpose and a stationary building will be erected in the nearest future.

The investigations of different elements of atmospheric electricity mentioned in the last report have been continued and developed as a special branch of the Institute of High Tension Research at the University of Uppsala.

Further detailed information of investigations in Sweden related to the Association will be given in the following Special Reports.

Special Reports

Investigations carried out at the Department of Electronics at the Royal Institute of Technology (Kungl. Tekniska Högskolan), Stockholm

by Hannes Alfvén

Terella experiments of the Birkeland — Malmfors — type have been continued by L. Block. The results will be published within soon.

The electric field theory of magnetic storms and aurora has been further developed and it seems possible to describe also the initial phase of a storm.

Publications.

H. Alfvén:
(1) Discussion of the origin of the terrestrial and solar magnetic fields. Tellus, vol. 2, no. 2, May 1950.
(2) Magnetic storm effect on cosmic radiation. Phys. Rev., vol. 94, no. 4, Sec.Ser., p. 1082, 1954.
(3) On the origin of cosmic radiation. Tellus. In the Press.

E. Å. Brunberg and A. Dattner:
(4) On the interpretation of the diurnal variation of cosmic rays. Tellus, vol. 6, no. 1, p. 73, 1954.
(5) Experimental determination of electron orbits in the field of a magnetic dipole. Tellus, vol. 5, no. 2, p. 135, 1953.

N. Herlofson:
(6) Plasma resonance in ionospheric irregularities. Ark. f. fysik, Bd. 3, no. 15, 1951.
(7) Radio echoes from meteor trails and ionospheric scattering centres. Doctor's Thesis, 1951.

B. Lehnert:
(8) On the behaviour of an electrically conductive liquid in a magnetic field. Ark. f. fysik, Bd. 5, no. 5, 1952.
(9) Experiments on non-laminar flow of mercury in presence of a magnetic field. Tellus, vol. 4, no. 1, 1952.
(10) Magneto-hydrodynamic waves in liquid sodium. Phys. Rev., vol. 94, no. 4, Sec.Ser., 1954.

S. Lundquist:
(11) Teorier för jordens permanenta magnetfält. Kosmos, Bd. 29, 1951.
(12) Studies in magneto-hydrodynamics. Ark. f. fysik, Bd. 5, no. 15, 1952.

K. G. Malmfors:
(13) A simple cosmic-ray-meter, plotting hourly values corrected for pressure. Ark. f. fysik, Bd. 4, no. 25, 1952.

Report from the Earth Magnetic Section of the Hydrographic Office of Sweden (Kungl. Sjökarteverket), Stockholm

by Nils Ambolt

The geomagnetic routine work in Sweden has been carried on along the same lines as earlier. Thus three stations, Lovö (59° 21′, 17° 50′), Kiruna (67° 50′, 20° 26′), and Abisko (68° 21′, 18° 49′) have been recording D, H and Z, and they are all provided with normal and quickrun registrations. One of these quickrun-sets was placed at disposal by the International Association of Terrestrial Magnetism and Electricity. All the stations are managed by the Hydrographic Office, though only Lovö belongs to this institution. The other two stations belong to the Swedish Academy of Science.

Connected with the geomagnetic observatory in Kiruna are other geophysical observatories recording ionospheric data, seismic activity, cosmic radiation and solar radiation. At the ionospheric station there is also a so-called "aurora radar"-recorder. The Kiruna observatory is slowly growing and it is hoped that it shall be able to function as a "Geophysical Centre" during the third Geophysical Year.

A sparse net of secular geomagnetic stations was measured in 1953 in cooperation with the neighbouring countries. In 1954 a temporary geomagnetic observatory was erected in the vicinity of Värnamo in order to have a registration under the point where the eclipse of the sun was total in the ionosphere at about 100 km height.

Absolute values for H and Z are determined by aid of QHM and BMZ instruments, which are compared every year at Rude Skov, Denmark.

Publications.

Nils Ambolt:
(1—3) Ergebnisse der Beobachtungen des magnetischen Observatoriums zu Lovö (Stockholm) im Jahre 1949, 1950, 1951. Kungliga Sjökarteverket, Stockholm.
Folke Eleman und Kjell Borg:
(4) Ergebnisse der Beobachtungen des magnetischen Observatoriums zu Lovö (Stockholm) im Jahre 1952. Kungliga Sjökarteverket, Stockholm.
(5) Average magnetic Declination 1950 in Denmark, Finland, Norway and Sweden. Published by a joint committee from the countries above as Jordmagnetiska Publikationer, no. 15.

Report from Uppsala Ionosphere Observatory (Uppsala Jonosfärstation) under the direction of the Research Institute of National Defence in Sweden

by Martin Fehrm
Head of Radio Department
and
Willy Stoffregen
Head of Uppsala Ionosphere Observatory

Uppsala Ionosphere Observatory started its work about four years ago and since January 1952 regular observations are distributed to the CRPL, NPL and other foreign and Swedish institutions. The ionosonde is operated on the range 1,4—17 Mc.

In the past two years regular radio conditions forecasts have been distributed to interested Swedish institutions.

The research program of the Observatory is concentrated on the following subjects:

1. Investigations on the frequency range 2 Mc til 16 kc (Rugby) in order to study the behaviour of long waves during ionospheric storm conditions. For this purpose field-strength records are

made on L.F. and V.L.F. stations. Further the atmospheric noise level is recorded. A new equipment for echo sounding in the range 0,2 to 2 Mc is under construction.

2. Special studies are made concerning the sporadic-E layer, especially of the type, which is common during the summer in temperate latitudes. Distant TV — reception in Sweden of London, Rome and others is in this connection subject of special investigations.

3. During the latest solar eclipse in Sweden a second station was erected for one month in the south of Sweden for ionospheric sweep records and field-strength measurements. Preliminary inspection of the material has shown that valuable results have been obtained.

4. In the nearest future the chief interest of the Observatory's research work will be the preparation of the research program during the international geophysical year.

Publication.

M. Fehrm and W. Stoffregen:
Uppsala Ionosphere Observatory. A preliminary report of its research problems (in Swedish). Report no. 1, 1954.

Report on the magnetic survey work of the mainland of Sweden carried out by the Geological Survey of Sweden (Sveriges Geologiska Undersökning), Stockholm

by Kurt Molin

The following investigation has been carried out of the movement of isoporic zero-lines for horizontal magnetic intensity in Sweden. The number of places at which determinations of the horizontal intensity H have been carried out in Sweden before 1928 amounts to 660 and among these there are 87 such places at which observations have been repeated at different times. At most of these 87 older points I and my collaborators have performed remeasurements during the period 1928—1934. From points at which we thus have 3 and more remeasurements the secular change of H has been examined.

The older H-determinations are performed in the years 1825, 1828, 1838, 1860, 1869, 1870, 1871, 1872, 1882, 1886, 1892, 1915 and I have tried to take into consideration the different H-standards and to reduce them to the same standard. For uniformity it was rather natural to effect an agreement to the Rude Skov H-standard.

The secular variation of a magnetic element can be expressed by a finite sine-function which in regions of maxima and minima may be replaced by a parabolic formula, giving the time for maximum of H. From such time-values the isoporic zero-lines are drawn for the years 1870, 1880, 1885, 1890, 1895, 1900 and 1905. The movement of the isoporic zero-lines seems to proceed in a south-westerly direction from 1870 to 1905.

With the aim of illustrating the slowness of the variation of H at the time of maximum the radius of curvature ϱ at the point in question was calculated or which is the same the inverted value of the acceleration. The lines of equal ϱ-values show fluctuations of regional characteristics. The ϱ-values vary from north to south from 3,0 to 1,5 $(\text{year})^2 . (\text{gamma})^{-1}$.

Publication.

K. Molin: Movement of isoporic zero-lines for horizontal magnetic intensity in Sweden. Ark. f. geofysik, Bd. 1, no. 17, Stockholm, 1952.

Report from the Institute of High Tension Research (Institutet för högspänningsforskning) at the University of Uppsala

by Harald Norinder

The investigations of the electromagnetic field as caused by lightning discharges have been carried out in different ways.

Electric field components. In a first group of investigations open antenna circuits in combination with amplifiers and specially constructed cathode-ray oscillographs have been used in order to record with the E-method the variations of the vertical electric field components from lightning discharges. In these investigations the variations of the electric field have been analysed by simultaneously recording stations at varying distances from the lightning paths.

Magnetic field components. In a second sequence of investigations shielded frame aerials have been used also in combination with amplifiers and cathode-ray oscillographs. The method allowed either a measurement of the variations of the magnetic field, the H-method, or a measurement of its first derivative with time, the dH/dt method. Three frame aerials, two vertical and one horizontal with an angle of 90° between them, have been used and allowed simultaneous records of the magnetic components in the three planes.

The thunderstorm season of 1953 showed to be very profitable for the investigations and gave very extensive oscillographic records from a little more than 2000 lightning strokes in the vicinity region (up to 20 km) of the observation stations. In the vertical components maximum values of $200 - 300 \times 10^{-4}$ Gauss were obtained. Simultaneous records from horizontal and vertical components showed in average that the horizontal components attained a third part of the corresponding vertical force values. The extensive material is being printed for publication.

Model tests with artificial lightning discharges. Many phases of lightning discharges in the free atmosphere are very complicated and also very faint with regard to their intensity of luminosity, e.g. the faint streamers and predischarges. This has necessitated model tests of long electric sparks. These sparks have been regulated in such a way that they in special respects reproduce what happens with a natural lightning discharge.

Atmospheric electricity in the lowest layers of the air. Investigations in special branches of atmospheric electricity have been developed at the institute since the Brussels Assembly. Beside problems of the ions in the lowest layers of the air there have been taken up investigations related to production of ions in closed rooms by artificial means.

Considerable parts of the earth's surface in Sweden are during long winter periods covered with snow and ice. This has lead to some investigations related to the electrification of snow cristals and ice particles.

Publications.

H. Norinder and O. Salka:

(1) Stosswiderstände der verschiedenen Erdelektroden und Einbettungsmaterialien. Bull. des SEV, Jg. 1951, No. 10.

(2) Mechanism of positive spark discharges with long gaps in air at atmospheric pressure. Ark. f. fysik, Bd. 3, no. 19, 1951, Stockholm.

H. Norinder and R. Siksna:

(3) Ionic density of the atmospheric air near the ground during thunder-storm conditions. Ark. f. geofysik, Bd. 1, no. 16, 1951, Stockholm.

(4) Height variations in the concentration of ions near the ground during quiet summer nights at Uppsala. Tellus, vol. 3, no. 4, 1951, Stockholm.

H. Norinder:

(5) Recherches effectuées en Suède sur les perturbations des lignes électriques produites par la foudre. Bull. de la Société française des Electriciens, 7e Série, tome II, no. 17, Mai 1952, Paris.

(6) Thunderstorms. The electric field variations radiated from lightning discharges. Compte rendu de la deuxième réunion de la Commission mixte de Radio-Météorologie (16 au 18 août 1951).

A. Vassy, H. Norinder and E. Vassy:

(7) Spectres d'étincelles sous très haute tension dans l'air et températures de couleur. Comptes rendus des séances de l'Académie des Sciences, tome 234, p. 1957—1959, séance du 12 mai 1952, Paris.

R. Siksna:

(8) Measurements of large ions in the atmospheric air at Uppsala. Ark. f. geofysik, Bd. 1, no. 18, 1952, Stockholm.

H. Norinder and R. Siksna:

(9) Ions produced in a room by ultra-violet light from a quartz-mercury arc and by an open electric heater. IVA, vol. 23, no. 2, 1952, Stockholm.

H. Norinder:
(10) Experimental lightning research. Journ. of the Franklin Institute, vol. 253, no. 5, 1952.
(11) Variations of the electric field in the vicinity of lightning discharges. Ark. f. geofysik, Bd. 1, no. 20, 1952, Stockholm.
H. Norinder and O. Karsten:
(12) Investigation of resistance and power in experimental lightning discharges. Journ. of the Franklin Institute, vol. 253, no. 3, 1952.
H. Norinder and R. Siksna:
(13) Variations of the concentration of ions at different heights near the ground during quiet summer nights at Uppsala. Ark. f. geofysik, Bd. 1, no. 19, 1952, Stockholm.
H. Norinder and O. Salka:
(14) Mechanism of long-gap negative spark discharges in air at atmospheric pressure. Ark. f. fysik, Bd. 5, no. 24, 1952, Stockholm.
H. Norinder and R. Siksna:
(15) Ions produced in the air at atmospheric pressure by ultra-violet light from a quartz-mercury arc. Ark. f. fysik, Bd. 5, no. 23, 1952, Stockholm.
R. Siksna:
(16) Positive ions formed by an open electric heater. Ark. f. fysik, Bd. 5, no. 25, 1952, Stockholm.
(17) Mobility spectra of ions formed in a room by negative corona discharge. Ark. f. fysik, Bd. 5, no. 26, 1952.
H. Norinder and O. Salka:
(18) Screens in long discharge gaps. Ark. f. fysik, Bd. 6, no. 17, 1953, Stockholm.
H. Norinder and R. Siksna:
(19) Ions formed by corona discharge. IVA, vol. 23, no. 6, 1952, Stockholm.
(20) Ions formed in a room by negative wire corona. Ark. f. fysik, Bd. 6, no. 14, 1952, Stockholm.
H. Norinder, A. Metnieks and R. Siksna:
(21) Radon content of the air in the soil at Uppsala. Ark. f. geofysik, Bd. 1, no. 21, 1952, Stockholm.
(22) Radon and thoron contents of the soil-air at Almunge. Geologiska Föreningens i Stockholm Förhandlingar, Bd. 74, no. 4, 1952.
H. Norinder and R. Siksna:
(23) Ions formed in a room by positive wire corona. Ark. f. fysik, Bd. 6, no. 25, 1953, Stockholm.
R. Siksna:
(24) Mobility spectra of ions formed by positive corona discharge. Ark. f. fysik, Bd. 6, no. 28, 1953, Stockholm.
W. Pucher.
(25) Form der negativen Vorentladung in Luft bei Atmosphärendruck für Stossspannungen. Ark. f. fysik, Bd. 6, no. 37, 1953, Stockholm.
(26) Negativer Durchschlag von Luft in der Funkenstrecke Kugel-Platte bei Stossspannungen. Ark. f. fysik, Bd. 6, no. 36, 1953, Stockholm.
A. Vassy, H. Norinder and E. Vassy:
(27) Étude spectrophotométrique d'étincelles de grande longueur dans l'air. Ark. f. fysik, Bd. 6, no. 42, 1953.
H. Norinder and R. Siksna:
(28) On the electrification of snow. Tellus, vol. 5, no. 3, 1953, Stockholm.
(29) Mobility of atmospheric small ions during summer nights at Uppsala. Journ. of Atmosph. and Terr. Physics, vol. 4, p. 93, 1953.
R. Siksna:
(30) Mobility of small atmospheric ions in the air from the ground at Uppsala. Journ. of Atmosph. and Terr. Physics, vol. 4, p. 106, 1953.

H. Norinder and R. Siksna:
(31) Experiments concerning electrification of snow. Ark. f. geofysik, Bd. 2, no. 3, 1954, Stockholm.
H. Norinder and W. Pucher:
(32) Field intensities and charge densities in thunderclouds. Ark. f. geofysik, Bd. 2, no. 5, 1954, Stockholm.

THE UNION OF SOUTH AFRICA

Report on activities in the fields of terrestrial magnetism and atmospheric electricity, 1951—1954

1. *Atmospheric Electricity.*

Work in this field is centred at the Bernard Price Institute of Geophysical Research, The University of the Witwatersrand, Johannesburg. This Institute has been concerned with two main problems, the distribution of electric charges in the thunderstorm and the mechanism of the breakdown involved in lightning discharges.

Malan and Schonland (1951) showed by means of field-change measurements on lightning leaders that large frontal thunderstorms contain a centre of negative charge N in the form of a nearly vertical column whose base is at the —50°C level and whose top often extends up to the —40°C level but not beyond it. A positive charge, P, lies above this column and a smaller positive pocket, p, below it (*Malan*, 1952). In view of the light which the position of this negative column in the cloud may shed on the question of the generation of charge in thunderclouds it has been made the subject of further extensive study. *Malan*, in a paper in the press, has shown that a column of height 6 kms. is involved in the great majority of discharges to ground, whether these show one or many intermittent strokes, the flashes of few strokes being followed by a continuous discharge of a column of the same length as that intermittently discharged by flashes of many strokes. *Hacking* (unpublished) has studied the heights from which come the separate strokes of a discharge to ground by a triangulation method involving three field measuring stations and has in this way independently verified the general accuracy of the column concept, though the column is found to depart considerably from the vertical at times. *Hewitt* (1952) has used 50 cm. radar equipment for the same purpose. The lower positive charge, which appears responsible for initial breakdown (N—p) in a flash to ground, has been studied by *Malan* (1952) who has also made unpublished studies of the discharge within the cloud which show that it frequently involves an intermittent P—N discharge process in which the N column is neutralised by streamer processes discharging N from the top downwards. *Malan* has also obtained photographic evidence for the J or junction streamers deduced from field-change measurements to render conducting fresh sections of the N column in the quiescent intervals between intermittent strokes.

The method of propagation of the stepped first leader has been examined by *Schonland* (1953) who has put forward a new explanation of this process based on the properties of a pilot streamer. Extensive studies have also been made by *Malan* and *Clarence* of the slow initial processes preceding the appearance of the first leader of a flash to ground.

References.

Hewitt, F.: Proc. Phys. Soc. 1953, LXVI, 895.
Malan, D. J. and Schonland, B. F. J.: 1951, Proc. Roy. Soc. A. *206*, 145, *209*, 158.
Malan, D. J.: 1952, Ann. de Géophys. *8*, 385.
Schonland, B. F. J.: 1953, Proc. Roy. Soc. A. *220*, 25.

2. *Terrestrial Magnetism.*

Activities in this field are carried out by the Magnetic Observatory at Hermanus, whose Director Dr. A. van Wijk reports as follows: —

I. *Observatory Work.*

The routine recording of the magnetic elements continued without interruption. Maintenance of the equipment included a careful check of the orientation of the Askania variometers. The base-line values of the magnetograms were controlled by regular observations with (a) an Askania magnetometer-theodolite for H and D, (b) a Schuster-Smith Coil Magnetometer for H, and (c) an Askania standard inductor for I. Horizontal intensity readings with instruments (a) and (b) agreed within one gamma.

The period 1951—1954 saw the publication of the final results of observations covering the period 1945—1950. (Ref. 1).

II. *Field Work.*

In view of the rapid changes in the elements *H* and *Z* at Hermanus, and of the recent reversal of the secular change in *D*, the fifty repeat stations in Southern Africa were re-observed during 1952—53. An account of this work is being prepared in the form of a supplement to the earlier report on the secular variation programme (Ref. 2). The results for the six stations in Rhodesia were summarized in a preliminary report published in 1953. (Ref. 3).

A detailed picture of the magnetic field in South Africa is gradually unfolding itself. Field Officers of the Trigonometrical

Survey Office engaged in a topographical survey of the Union of South Africa are observing the magnetic declination at a large number of intermediate points. The Geological Survey Office, on the other hand, is carrying out an intensive survey of the vertical component. In both these projects the network of primary field stations and the continuous registrations at Hermanus are providing the necessary control.

III. *Research.*

Owing to the heavy field programme and the continued shortage of staff, research at the Magnetic Observatory has been on a restricted scale. Items under investigation are (a) lunar-diurnal effects in the magnetic field at Cape Town, and (b) the annual variation of the magnetic elements (Ref. 4).

A recent paper on the use of the Quartz Horizontal-Force magnetometer for declination measurements has attracted wide attention. (Ref. 5).

IV. *International Collaboration.*

A Kew-pattern magnetometer and two dip circles belonging to the Serviço Meteorológico de Angola were re-conditioned and calibrated when an official of that Department visited Hermanus in 1952.

In view of the proposed establishment of a magnetic observatory in Moçambique, the Chief of the Serviço Meteorológico de Moçambique visited Hermanus in March 1954 to examine the lay-out of the Hermanus Observatory.

Following the international comparison of horizontal intensity standards (Hermanus — Rude Skov — Cheltenham) carried out on the initiative of the Hermanus Observatory in 1949, a further comparison (Manhay — Hermanus — Elisabethville — Rude Skov) was carried out in 1951 on the suggestion of Dr. Koenigsfeld, in his capacity as Director of Manhay Observatory and Member of the Committee on International Comparison of Standards.

References.

1. "Results of Observations made at the Magnetic Observatory, Hermanus" (Three volumes, 1945—46, 1947—48, 1949—50. Government Printer, Pretoria).
2. "The Secular Variation of the Earth's Magnetic Field in South Africa, 1939—1948" (Government Printer, Pretoria, 1951).
3. "Magnetic Observations at the Secular Variation Stations in Southern Rhodesia" (S. Afr. Journal of Science, Vol. 50, No. 4, Nov. 1953).
4. "Annual Variation of the Geomagnetic Elements" (J. Geoph. Res.. Vol. 58, No. 3, Sept. 1953).
5. "Note on the Use of the Quartz Horizontal-Force Magnetometer for the Determination of Magnetic Declination" (S. Afr. Journal of Science, Vol. 47, No. 11, June 1951).

UNITED STATES

United States National Report
Terrestrial Magnetism and Electricity
1951, 52 and 53
by

L. R. Alldredge, Secretary
Section of Terrestrial Magnetism and Electricity
American Geophysical Union

Table of Contents

Chapter I

INTRODUCTION

During the past triennium the Section of Terrestrial Magnetism and Electricity (Section D) of the American Geophysical Union (AGU) met each year near the first of May in Washington, D. C. An average of 100 members and guests attended the technical sessions of these annual meetings. Section D has consistently supported the movement for an International Geophysical Year (IGY) as evidenced first by formal resolutions made in 1951 and more recently by the activity of many members on the U. S. National Committee for the IGY.

The number of workers studying the physics of the upper atmosphere has steadily increased in recent years. This new emphasis has resulted in a proposal made by a commission of the Executive Committee of the International Union of Geodesy and Geophysics (IUGG) to change the name of the "International Association of Terrestrial Magnetism and Electricity", which is the Association for which Section D of the AGU is the United States National Committee, to the "International Association of Geomagnetism and Ionospheric Physics". In a recent action taken by the Executive Committee of the American Geophysical Union it was decided to make a corresponding change in the name of Section D if the IUGG does act favorably upon the above proposal.

The fields of Geophysics covered by Section D are so varied that it would be impossible for the secretary to obtain a comprehensive coverage of the progress during the past three years without soliciting the help of experts in the various fields. Accordingly, the following men were asked to submit reports on the subject matter indicated:

E. B. Roberts — General Geomagnetic Measurements and Theory
J. W. Joyce — Magnetic Airborne Surveys
M. A. Tuve — Atmospheric Electricity
A. H. Shapley — Ionospheric Physics
C. W. Gartlein — Auroral and Night Sky Studies
S. F. Singer — Cosmic Rays
H. T. Stetson — Cosmic Terrestrial Relations

The response from these scientists was gratifying. The chapters which follow are made up of the separate reports submitted by these men. They have been edited by the secretary to remove duplications and to achieve a measure of uniformity of style. Some of the contributors saw fit to rely heavily on existing bibliographical services whereas others preferred to indicate progress in their field, principally by listing published papers including the full title. The secretary laments the resulting lack of uniformity but feels that under the circumstances the reports should be left this way. As might be expected the report on Cosmic Terrestrial Relations contained a great deal of material which was also contained under the other headings. For this reason it suffered most in the editing process.

Chapter II

GENERAL GEOMAGNETIC MEASUREMENTS AND THEORY

Compiled by

E. B. ROBERTS

Part A: *U. S. Coast and Geodetic Survey*

(1) *Magnetic Observatories*

Cheltenham has continued in operation with three magnetographs of standard- and low-sensitivities, and with a cosmic ray meter operated for the Department of Terrestrial Magnetism of the Carnegie Institution of Washington. International magnetic standards established by the DTM, CIW have been maintained, and numerous inter-comparisons and standardizations of magnetic instruments of the Bureau and of Foreign Governments have been made here.

College (Alaska) operated with two magnetographs, a standard- and low-sensitivity instrument, and with seismological equipment.

Sitka, the oldest magnetic observatory in Alaska, operated with a normal- and a low-sensitivity magnetograph, and with a two-component seismograph.

Barrow continued full-time operation with a low-sensitivity magnetograph recording D, H and Z.

Honolulu maintained its normal operation with a high-sensitivity magnetograph and a three-component seismograph.

San Juan continued operation with a standard-sensitivity magnetograph having a sealed cover for reducing deleterious effects of high tropical humidity. There is a three-component seismograph at the observatory.

Tucson has a standard-sensitivity magnetograph that is unique in having a specially sensitive D variometer (scale value 0.5 min. per mm.) that makes use of a double reflection from the suspended mirror. High-sensitivity three-component seismographs are also included in the observatory equipment. Atmospheric Electricity recording equipment is operated cooperatively with the Department of Terrestrial Magnetism of the Carnegie Institution of Washington.

Fredericksburg Magnetic Observatory is expected to replace Cheltenham within the next two years. Funds have been appropriated by the United States Congress, and building plans and specifications have been prepared for use in contracting for the construction work. High- and low-sensitivity magnetographs and rapid-run recorders will be provided, and there will be facilities for development, test, comparison, and standardization of instruments and equipment. The Fredericksburg site is 75 kilometers south-west of Cheltenham, at Latitude 38° 12′.4 North, Longitude 77° 22′.0 West of Greenwich, on a reservation to which the Coast and Geodetic Survey has acquired title.

Automatic Declination Recording Stations continue in operation at Gatlinburg (Tennessee) and Logan (Utah), recording variations in magnetic declination on slow-speed photographic tape. Service is required only at intervals of several months.

A magnetic Observatory was in operation at Houston, Texas, cooperatively with the University of Houston, from October 1950 to November 1953, recording all three components: D, H, and Z.

Assistance was given to Instituto Geográfico de Colombia in Bogota, Colombia, South America, at the installation of the Fuquene Magnetic Observatory by sending a technician from this Bureau.

(2) *Ground Magnetic Surveys*

In the continuing endeavor to obtain data for secular-change studies, particularly for the construction of isomagnetic charts, magnetic stations have been occupied by U. S. observers in the United States and Alaska. Emphasis is being placed where possible on the establishment of pairs of repeat stations to provide greater assurance of continuity in secular-change determinations. During the period of this report many magnetic stations were occupied in other American Republics and on islands of the Caribbean by the Inter-American Geodetic Survey, and the results of this work have been made available to this Bureau. A record of the station occupations is shown in the table following:

Repeat Stations

Area	*New* Complete	*New* D only	*Old* Complete	*Old* D only	Other stations	Total
Alaska		5		1	69	75
Caribbean Area	5	10	6	1		22
Central America	4	2	17	2	1	26
Mexico	30					30
South America	48	1	36			85
United States (general)	7		61	7	5	80
Great Lakes Area (U. S. & Canada)		1		26		27
U. S. (Compass Rose sites)					19	19
Totals	94	19	120	37	94	364

The above table includes, also, occupations of magnetic stations by the United States Lake Survey, Corps of Engineers, U. S. Army, in their operation of gathering data for the construction of an isogonic chart of the Great Lakes area.

(3) *Magnetic Instruments*

An Askania Variograph, a portable three-component magnetic recording instrument, was purchased from the manufacturer in Germany in 1953. Preliminary tests of limited scope indicate satisfactory performance of the instruments. It is expected that more complete results of the tests will be reported by the Committee to Promote Observations of Daily Magnetic Variations in Low Latitudes.

(4) *Charts*

Isogonic, isoclinic, and isomagnetic charts of H, Z, and F for the United States and for Alaska, for epoch 1955.0, are being compiled and will be published by the Coast and Geodetic Survey on or about January 1, 1955. All of the charts will contain isoporic lines. The United States charts will show somewhat more detail of line configuration than the World Charts described below, but the lines in the border areas of the U.S. Charts will coincide with corresponding lines on the World Charts.

A complete set of World Magnetic Charts (for D, I, H, Z, and F) for epoch 1955.0 is being compiled by the Coast and Geodetic Survey for publication by the United States Navy Hydrographic Office on or about January 1, 1955. Through a program of intercomparison with the Royal Observatory of England and the Dominion Observatory of Canada, it is expected that all but minor differences will be eliminated between the charts published by the United States and those for the same epoch that are being published by Great Britain and Canada. In addition to the World Magnetic Charts there will be a polar Isogriv Chart of the north polar area, on which lines of equal "grivation" will be shown. The reference framework will be rectangular grid rather than the geographic coordinates, grid north being the direction on the chart of any line drawn parallel to the Greenwich Meridian. The northerly direction of the Greenwich Meridian (or southerly direction of the 180th Meridian) determines the sense of the grid north direction. Grivation at any location on the chart is the angle between grid north and magnetic north.

The World Charts are based on all available observations between 1900 and the present time, each observation being reduced to the chart epoch by the application of secular change derived from observatory and repeat-station data, using the impulse method devised in the Coast and Geodetic Survey. After all observations are reduced to epoch, the mean value of the magnetic element is plotted at the mean position in each one-degree quadrangle for control of the isolines. From the basic isopors and isomagnetic lines of D, H, and I, scalings are made at five-degree grid inter-sections for the computation of Z, F, $\triangle$ Z, and $\triangle$ F. However, within the regions where Inclination exceeds 80°, Z replaces I as a basic chart, and I is computed from H and Z.

Another special isogonic chart being compiled by the Coast and Geodetic Survey covers the area of the Great Lakes, depicting the isogonic lines for epoch 1955.0 in somewhat greater detail for that area than will be shown on the U. S. Isogonic Chart. Preparation of this chart is a cooperative project between the Coast and Geodetic Survey and the U. S. Lake Survey, Corps of Engineers, U. S. Army; its primary purpose is to furnish magnetic information for the use of navigators on the Great Lakes.

(5) *Publications and Reports*

Beginning with 1950, magnetic observatory publications of the Coast and Geodetic Survey have been in the form of a single yearly volume for each observatory, containing both reproductions of magnetograms and tabulations of hourly values of D, H, and Z, with daily sums and means and with hourly sums and means (by months). Results for 1950 have been published for Cheltenham, Tucson, San Juan, Sitka, College, and Honolulu; good progress has been made on the preparation of 1951 results for publication.

Magnetic Observatory Manual, by the late H. E. McComb, Special Publication No. 283 of the U.S. Coast and Geodetic Survey was published in 1953, and has been widely distributed.

Reversible Susceptibility and the Induction Factor used in Geomagnetism, by David G. Knapp, Special Publication No. 301 of the U. S. Coast and Geodetic Survey, published in 1954, is a specialized pamphlet developing some relations which connect certain parameters of magnets, as traditionally used in geomagnetic work, with the pertinent physical properties of the materials. It also discusses comprehensively the small effects of the ambient medium on the actions of magnets.

Another volume in the long-continued series of United States Magnetic Tables and Magnetic Charts, the current one being for 1955, is now being compiled and will be ready for publication in 1956. The volume will include secular change tables useful for determining the secular change of D, H, and I at any point in the United States between any two dates for which sufficient magnetic data are available — specifically, between any early date and 1955, the date of the tables.

(6) *Magnetic Field Changes*

The isopors or lines of equal annual change for 1955 show no striking changes since the previous charts were published. The foci are still in about the same location, though for dip and vertical intensity the rather strong focus of negative change in the tropical Atlantic has become even stronger and more widespread than it was in 1945. In horizontal intensity the foci still, as in 1945, seem to fall into a pattern of alternating zones of positive and negative change encircling the earth, the total area exhibiting each sign being about the same. This, of course, contrasts sharply with the previous era of long standing when the areas of negative changes were much larger than those of positive changes.

Part B: *Geophysical Institute, University of Alaska*

(The following paragraphs on activities of the Institute in the specific field of geomagnetism are taken from a report received about February 8, 1954 from the Director of the Geophysical Institute, C. T. Elvey.)

Much attention has been given to geomagnetic investigation. Considerable progress has been made with very extensive study of the solar and lunar daily variations of the three magnetic elements at Sitka. The data used cover about 50 years, from the institution of the observatory by the United States Coast and Geodetic Survey, in 1902, up to the end of 1952. Much help was received in this work from the USC&GS and from the Watson Scientific Computing Laboratory of Columbia University. A preliminary report on part of the results for the solar daily variation was given at the Third Alaskan Science Conference, September, 1953.

The morphology of magnetic storms has also been studied. Using the material on which Chapman based his first paper on this subject (Proc. Roy. Soc. London, A, *95*, 61—83, 1919) the time variation of the SD part of the variation has been determined in more detail as a function of storm time. The results have been published, and a new general discussion of magnetic storm morphology is in course of publication. A preliminary study of the storm-time variation of the horizontal magnetic force at Sitka has been made, and is being published. An extensive investigation of storm morphology based on new material has been begun, and as a preliminary 346 magnetic storms during the period 1902 to 1945 have been classified according to intensity on a new basis.

A study has been made (and its results are being published) of the problems of geomagnetism in which rocket-borne magnetometers can give valuable assistance.

A note has been published concerning the enhancement of the sudden-commencement change of horizontal force at Huancayo in the case of magnetic storms that begin during the day hours at that observatory.

Part C: *Gates and Crellin Laboratories, California Institute of Technology*

(The following paragraph was received from O. R. Wulf about February 15, 1954.)

In connection with the mechanism of the production of geomagnetic activity Nicholson and Wulf[1] have given evidence that there is a tendency for quiet days to precede disturbed days. It is suggested that this may be inherent in the mechanism. From the point of view of an atmospheric theory of magnetic activity earlier outlined, this in turn suggests investigation of the character of changes in the large-scale circulation of the atmosphere that might be involved in such activity. Wulf has continued earlier studies[2] of the daily variation of the earth's magnetic field in relation to the large-scale circulation of the atmosphere based on the implications of the dynamo theory of the daily variation of the field and the possibility that large-scale air motions in the ionosphere and in the low atmosphere may be appreciably interrelated. Wulf[3] has suggested that a source of excitation of the airglow and the aurora may be found in large-scale zonal winds in the ionosphere cutting the earth's magnetic field and leading by dynamo action to potential differences sufficient to produce excitation by electron impact.

Part D: *Department of Terrestrial Magnetism, CIW*

(This information was supplied by E. H. Vestine.)

Astronomers have found from accurate time determinations, based on observations of the stars, the moon, and Mercury, that the earth does not rotate at a uniform rate. After suitable corrections based on the interactions of astronomical bodies and on the slow deceleration of the earth due to tidal action in shallow ocean areas, there yet remains a considerable and puzzling fluctuation in the rate of the earth's rotation during time intervals as short as fifty years.

It now appears likely that an explanation of this has been found; it may be related to slow changes in the magnetic field of the earth. From a study of the time fluctuation in the rate of westward drift of the world-wide geomagnetic field during the period 1885—1945, it has been inferred that there is a cor-

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1 Nicholson and Wulf, Pub. A.S.P., *64*, 265 (1952).
2 Wulf and Hodge, J. Geophys. Res., *55*, 1 (1950).
3 Wulf, J. Geophys. Res., *58*, 531 (1953).

responding time fluctuation in motion westward of the outer portion of the earth's liquid core. The changes in motion of the outer core are about 25 times as rapid as those found from astronomy for the earth's surface, and in the opposite sense. The irregular motion of heavy liquid in the earth's core, shown by the magnetic changes, seems to be what is required to explain the fluctuation in the rate of the earth's rotation on the basis of conversion of angular momentum.

This deduction is checked in another way. The geomagnetic data show that the westward fluctuation in motion of the earth's outer core is accompanied by a fluctuating motion of the outer core about an axis perpendicular to the earth's axis of rotation. This transverse supply of angular momentum, with the same moment of inertia required for explaining the fluctuation in rate of rotation, is adequate to explain the year-to-year variations of latitude observed by astronomers. Preliminary calculations give a shift of the north pole relative to the axis of rotation, of about 12 feet from 1910 to 1940, in good accord with some studies by astronomers. Hence, two major geophysical problems are solved by the same mechanism. Other existing experimental data on the earth and atmosphere show that only in the core does there exist the capacity for the rapid and large changes in angular momentum required.

This study at DTM also affords an estimate of the upper limit of electric conductivity of the lower mantle. In order that the electromagnetic couple between core and mantle provide suitable time constants for relative motion, the electric conductivity of the lower mantle should be about 7.5×10^{-9} emu. A simultaneous study undertaken at Scripps Institution gave similar results.

In cooperative study by the Geophysical Institute of Alaska and Department of Terrestrial Magnetism it was discovered that the sudden commencement of the magnetic storms at Huancayo may be as much as four times as great in amplitude in the daytime as at stations some hundreds of km distant from the magnetic equator.

In another study it was found that a similar augmentation of the initial phase occurs also at Huancayo in the daytime. These two results permit the new conclusion that the immediate source of field during the sudden commencement and initial phase is located within the atmosphere. Since it is known that the major sources of magnetic disturbance in polar regions are atmospheric in location, it may be inferred that about 75 per cent of the field arises from electric currents flowing in the atmosphere.

The foregoing results were predicted and found by the dynamo theory of magnetic disturbance, on the basis that the dynamo theory of the quiet day diurnal variation leads to the expectation of augmentation by day at Huancyao. An attempt was made to derive possible wind systems for the main phase of magnetic storms, using atmospheric electric current systems derived from the data. The winds derived appear to agree with some observed features of ionospheric winds, but a mechanism for producing the sudden commencement of storms was not found. The theory also predicts the presence of toroidal fields, especially in auroral regions. It is believed that the dynamo theory of disturbance may be at least partially responsible for magnetic storms. As our Japanese co-workers have shown, no real difficulty has been found other than that the upper air winds may not blow in the manner required.

An interesting consequence of the dynamo theory is that the zonal winds in ionized regions should produce toroidal magnetic fields in the ionosphere. The main current flow yielding these magnetic fields may be upward near the equator, thence polewards, and finally equatorwards at lower levels. If the latter are near the E-region, westward flowing Hall currents may be expected, yielding the storm-time variation at ground level. The oppositely directed Hall currents in higher regions where the gyrofrequency exceeds the collisional frequency should be negligible, if the F-region is electrically neutral. Initially, if the wind-system is heat driven, the air circulation will be mainly meridional, producing the initial phase of storms by the dynamo action of electrically conducting air moving equatorwards at lower levels of the ionosphere. It can be shown that the fate of such a meridional circulation, once initially established, will as the result of further acceleration become a mainly zonal circulation. In this case the counter-acceleration of the zonal winds will tend to reduce and extinguish the original meridional flow. A slow recovery to the initially undisturbed condition may then take place.

Part E: *Applied Physics Laboratory, Johns Hopkins University*

(This information was received from E. H. Vestine.)

An observatory type variometer measuring changes in total magnetic intensity with time has been developed. In this instrument the magnet system is suspended on a horizontal quartz fiber. The magnet is supported in the plane of the geomagnetic field, with its magnetic axis normal to the total field. Tests made thus far have been encouraging.

Part F: *Naval Ordnance Laboratory*

(This information was provided by L. R. Alldredge.)

The Naval Ordnance Laboratory has developed an improved airborne magnetometer which makes it possible to determine the entire magnetic vector from measurements made in an airplane. More details of this are given under the chapter on Magnetic Airborne Surveys. A complete account of this development has been submitted to the Transactions of the American Geophysical Union for publication.

A study has been made of time variations in the Earth's magnetic field in a higher frequency range than is common in geomagnetic work. An analysis of earlier records of vertical component variations taken at Tucson, Arizona, during short recording intervals in 1947 and 1948 showed peak amplitudes as large as 0.6 gamma with a pulse duration of 60 seconds. The amplitudes were roughly inversely proportional to the one-half power of the frequency in the frequency range from 1/100 cps to 1.0 cps.

Variations in the horizontal component of the Earth's magnetic field were measured at Pt. Barrow, Alaska, in July and August of 1950. The amplitudes of the variations were approximately inversely proportional to their frequencies. The average of three largest signals in each three-hour period decreased from about 20 gamma at 0.0075 cps to about 0.5 gamma at 1 cps. The amplitudes correlated closely with the K indices at Pt. Barrow. Similar measurements have been made at White Oak, Maryland. The correlation with the local K indices was not as good as it was at Pt. Barrow. In all the measurements in this frequency range the record of the variations is made on magnetic tape and subsequently played back 60 times faster than the recording speed to simplify analysis.

Data have been obtained on the audio frequency geomagnetic field fluctuations at Pt. Barrow, Alaska; Panama City, Florida; and White Oak, Maryland. Results indicate that the major source of these fluctuations is atmospherics. Signal strength has been found to vary approximately inversely as the first power of frequency at all three stations. Extrapolating the low frequency end of these curves yields values at 1 cps which are larger by at least an order of magnitude than the measured values at 1 cps indicating that a different source is responsible for the lower frequency variations below 1 cps. In the audio frequency range, for the three stations considered, the signal strength decreased with increasing latitude, as would be expected for manifestations of thunderstorm activity and as opposed to fluctuations associated with ionospheric activity.

The above work on magnetic field variations has been reported at the technical meetings of the AGU and abstracts of the work can be found in the published program schedules. It is expected that it will soon be published in detail.

Chapter III

MAGNETIC AIRBORNE SURVEYS

J. W. JOYCE

Steady progress has been reported in the development and uses of airborne magnetometers during the period since the Brussels Meeting of the International Union of Geodesy and Geophysics in 1951.

In the United States, airborne surveys have been flown for both prospecting and mapping purposes. The U. S. Geological Survey has continued to operate the total intensity magnetometer in about the same form it had in 1951. Flight traverse miles have been surveyed at a rate of about 25,000 a year. Emphasis has been placed on major geological features such as the Appalachian Geosyncline and the Boulder Batholith. Interpretation techniques have been improved and models have been utilized to aid in making such interpretations.

Commercial companies in the United States have surveyed areas on a speculative basis, selling results in the same way that aerial photographs are sold.

The mapping operations are the results of joint efforts by the U. S. Coast and Geodetic Survey, the U. S. Naval Ordnance Laboratory, the U. S. Naval Hydrographic Office, and the U. S. Air Force. Progress to date includes the development of successively improved instruments, designated as Airborne Vector Magnetometers VAM-1A and VAM-2A. The first of these instruments was reported at Brussels, and a descriptive paper on the second is now in preparation. The VAM-2A has been flight tested to the extent of about 40,000 miles of traverse, and based on these tests, probable errors in the elements F, I, D, H and Z are estimated to be 15 gammas, 3 minutes, 5 minutes, 40 gammas, and 30 gammas (for a dip angle of 60°) respectively. It is expected that improved magnetic compensation of the aircraft will further reduce errors, particularly for the elements F, H and Z. Flights were usually made at an altitude of 10,000 feet. Plans are now being made to fly at 20,000 feet to take advantage of smoother air as soon as pressurized aircraft become available.

In conclusion, it can be said that despite relatively high costs of instrument development and construction, as well as the rather extensive auxiliary equipments needed to properly locate the magnetic profiles geographically, airborne magnetic surveys are being performed at increasing rates in many areas, and instrumental performance and data reduction techniques are being steadily improved.

More detailed information can be found in the report of the Special Committee for Magnetic Airborne Surveys.

Chapter IV

ATMOSPHERIC ELECTRICITY

E. H. VESTINE

A statistical study by G. R. Wait, published posthumously, covers measures of total conductivity, potential gradient, and current density at Tucson, Arizona, for the 17 years 1935—1951.

The diurnal variation in positive and negative conductivity, potential gradient, and air-earth current is given in terms of 17-yearly means by months.

The corresponding means by months are also derived. The most conspicuous seasonal variation is a decrease in conductivity and a corresponding increase in potential gradient during the winter months. This probably arises because of a local effect due to increased pollution during the winter.

The year to year changes in the annual means of these components are also derived. Apart from fluctuations of a few years, the tendency of the potential gradient is to rise approximately linearly with time, and that of conductivity is to fall at an increasing rate. These are undoubtedly due to increased pollution of the air. However, the air-earth current is not constant, so that other local or world wide effects may be present.

Chapter V

IONOSPHERIC PHYSICS

A. H. SHAPLEY

Excellent summaries of progress in ionospheric physics in the U. S. exist in several places, in particular the reviews which appear annually in the Proceedings of the Institute of Radio Engineers, and need not be repeated here in extenso. In addition, abstracts appear regularly in Physical Abstracts and Proc. I.R.E. and lists of publications in the Journal of Geophysical Research and the Transactions of the American Geophysical Union. The present report will mention only the types of work being undertaken at some of the principal research centers and some unpublished studies.

The lower regions of the ionosphere have been explored in low frequency experiments at Penn State, CRPL and elsewhere. Principal results at CRPL are: strong correlation of irregularities shown in 160 kc soundings and geomagnetic K-indices, evidence for a strong absorbing region to oblique rays below 80 km, and the description of a night-time layer between E and F1 heights from observations with a sweep-frequency LF recorder. Progress has been made, especially at Penn State, on developing a suitable theory of wave propagation at low frequencies where the usual ray theory is a poor approximation. The theory has been compared in detail with 150 kc soundings.

CRPL has begun a systematic study of oblique incidence HF propagation with synchronized sweep frequency recorders at either end and vertical soundings at the midpoint. Early results in general were closely in accord with standard transmission theory. Studies of the regular ionospheric layers also include eclipse effects and travelling disturbances by the Carnegie Institution. Ionospheric storm studies at CRPL have concerned storm time variations and regional maps of F2 layer disturbances, in addition to the systematic radio propagation disturbance forecasting program. Auroral-radio studies have been carried on at Cornell and at Alaska's Geophysical Institute.

Apparent wind motions at ionospheric heights have been measured at Stanford by meteor techniques and by CRPL and Stanford by the drift of fading patterns along the ground. Speeds are commonly 100—300 meters per second with some apparent diurnal and seasonal trends. The results by the two methods show only rough correlation. The search for general tidal effects in the ionosphere (CRPL) has met with only limited success. The role of turbulence has been considered at Penn State and elsewhere and is getting increased attention.

Propagation of VHF radio signals over long distances by ionospheric scattering has been described, a 50 mc signal being always present in an experiment over a 775 km transmission path. Long distance backscatter of HF signals has been studied at Stanford, MIT and CRPL and this promises to be an important technique to augment vertical soundings in the evaluation of propagation on oblique transmission paths. The scatter seems almost entirely from the ground, via the ionosphere, and not from the ionosphere itself; there is negligible difference between land and water as scattering regions. CRPL has made sweep-frequency as well as fixed-frequency experiments.

Chapter VI

AURORAL AND NIGHT SKY STUDIES

C. W. GARTLEIN

The Conference on Ionospheric Physics (Pennsylvania State College, July 1950) and the Conference on Auroral Physics (London, Ont., July 1951), both sponsored by the Geophysics Research Directorate of the Air Force Cambridge Research Center, and the work of Meinel and Gartlein on hydrogen have given auroral research a great stimulus. To keep this report to reasonable length only brief remarks are made on the work of each group. This is immediately followed by a bibliography of work done by that group. A chart at the end summarizes work being done.

Part A: *Air Force Cambridge Research Center, Geophysics Research Directorate*

The Geophysical Research Directorate of the Air Force Cambridge Research Center under the direction of N. C. Gerson and N. J. Oliver has made short period observations of both aurora and night sky. It also sponsors many other projects. A list of papers follows:

(1) Chamberlain, J. W. and N. J. Oliver — OH in the airglow at high latitudes, Letter Phys. Rev. 90, 1118, June 15, 1953
(2) Chamberlain, J. W. and N. J. Oliver — Stellar absorption lines in night-sky spectra, Astrophys. J. 118, 197—9, September 1953
(3) Chamberlain, J. W. and N. J. Oliver — Atomic and molecular transitions in auroral spectra, J. Geophys. Res. 58, 457—472, December 1953
(4) Gerson, N. C. — Radio observations of the aurora on November 19, 1949, Nature 167, 804—5, May 19, 1951
(5) Gerson, N. C. — Correlation of auroras with increased cosmic ray intensity (November 19, 1949), Letter to Nature 167, 894—5, June 2, 1951
(6) Gerson, N. C. — A critical survey of ionosphere temperature, Rep. Phys. Soc. Progress in Phys. 14, 316—65, 1951
(7) Gerson, N. C. and J. Kaplan — Nomenclature of the upper atmosphere, J. Atmos. Terr. Phys, 1, 200, 1951
(8) Oliver, N. J. — Some recent work on the night airglow, URSI Program Ottawa Ont. 1953, p. 14, abst.
(9) Oliver, N. J., S. J. Wolnik, J. C. Scanlon and J. W. Chamberlain — Some remarks on spectra of low-intensity auroras, Letter J.O.S.A. 43, 710, Aug. 1953
(10) Edwards, H. D. — Day sky brightness (airglow) measured by Rocket-borne photo-electric photometer, URSI Program Ottawa 1953, p. 14, abst.
(11) Foderaro, A. and T. M. Donahue — Production of sodium airglow excitation by imprisonment of resonance radiation, Letter in Phys. Rev. 91, 1561, September 15, 1953

Part B: *Geophysical Institute, University of Alaska*

The Geophysical Institute of the University of Alaska under the direction of C. T. Elvey and Sydney Chapman has begun intensive visual observations of aurora from 5 stations in Alaska and is developing new methods for this work. A program of photometry, spectroscopy and radio reflection research has begun. A list of publications follows:

(1) Wilcox, J. B. — Characteristics of night sky at College, Alaska, Mixed Commission on Ionosphere, Brussels, 81—84, 1950
(2) Elvey, C. T. — Progress in studies of the airglow in upper air research, Amer. J. Phys. 18, 431—7, October 1950
(3) Barbier, D. and D. R. Williams — Observations of the aurora borealis, J. Geophys. Res. 55, 401—14, December 1950

(4) Barbier, D. and H. Petit — Photometric results on airglow and aurora at College, Alaska, Ann. Géophys. 8, 232—47, no. 2, 1952
(5) Heppner, J. P., E. C. Byrne and A. E. Belon — The association of absorption and E_s ionization with aurora at high latitudes, J. Geophys. Res. 57, 121—134, March 1952
(6) Hepner, G., L. Herman and R. Herman — Processes of emission of the molecular and atomic spectra of nitrogen observed in the light of the polar aurora, Trans. Amer. Geophys. Union 33, 489—494, August 1952
(7) Herman, R., C. Weniger and L. Herman — Emission of the forbidden oxygen lines by molecular dissociation, Letter in Phys. Rev. 82, 751, June 1, 1951
(8) Herman, L. and H. Leinback — A photographic study of changes of infra red emission in the polar aurora, Trans. Amer. Geophys. Union, 32, 679—82, October 1951
(9) Chapman, S. — The geometry of radio echoes from aurorae, J. Atmos. Terr. Phys. 3, 1—29, 1953
(10) Chapman, S. — Notes on auroral geometry and optics, I — to locate an elevated point viewed from two ground stations in the same diametral plane, J. Geophys. Res. 58, 347—52, 1953
(11) Chapman, S. — Note on the grazing — incidence integral (Ch (x, χ)) for monochromatic absorption in an exponential atmosphere, Proc. Phys. Soc. London B—66, 710—712, 1953
(12) Chapman S. and D. W. N. Stibbs — Solar eclipses and the aurora borealis, Sky and Telescope 13, 35—39, December 1953
(13) Cain, J. C. — Auroral radio-echo table and diagram for a station in geomagnetic latitude 56°, J. Geophys. Res., 58, 377—380, 1953
(14) Knecht, R. W. — Relationship between aurorae and sporadic E echoes, Trans. Amer. Geophys. Union, 33, 323, 1952 (abst.)
(15) Agy, V. — The location of the auroral absorption zone, URSI Program, Ottawa, 1953, p. 31, abst.

Part C: *Institute of Geophysics, University of California*

The Institute of Geophysics of the University of California at Los Angeles has continued work on study of excitation conditions in night sky spectra and under contract with the U. S. Weather Bureau has summarized data on the upper atmosphere. Papers are listed below:

(1) Kaplan, J. — Survey of data and theoretical analysis of the upper atmosphere, Univ. of California at Los Angeles, 1950 (U. S. Weather Bureau Contract Cwb 7904)
(2) Kaplan, J. — Laboratory studies related to the physics of the upper atmosphere, Mém. Soc. Roy. Sci. Liège 12, 295—302, 1952

Part D: *Colgate University*

D. K. Berkey of the Physics Department of Colgate University has studied the intensity versus heights of some auroral features on Cornell plates. He has acquired a grating spectrograph, dispersion about 60 Å per mm., which he used in Norway on a Fulbright Fellowship. He obtained several fine aurora and night sky spectra and continues use of this at Colgate. The spectrograph focusses an image of the sky on the slit so spectrum versus height determinations can be made.

C. L. Henshaw has continued to supervise and operate the second station for height determinations with Cornell.

Part E: *Department of Terrestrial Magnetism, Carnegie Institution of Washington*

E. H. Vestine has contributed important papers on new auroral theory as follows:

(1) Vestine, E H. — Note on geomagnetic disturbance, J. Geophys. Res. 58, 539—541, December 1953
(2) Vestine, E. H. — Winds in the upper atmosphere deduced from the dynamo theory of geomagnetic disturbance, J. Geophys. Res. 59, 93—128, March 1954

Part F: *Cornell University*

C. W. Gartlein of the Physics Department has continued to collect visual aurora observations from a wide territory to give a continuous record for 15 years. Patrol spectrograms and photoelectric records are also available for each night in the program under sponsorship of the National Geographic Society. Motion picture records have been taken of all displays since 1939.

The extensive ionosphere project under H. G. Booker and the aurora program operate simultaneously on the larger displays.

Unpublished results concern the relation between K figure and southern extent of aurora, and the shape of the south side of the overhead auroral zone. A list of papers follows:

(1) Moore, R. K. — A V.H.F. propagation phenomenon associated with aurora, J. Geophys. Res. 56, 97—106, March 1951
(2) Moore, R. K. — Aurora and magnetic storms, QST vol. 35, 14—19, June 1951
(3) Moore, R. K. — Theory of radio scattering from the aurora, Trans. Inst. Radio Eng. Prof. Group on Ant. and Prop. nr. 3, 217—30, August 1952
(4) Booker, H. G., C. W. Gartlein and B. Nichols — An interpretation of radio reflections from the aurora, URSI Program, Ottawa, 1953, p. 33 abst.
(5) Gartlein, C. W. — Protons and the aurora, Letter in Phys. Rev. 81, 463—4, February 1, 1951
(6) Gartlein, C. W. — Protons and the aurora, Letter to Nature 167, 277, February 17, 1951
(7) Gartlein, C. W. — Protons and the aurora, Letter Trans. Amer. Geophys. Union 32, 120, February 1951
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(14) Gartlein, C. W. and D. S. Kimball — A graphic method of reporting aurora observations, Trans. Amer. Geophys. Union 33, 321, 1952 (abst.)
(15) Gartlein, C. W. and G. Sprague — Hydrogen in aurorae, URSI Program, Ottawa, 1953, p. 12
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(17) Kimball, D. S. — The aurora, Sky and Telescope 13, 40—43, December 1953
(18) School of Electrical Engineering, Cornell University, Ithaca, New York. Quarterly progress reports, Studies on propagation in the ionosphere. Work under U. S. Signal Corps Contract W36—039—SC—44518 and SC—15547

Part G: *Central Radio Propagation Laboratory, National Bureau of Standards*

The Central Radio Propagation Laboratory of the National Bureau of Standards has studied relation of radio transmission in Alaska to auroral phenomena. Papers are listed under Geophysical Institute, University of Alaska.

Part H: *Harvard College Observatory*

D. H. Menzel of the Harvard College Observatory has applied hydrodynamic theory to the study of formation of the aurora.

O. Oldenberg and L. M. Branscomb have made extensive studies, laboratory and theoretical, on excitation processes in night sky and aurora. A list of papers follows:

(1) Branscomb, L. M. — Anomalous molecular rotation and the temperature of the upper atmosphere, Phys. Rev. 79, 619—26, August 15, 1950
(2) Branscomb, L. M. — The infrared spectrum of active nitrogen, Phys. Rev. 82, 83—86, April 1, 1951
(3) Branscomb, L. M. — Criteria for pre-exposure of spectroscopic plates, J.O.S.A. 41, 255—260, April 1951
(4) Branscomb, L. M. — Emission of the atmospheric oxygen bands in discharges and after glows, Letter in Phys. Rev. 86, 258, April 15, 1952
(5) Branscomb, L. M., R. J. Shalek and T. W. Bonner — Intensity distribution in nitrogen bands excited in auroras and by high-energy protons and hydrogen atoms, Trans. Amer. Geophys. Union 35, 107—113, February 1954
(6) Menzel, D. H. — Magnetic hydrodynamic theory of prominences and of the aurora borealis, Convegno di Scienze Fisiche Mathematiche e Naturali 14—19 September 1952, Rome, Accad. Naz. di Lincei 1953
(7) Menzel, D. H. — The origin and physical state of the aurora borealis, Trans. Amer. Geophys. Union 33, 316, 1952 (abst.)
(8) Oldenberg, O. — Excitation of sunlit aurora, Z. Phys. 133, 15—20, 1952
(9) Oldenberg, O. — Active nitrogen, airglow, Phys. Rev. 90, 727—30, June 1, 1953

Part I: *Naval Research Laboratory*

The Naval Research Laboratory under the direction of E. O. Hulburt has studied the intensity distribution and changes in the twilight sky and have contributed ideas on the manner of solar particle influx.

Secretary's note: For more details on this problem see Part C of Chapter VIII.

A list of papers follows:

(1) Koomen, M. J., C. Lock, D. M. Packer, R. Scolnik, R. Tousey and E. O. Hulburt — Measurements of the brightness of the twilight sky, J. O. S. A. 42, 353—6, May 1952
(2) Hulburt, E. O. — Explanation of the brightness and color of the sky, particularly the twilight sky, J.O.S.A. 43, 113—18, February 1953
(3) Bennett, W. H. and E. O. Hulburt — Magnetic self-focusing of auroral protons, Letter in Phys. Rev. 91, 1562, September 15, 1953

Part J: *Naval Ordnance Test Station*

The Naval Ordnance Test Station at Inyokern, California has made some aurora studies in Alaska in cooperation with the Geophysical Institute and made important studies of nightglow distribution and variation. A list of papers follows:

(1) Davis, D. N. — Variation of (OI) emission (5577) on the night of 5/6 January 1951, J. Geophys. Res. 56, 567—575, December 1951
(2) Roach, F. E. and H. B. Petit — On the diurnal variation of (OI) 5577 in the nightglow, J. Geophys. Res. 56, 325—53, September 1951
(3) Roach, F. E. and H. B. Petit — The annual variation of sodium D in the night glow, Ann. d'Astrophys. 14, 392—8, November 4, 1951
(4) Roach, F. E. and H. B. Petit — Excitation patterns in the night glow, Mém. Soc. Roy. Sci. Liège 12, 13—42, no. 1—2, 1952
(5) Roach, F. E., D. R. Williams and H. B. Petit — Diurnal variation of (OI) 5577 in the night glow, geographical studies, J. Geophys. Res. 58, 73—82, March 1953
(6) Roach, F. E., D. R. Williams and H. B. Petit — Diurnal variation of (OI) 5577 in the night glow, Astrophys. J. 117, 456—60, May 1953
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(8) Asburn, E. V. — Brightness and color of the twilight sky, Letter to J.O.S.A. 43, 805—6, September 1953
(9) Ashburn, E. V. — The density of the upper atmosphere and the brightness of the twilight sky, J. Geophys. Res. 57, 85—93, March 1952
(10) Roach, F. E., H. B. Petit, E. Landberg-Hanssen and D. N. Davis — Observations of the zodiacal light, Astrophys. J. 119, 253—273, January 1954

Part K: *Yale University*

D. S. Kimball of Yale University Observatory has made visual aurora observations for many years, has largely designed a new system of reporting visual observations and tested this for two years on a group of observers from the American Association of

Variable Star Observers. He is now studying the great aurora of 1859 and 28 auroras of recent years. He is developing charts to display these data and show the morphology and geographical coverage of the aurora. His work is part of the Cornell program.

Part L: *Yerkes Observatory*

A. B. Meinel of the Yerkes Observatory has directed an extensive program on the night sky and aurora giving important results on new bands, hydrogen influx and motions in the aurora. A list of papers follows:

(1) Meinel, A. B. — New N_2^+ bands in infrared of auroras, C. R. Acad. Sci. Paris 231, 1049—50, November 13, 1950
(2) Meinel, A. B. — A new band system of N_2^+ in the infrared auroral spectrum, Astrophys. J. 112, 562—3, November 1950
(3) Meinel, A. B. — O_2 emission bands in the infrared spectrum of the night sky, Astrophys. J. 112, 464—8, November 1950
(4) Meinel, A. B. — Evidence of entry into the upper atmosphere of high-speed protons during auroral activity, Science 112, 590, November 17, 1950
(5) Meinel, A. B. — On the entry into the earth's atmosphere of 57 kev. Protons during auroral activity, Phys. Rev. 80, 1096—7, December 15, 1950
(6) Meinel, A. B. — Doppler-shifted auroral hydrogen emission, Astrophys. J. 113, 50—59, January 1951
(7) Meinel, A. B. — The auroral spectrum from 6200 to 8900 Å, Astrophys. J. 113, 583—8, May 1951
(8) Meinel, A. B. — The spectrum of the airglow and the aurora, Rep. Phys. Soc. Prog. Phys. 14, 121—46, 1951
(9) Meinel, A. B. — The analysis of auroral emission borealis bands from the $A^2\Pi$ state of N_2^+, Astrophys. J. 114, 431—7, November 1951
(10) Meinel, A. B. and C. Y. Fan — Laboratory reproduction of aurora emission by proton bombardment, Note in Astrophys. J. 115, 330—331, March 1952
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(14) Meinel, A. B. — Aspheric field correctors for large telescopes, Astrophys. J. 118, 335—44, September 1953
(15) Fan, C. Y. and A. B. Meinel — Laboratory ionic-impact emission spectra, Astrophys. J. 118, 205—13, September 1953
(16) Meinel, A. B. — Systematic upper atmospheric motions during auroral displays, URSI Program Ottawa, 1953, p. 36, abst.
(17) Fan, C. Y. — The possible role of accelerated secondary electrons in the aurora, Astrophys. J. 119, 294—5, January 1954

Part M: *Miscellaneous Canadian Papers*

The important work at Saskatoon and Ottawa is represented by 14 papers in the U. S. journals, listed below:

(1) Turner, R. G. and R. W. Nicholls — Intensity distribution of first negative ($B^2\Sigma \rightarrow X^2\Sigma$) band system of N_2^+, Letter to Phys. Rev. 82, 290, April 15, 1951

(2) Montgomery, C. E. and R. W. Nicholls — Fractional transition probabilities of the first positive band system ($B^3\Pi$—$A^3\Sigma$) of molecular nitrogen, Letter in Phys. Rev. 82, 565—6, May 15, 1951
(3) Jarmain, W. R., P. A. Fraser and R. W. Nicholls — Vibrational transition probabilities of diatomic molecules: N_2, N_2^+, NO and O_2^+, Astrophys. J. 118, 228—33, September 1953
(4) Dahstrom, C. E. and D. M. Hunten —O_2^+ and H in auroral spectrum, Letter in Phys. Rev. 84, 378—9, October 15, 1951
(5) Jones, A. V., D. M. Hunten and G. G. Shepherd — Rotational temperatures of auroral N_2^+ bands, Astrophys. J. 118, 350—1, September 1953
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(11) Forsyth, P. A. — Radio measurements and auroral electron densities, J. Geophys. Res. 58, 53—66, March 1953
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Part N: *Summary*

The chart below has been designed to give quick reference to the work of various groups as well as to locate all the work on a given subject.

The names at the left indicate the parts of the bibliography where the work indicated in a given line is listed.

The writer feels that the work reported is representative of the work being done in the U. S. but this report makes no claim to completeness.

Summary of Auroral and Night Sky Studies

Type of Work

Organization	Obs.					Spectra										Theory			
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	P	Q	R	S	T	U
Air Force			O			X	X	X	X O	X	O	O	O		O		X	O	X	O
Univ. of Alaska	X		X O	X O	X	X	X	X	X O	X	O					X O		X O	X	
Univ. of Calif.									O					O		X O	X			
DMT, CIW																	X			
Colgate Univ.			X	X			X	X	X		O	O	O							
Cornell Univ.	X	X	X	X		X	X	X	X		O	O					X		X	
CRPL, NBS																			X	
Harvard Univ.							X		X O		O					X O	X	X O		X O
Naval Res. Lab.			O														X	O		
Naval Ord. Test Station			O	O							O	O						O		
Yale Univ.	X																			
Yerkes Obs.	X	X		X		X	X	X	X O	X			O	O	O	X	X	X O		O
Misc. Canadian	X		X			X	X	X	X	X						X		X	X	X

A Visual
B Motion Pictures
C Photometric
D Height
E Infra Red
F Infra Red
G Hydrogen
H Atomic
I Molecular
J Ultra Violet
K Oxygen Atomic
L Sodium
M OH Bands
N Vegard Kaplan b.
P Continuum
Q Lab. Prod.
R Auroral
S Excitation
T Radio Exper.
U Temperatures

X indicates auroral studies O indicates night sky studies

Chapter VII
COSMIC RAYS
S. F. SINGER

Since the end of the war the subject of cosmic rays has become of increasing interest to a great variety of physicists; to nuclear physicists, to meson-physicists, to geophysicists and to astrophysicists. For the purpose of this report, however, we will confine our discussion to topics which are of interest to the last two categories named. These are the topics which bear on the question of the origin of cosmic rays and, more particularly, on the interpretation of variations in their intensity in terms of electromagnetic conditions in the vicinity of the earth and in terms of processes occurring in the solar atmosphere.

We will discuss here our improved knowledge of the properties of the primary cosmic radiation, its composition and energy spectrum, the absence of low energy primaries and its interpretation, and the variety of fluctuations and variations of the cosmic ray intensity which has been studied in the past three years. Only work done in the United States will be described here.

Part A: *Composition of Primary Radiation*

The determination of the composition of the primary cosmic radiation has been attacked by a variety of methods, both in rockets and in balloons. Perlow and his colleagues (1), at the Naval Research Laboratory, have used proportional-counter telescopes mounted in rockets to determine the distribution-in-ionization of the incoming radiation. From this work they are able to give a good value for the proton-alpha ratio of the primary radiation at White Sands, New Mexico, (geomagnetic latitude $\Phi = 41°$). It was found that the proton-alpha ratio in the primary radiation is 5.3/1.0. At the same latitude, in another rocket experiment Van Allen (2) has used an omnidirectional pulse ionchamber to give upper limits of the flux of heavy primaries with Z greater than three.

A rocket exposure of photographic emulsions has been carried out by Yagoda (3) with the hope of finding extremely heavy primaries which would not penetrate through even a thin layer of the atmosphere. However, the main detailed work on the composition of the primary radiation so far has been done with exposures of photographic plates, and sometimes cloud chambers, with scintillation counters and proportional counter telescopes in balloons at some distance below the top of the atmosphere. The groups involved in these investigations have been the Minnesota group under Ney (4); the University of Rochester Group under Kaplon (5); and a Naval Research Laboratory Group, consisting of Davis and Johnson (6). The latter workers, and also Linsley (7) have measured the proton-alpha ratio. There is essential agreement among the various experimental groups that α-particles constitute about 15 % of the flux, heavier nuclei $\sim$ 1—2 %. However, as a consequence of the effects of the residual atmosphere there exist still a number of outstanding problems relating, mainly to the question of the presence or absence of Li Be and B nuclei in the incident primary radiation.

The question is of particular importance since it relates to the mean path length of the cosmic radiation; if it is assumed that the Li Be and B nuclei are produced only by the fragmentation of heavier nuclei, their presence in the primary radiation would indicate a long path length, hence mean life, of cosmic radiation. The most recent experiments by Kaplon, Racette, and Ritson (8) using emulsions and by Stix (9) using proportional counters and cloud chambers give an upper limit of $\sim$ 7 g/cm^2 of interstellar hydrogen for the path length. Singer has pointed out that observation of He^3 and H^3 fragments in the primary radiation would give a more sensitive test of the mean path length of the cosmic radiation; their calculated rate of production is very much higher than that of Li Be and B (10).

It is important to mention that balloon results by Critchfield, Ney and Oleska (11) have set an upper limit of 1 % to the presence of primary electrons, while rocket experiments by Perlow and Kissinger (12) indicated that less than 0.1 % of the energy flux above the atmosphere was in the form of γ-rays.

Part B: *Primary Energy Spectrum*

The primary spectrum has been measured both in rocket and balloon experiments. Van Allen and Singer (13) have conducted a series of rocket flights at various latitudes and thereby obtained the energy distribution (or more properly speaking the magnetic rigidity distribution) of the primary radiation, mostly protons. The differential momentum spectrum is found to be of the form $n(p)\ dp = Kp^{-\gamma}\ dp$ with γ equal to 1.1 in the latitude sensitive region (momenta less than about 30 Bev/c) rather than 1.8; hence the energy spectrum is considerably flatter (i.e. a larger fraction of high energy primaries) than had hitherto been suspected. Almost the same results were obtained in a series of balloon flights at various latitudes carried out by Winckler et al (14). Pomerantz and McClure (15), Vidale and Shein (16) and others have made measurements at various latitudes and obtained flux values in good agreement with those of the other workers.

The question of the actual incident flux of primaries is not quite solved because some secondaries are scattered back out of the atmosphere and add to the radiation above the atmosphere even in rocket experiments. This so-called albedo radiation has to be subtracted from the total flux in order to determine the primary flux. It has proved to be quite a difficult problem to distinguish between primary and albedo radiation. By applying geomagnetic theory Treiman (17) concluded that due to being captured by the earth's field upward moving albedo tends to return into the atmosphere at about the same latitude. The problem has been attacked experimentally in various ways. Singer (18) and Van Allen (19) have compared the experimental directional dependence with geomagnetic theory to separate the two effects; this has proved to be particularly successful at the equator where there exists a large West-to-East asymmetry from geomagnetic theory but where the experimental results show a much smaller value, presumably due to a "washing-out" effect by albedo. Perlow (1) has determined the range of the soft albedo radiation in lead by a variety of coincidence-anticoincidence arrangements. Winckler (20) has used the directional properties of the Čerenkov counter to check on the direction of travel of the radiation at high latitudes and has thereby measured the flux of upward moving fast albedo. All of these experiments give a value for the albedo in the vertical direction of something like 10 % of the total radiation.

The energy spectra of the heavy nuclei components of the primary radiation have been measured in photographic plate experiments by the Minnesota (4) and Rochester (5) groups. These are free from albedo corrections since for nuclei with charge $Z > 1$ it is possible to identify individual tracks as primaries and measure their energy. By various techniques it has become possible to extend this work up to energies of 5×10^{10} ev/nucleon.

The spectrum at very high energies up to 10^{17}ev has been discussed by the Cornell group (21) on the basis of analysis of underground and air shower experiments. There is little doubt that the spectrum exponent γ increases with energy, from 1.1 at 10^{10}ev up to a value of about 1.8 at 10^{17}ev.

Part C: *Latitude Cut-Off*

It has been suspected for some time that there exists a latitude cut-off in the primary radiation which was thought to be due to the effects of a solar magnetic field which kept low energy particles away from the earth's orbit. The experimental evidence was based on measurements within the atmosphere, and one could not be quite sure that the lack of increase observed as one went to high latitudes was indeed due to an absence of low energy primaries or to the absorption in the residual atmosphere. The problem was tackled by means of rocket experiments, by Van Allen and Singer (22) who compared the intensities up to geomagnetic latitudes 58° with Pomerantz's (23) value at 69°; they deduced that there was no appreciable increase in flux in that range whereas according to the extrapolation of the spectrum there should have been an eight-fold increase. They conclude from this that there is an appreciable absence of protons with energies between 560 Mev and 170 Mev. This work has been extended in further rocket flights; no appreciable increase in flux was found all the way up to the pole. This allows one to extend the energy region in which there are no or very few primary protons from 170 Mev down to about 20 Mev (24).

The absence of an increase has also been confirmed by Neher (25), who took the precaution of making correlated flights at two latitudes in order to avoid the effects of fluctuations of the primary radiation. He measured the intensity by means of ionization chambers in high flying balloons.

A very important question is raised by the interpretation of this low energy cut-off in the primary radiation. In order to investigate this further one is interested in whether the other components of the primary radiation, the alpha particle component and heavier components, show a similar cut-off and whether this occurs at the same magnetic rigidity or not. From the work of Van Allen and Singer (22) it appeared that there was also an appreciable absence of alpha particles in the range 670 Mev to 520 Mev, although this conclusion was not quite as certain as that for protons. However, from a recent experiment (26) performed with ionization chambers at two latitudes one may conclude that the cut-off exists also for heavy primaries and occurs at very nearly the same latitude as it does for protons. In a series of high altitude balloon flights at various latitudes a group under Korff (27) at New York University has measured neutron fluxes, recently for the first time in the vicinity of the geomagnetic pole. Their results support the absence of low energy primaries.

Some of the outstanding problems still remain. It is not known whether the latitude cut-off could also be caused by other agencies besides a magnetic field; the evidence is not conclusive one way or the other. On the experimental side, it is not known whether the cut-off latitude shifts as a function of time or perhaps as a function of the solar cycle. However, since the technical means are now available, further experiments should be able to clear up these points. Finally, there remains the important question, whether there could not be a slight increase of cosmic ray intensity at high latitudes, indicating at least some presence of low energy cosmic rays at certain times. It would be of great interest to investigate this possibility.

Part D: *Diurnal Variation of the Primaries*

It was realized quite early that the existence of a latitude cut-off, if caused by an interplanetary magnetic field of dipole character, would as a necessary consequence carry with it a diurnal variation of the low energy part of the cosmic radiation since the dipole field would forbid certain directions of incidence. The amplitude of this diurnal variation depends, however, to a large extent on the degree of occupancy of normally forbidden orbits which can be filled up by particles scattered into them by the Earth's field. This effect has been calculated by Kane, Shanley, and Wheeler (28). Based on these calculations

Dwight (29) has computed the diurnal variation to be expected in the primary radiation. Several experiments have been carried out in order to check on the existence of such a diurnal variation in the primary flux. Bergstralh and Schroeder (30) have carried on balloon flights lasting for many hours in order to test Dwight's predictions. No such variations were found, however; in fact no diurnal variation greater than about 2 % could be discerned. Dwight's theory was therefore reexamined and corrected by Singer (31); he arrived at a diurnal variation so small as to be practically undetectable. More recently Treiman (32) has reexamined the whole problem and found some shortcomings in the original calculations on trapped orbits. One might, therefore, expect a fairly large diurnal variation (33) if the sun did indeed produce a dipole field in the vicinity of the earth. However, because of the irregular time fluctuations which occur in the primary radiation (25, 27), the accurate study of such diurnal variation would be difficult and require exposures extending over periods of days or weeks.

A diurnal variation has been searched for in the heavy nuclei component of the primary radiation. A large day-night ratio was first detected by Lord and Schein (34) and confirmed by the Minnesota group (35). Their latest measurements with emulsions (36), show no such effect; neither do the ionization chamber measurements of McClure and Pomerantz (37) or the cloud chamber measurements by Stix (9). However, Yngve's (38) most recent study with moving nuclear plates still shows a small rise near noon at latitude 55°.

Part E: *Investigations of the Secondary Radiation*

Since it is technically not very feasible to carry out long term observations upon the primaries themselves, or even on the radiation near the top of the atmosphere (at balloon altitudes), the cosmic radiation is generally observed at sea level or at mountain altitudes and occasionally also in airplanes. The charged secondary radiation which is measured is produced in the main by the medium energy portion of the primary radiation (about 20 to 30 Bev). An important advance in the technique in observing secondary radiations was made by Simpson (39) who, after studying the latitude dependence of cosmic ray neutrons, concluded that they would form a useful tool for investigating variations in the lower energy primary component (average energy about 5 Bev at mountain altitudes). Indeed it was found that many of the variations which had been observed by Geiger counters and ionization chambers could be more clearly resolved in the neutron counters, presumably because the changes were more pronounced in the low energy portion of the primary radiation. Simpson's group has set up neutron monitors at

Chicago, Climax, Sacramento Peak (New Mexico), Mexico City and Huancayo. A continuous neutron monitor has been installed at Fairbanks, Alaska, by Korff.

Part F: *Diurnal Variation*

The diurnal variation of the secondary component measured at sea level and mountain altitudes by means of ionization chambers and counters is quite small, of the order of 0.3 %; the diurnal variation of the neutron component is perhaps three times larger (40). Forbush has compiled a detailed history of the amplitude and phase of the diurnal variation during the past solar cycle. These results are of considerable importance in any theory which attempts to explain the diurnal variation and its relationship to the sun. Recently Alfvén (41) has used these data to put forth a new mechanism for acceleration of cosmic rays within the solar system.

Part G: *27 Day Variation*

That the cosmic ray intensity is linked closely to the sun is shown by the fact that there exists a well known 27 day recurrence in the cosmic radiation. This has been verified with experiments in counters and ionization chambers, but it is particularly prominent in neutron observations (42). It has been established (42) that there exists a strong correlation between solar M-regions and cosmic ray increases. These variations are worldwide and particularly pronounced ($\sim$ 10 %) in ionization measurements at high altitudes (43).

Part H: *Secular Variation*

Forbush (44) has analyzed ion chamber results and has established that there exists a secular variation extending over the last fifteen years. The variation is similar in stations at various latitudes and seems to be related, although not directly, to the sun spot number. This again has great significance in relation to the question of the origin of cosmic rays within the solar system.

Part I: *Irregular Variations*

Aside from the regular variations, either periodic or recurrent, there are also found certain occasional variations of the cosmic radiation. Most prominent are the increases which accompany some solar flares and the decreases, lasting sometimes several days, which accompany some magnetic storms.

Part J: *Solar Flare Increases*

That the cosmic radiation increases during some large solar flares has been known from the work of Forbush, Schein and Stinchcomb (45). However, it has been found that many of the other large flares also produce cosmic ray increases which are quite small. Firor (46) has analyzed the data obtained with neutron counters at Climax, Colorado; he finds an increase in neutron intensity occurring at a definite angle to the sun-earth line whenever a solar flare occurs. This can be interpreted as the production or acceleration of low energy cosmic rays near the sun; the radiation proceeds along the sun-earth line essentially undeflected and is then deflected in the earth's magnetic field. It can be shown that the strongest impact zones would be at 9 a.m. and 4 a.m. The increases in neutron intensity do in fact occur predominantly at 4 a.m. This result can also be used to place an upper limit on a possible solar dipole moment as has been done by Treiman (47). He obtains a value of 10^{32} gauss-cm^3.

Part K: *Magnetic Storm Decreases*

Decreases of cosmic ray intensity accompanying magnetic storms were first described by Forbush. There has been some doubt as to whether the decreases are due to a magnetic redistribution by a ring current circling the earth's equator as first suggested by Chapman. A number of authors, most recently Treiman (48), have examined this effect theoretically; on the basis of their work the ring current effect appears too small. A recent experimental finding by Singer (49) gives definite evidence in the same direction. A magnetic storm decrease was found at Thule, Greenland, near the geomagnetic pole. Clearly, no symmetrical ring current or any change in the earth's dipole field could account for this decrease. It is concluded that the cause of the cosmic storms must lie in the vicinity of the earth but is probably tied up more directly with the solar corpuscular beam which also produces the magnetic storms, as originally suggested by Alfvén (41). Morrison (50) has proposed a model in which a turbulent magnetic field in the beam keeps cosmic rays from reaching their steady-state intensity.

This brief summary does not pretend to be a complete account of the work done in the United States during the past three years. Only those topics have been discussed which are thought to be of particular significance in connection with the cosmic ray research of the forthcoming International Geophysical Year.

Cosmic Ray References

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Chapter VIII

COSMIC TERRESTRIAL RELATIONS

HARLAN T. STETSON

The Special Committee on Cosmic Terrestrial Relations of the American Geophysical Union was first appointed by the Executive Committee in 1938 for the purpose of promoting and collating research in the field of solar terrestrial relationships and other cosmic phenomena related to the general field of geophysics. Its present membership, appointed for the period 1953—56, is as follows: Harlan T. Stetson, Chairman; E. O. Hulburt, Vice-Chairman; Herbert Riehl, Ross Gunn, Serge A. Korff, Robert R. McMath, W. T. Thom, Jr. Other members who served during the last three years include Horace R. Byers and George P. Woollard.

The field of investigation is a broad one and the reports of the committee have included solar investigations, upper atmospheric research, ionospheric investigations, radio astronomy, cosmic ray investigations and meteorological progress particularly as concerns cosmic and solar effects upon the upper and lower atmosphere. Only the work of the committee related to section D of the AGU will be covered here.

A recent publication on "The Sun" edited by Gerard P. Kuiper, has recently been published by the University of Chicago Press (1953). Sections of this volume deal with solar terrestrial relations including solar radio frequency emissions.

During the last three years sunspots as measured by the Zürich index has declined from the value of 108.5 attained in May 1951 to a low of 0.0 in January 1954. The continuity of many days in which no spots are observed is indicative that at the present date (March 1954) we must be near the minimum of the sunspot cycle. The many months of low solar activity afford opportunity for the study of geomagnetic and ionospheric phenomena when disturbances attributable to solar outbursts are at a minimum.

Part A: *McMath-Hulburt Observatory*

The McMath-Hulburt Observatory of the University of Michigan reports through the courtesy of Miss Helen W. Dodson, as follows:

The program of the McMath-Hulburt Observatory is concerned primarily with basic solar research. This program can be said to be related to the problems of solar-terrestrial relations in so far as any progress in the understanding of the physical nature of the sun may lead, directly or indirectly, to improved understanding of the ways in which the sun affects the earth. In the last two years a more direct concern with the problems of solar-terrestrial relations has been developed. To further this aspect of solar research, two new instruments have been installed at the Observatory. One is a total field variometer that records certain aspects of the variation in the earth's magnetic field; the second is an instrument that measures the intensity of the 5 Mc/sec WWV signal as received at Lake Angelus. With the data from these two recorders, it is now possible to make immediate comparisons between disturbances in the ionosphere, the geomagnetic field, and observed changes on the sun.

(1) *Observation and analysis of the solar spectrum with high dispersion:*

This work covers both the photographic and infrared regions of the spectrum and deals with spectra of detailed features of the sun such as the limb, prominences, and flares as well as the fundamental solar spectrum.

(2) *Relative energy distribution in solar spectrum:*

New determinations of the relative energy distribution in the solar spectrum have been made, in part at Lake Angelus, and in part with our infrared spectrograph attached to the Snow Telescope at Mount Wilson.

(3) *Monochromatic studies of solar activity:*

Continuous, monochromatic, photographic studies of rapidly changing solar activity have been made in the light of atoms of hydrogen, helium, and ionized calcium. The spectroheliographic studies of the disk show the development of *plages* and sun spots, the growth and activity of the dark flocculi, and the outbreak of flares. Similar monochromatic studies at the limb show the development and motion of prominences. Combined limb and disk observations have proved especially valuable in studying the intensity of prominences and in relating them to features on the solar disk.

(4) *Flares:*

The intensity, area, and position of these sudden brightenings have been studied from photographic records. Photometric light curves have made possible measures of rates of rise and decline as well as maximum intensity. Theoretical studies have shown that the greatly widened Hα-line observed in some flares can be explained by radiation damping. Study of reports of Hα-width reveals that the width apparently increases with central meridian distance of the flare. Limb and disk photographs, photometric measures, and ionospheric data combine to indicate that at least certain flares are elevated solar features.

(5) *Solar radiation at radio frequencies:*

Cooperative studies with the radio astronomers at Cornell University and the National Research Council of Canada have formed the basis of investigations of flare-associated radiation at 200 Mc/sec and 2800 Mc/sec. It is hoped that the study of flares at radio frequencies will assist in identifying the flares that are to be associated with certain types of geomagnetic storms.

(6) *High velocity ejections:*

Observations with the spectroheliograph and the Stone Radial Velocity instrument at the time of flares near the solar limb provide evidence for the ejection of hydrogen and calcium atoms with velocities at least as great as 350—750 km/sec near the time of the start of the flares. Bursts at 2800 Mc/sec and 200 Mc/sec accompanied the flares and ejections.

(7) *Comparison of solar activity and terrestrial disturbances:*

Charts containing solar, ionospheric, and geomagnetic data have been compiled and assist in the identification and study of solar regions associated with terrestrial disturbances.

Part B: *Harvard College Observatory*

In summarizing theoretical studies Dr. Menzel, Director of the Harvard College Observatory comments as follows:

The most significant contributions made at Harvard and at its associated observatories lie in the interpretation of solar phenomena in terms of magnetohydrodynamics. A system of classification of solar prominences has been developed in terms of their behavior. The system is still preliminary and is being tested. A distinct difference is found between prominences that appear in the spot zones and in the non-spot zones. A great difference is noticed in the prominences where material tends to come from above and where much of the motion comes from below. There is increasing evidence that the motive force for the expulsion of material from the sun or sunspots is an intense electric current flowing in the ionized gas. As is well known from electrodynamics, a current loop tends to increase its radius and also exerts a pressure on the wire that would attempt to decrease the size of the wire if that were possible. Since in the solar atmosphere the "wires" are made of gas, the "pinch effect" is notable in many prominences. Most of the fine filaments of prominences can be attributed to the presence of currents.

The motion of knots in prominences is peculiar. These knots are sometimes attributed to gas moving along a magnetic field. In other words, the motion of the gas is supposed to map out the lines of force. This interpretation may be challenged. In fact, the motion is more nearly perpendicular to the lines of force than parallel to them. There are many subtle arguments that favor this conclusion, but it is important in our knowledge of the sun to realize that flow of material follows the line of a current rather than the line of a magnetic field.

Loops of current, held together by the pinch effect, actually exist between the earth and the sun. These dynamic doughnuts ring the earth and cause magnetic storms, aurora borealis displays, etc. The details are complicated, and are still being worked on.

These phenomena all have an effect on ionospheric radio propagation. For example, the pinching down of the gas in the neighborhood of sunspots sometimes occurs with the force of shock waves and results in the release of enormous amounts of ultraviolet radiation in a short time. This ionization is responsible for the sudden ionospheric disturbances. A list of papers related to this phenomenon follows:

(1) Menzel, D. H. and B. Bell — The variation in prominence distribution over the sunspot cycle, Convegno di Scienze Fisiche Matematiche e Naturali, 14—19 Settembre 1952, Tema: Problemi Della Fisica Solare, Rome, Accademia Nazionale Dei Lincei, 1953
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Part C: *Naval Research Laboratory*

For work accomplished in the field of solar terrestrial relationships at the Naval Research Laboratory, E. O. Hulburt, Director of Research, gives the following summary:

(1) *Upper atmosphere rocket work:*

By means of rocket-borne equipment the solar spectrum was photographed to 1800A, with a resolution varying from 0.3A at 2800A, to 0.8A at 2100A, and to a rather low value at 1800A. The analysis of the spectrum from 2990A to 2635A was completed, with about 500 lines, and 1054 probable contributors listed; this will appear in the Astrophysical Journal in 1954, in a paper by Wilson, Tousey, Purcell, Johnson and Moore.

The solar intensity distribution from 3400A to 2200A was derived from the rocket spectra; in the range 3000A to 6000A new data were obtained by Dunkelman and Scolnik from Mount Lemmon, Arizona; the entire solar curve and its relation to the Smithsonian work on the solar constant were considered, and a new value, 2.00 cal cm^{-1} min^{-1}, proposed for the solar constant (1).

Work on the vertical distribution of ozone was completed, and data between 35 and 70 km were found in agreement with a new photochemical calculation based on the densities and solar intensities measured from rockets and including the oxygen recombination reaction (2).The diurnal heating effect in the upper atmosphere due to absorption of solar energy by ozone, was computed from ozone distribution and solar energy distribution data obtained from the rocket flight of June 1949 (3).

Measurements of solar radiation by means of rocket-borne photon counters, showed that (4, 5, 6):

(a) The intensity of the Lyman alpha line of hydrogen from a quiet sun is 0.1 erg cm^{-2} sec^{-1} and that it is an emission line of width less than 1A superimposed on a background continuum effectively less in intensity than a 4500°K blackbody sun.

(b) That the continuum near 1500A is abruptly absorbed near 100 km, in agreement with a rapid transition from molecular to atomic oxygen near this level.

(c) The shape of the x-ray spectrum is consistent with a 10^6 degree temperature in the corona; soft x-ray intensities of the order of 0.1 erg cm^{-2} sec^{-1} were observed from a quiet sun and as much as 1 or 2 ergs cm^{-2} sec^{-1} from an active sun; these intensities are adequate to account for E-layer ionization and absorption was observed to occur in the correct range of altitudes.

From measurements on the Viking flight of August 7, 1951, it was found that the atmospheric density at 160 and 219 km was 1.2×10^{-6} and 1.0×10^{-7} grams per cubic meter, respectively. The wind at 200 km was 80 meters per second from the southeast (7). The program to determine upper atmospheric pressure, temperature, and density values was extended to the arctic regions during the summer of 1953. Measurements were made at 74°, 62° and 43° north latitudes. A new technique in meteorological research was developed and used; altitudes up to 80 km were reached with a relatively inexpensive rocket launched from a skyhook balloon at 25 km above sea level. Preliminary analysis of the flights at 74°N indicates that the arctic density values for the 25 to 40 km altitude region are about equal to those measured in rocket flights at White Sands.

The composition of the upper atmosphere between 95.8 km and 137.3 km above sea level has been studied by means of a radiofrequency mass spectrometer. The spectrometer, installed in an Aerobee rocket launched at White Sands Proving Ground, New Mexico, at 0009 hours (MST) on February 12, 1953, measured the relative aboundance of all gases between mass numbers 54 and 6 on the ascent and descent of the rocket. 172 individual traverses of this mass range were made at a rate of 0.94 per second. Analysis of the samples was recently completed. The data show that the ratio of argon to molecular nitrogen failed to change as a function of altitude in a manner consistent with the existence of diffusive separation. However, it must be pointed out that strong evidence exists that the gas analyzed by the spectrometer was in some part contaminated by gases originating from the rocket.

Radio propagation experiments in the ionosphere were successfully made with four rockets. All firings took place at White Sands Proving Ground within two hours of local noon. The basic data consisted in refractive index and attenuation measurements in the neighborhood of the rocket for both the ordinary and the extraordinary components of a 4.274 mc c.w. signal. In all four flights a steep electron density gradient was observed, beginning at approximately 92 km. The electron distribution was obtained up to 150 km in September 1949 and up to 165 km in November 1950, and were in good general agreement in the 92 to 140 km region. The electron density increased rapidly between 92 and 110 km and remained at a large value above 110 km, indicating that the E-layer probably remains dense up to the F-layer during the day time. This casts considerable doubt on the present theories of the formation of separate layers by photo-ionization processes. Measurements of the earth's magnetic field made at 105 km and 139 km were found to agree with the inverse cube law. The data from two flights showed that the Lorentz polarization term should not be used at four megacycles in the Appleton-Hartree formula. The September 1949 flight showed the existence of an ion layer between 80 and 95 km with a maximum of 5×10^8 ions/cc at 91 km. Collision frequencies computed at 105 km and 139 km were in agreement with values obtained from ground measurements (8).

Cosmic gamma-ray experiments showed that low-energy gamma rays (0.1 to 15 Mev) were present in considerable numbers throughout the atmosphere below 40 km, and in small numbers above. The origin of this radiation in the atmosphere is the Bremsstrahlung process of the electrons of the soft component, followed by multiple Compton scattering. Above 40 km, about 25 pct of the observed radiation can be attributed to an albedo effect associated with the curvature of the earth. It was suggested that the remaining 75 pct is an albedo due to diffusion upward of atmospheric radiation. On an energy basis, the soft gamma radiation above 40 km amounted to only 1/2000 of the incoming charged-particle radiation (9).

Cosmic ray experiments were conducted during two balloon flights at Minneapolis, Minnesota ($\Phi = 55°$N) in September and October, 1952. Analysis of the data yielded an improved determination of the intensities of singly and doubly charged primary cosmic-ray particles. The particles were identified by ionization and range measurements, ionization being determined by three proportional counters and range by penetration of lead absorbers below the proportional counters. Secondary electrons and slow protons were identified and eliminated from the primary intensities. The resultant alpha-particle intensity exhibits an attenuation length of about 50 g/m cm^2 in air. The vertical intensities extrapolated to zero atmospheric depth, for singly and doubly charged particles are 0.21 ± 0.01 and 0.035 ± 0.004 $(cm^2 \text{ Sterad})^{-1}$, respectively. The possibility exists that the alpha-intensity is high, because of a systematic error. The systematic error is no larger than 20 pct (10).

(2) *Cosmic ray work from balloons:*

Observations in stratosphere-exposed nuclear emulsions of the production and decay of charge hyperons (particles intermediate in mass between proton and deuteron) show that these particles can originate in fundamental-type collisions between nucleons (11). The decay scheme $\Lambda^{\pm} \rightarrow \Lambda^{\circ} + \Pi^{\pm} + (100 \pm 20 \text{ Mev})$ fits the observation and leads to a computed mass of 2650 electron masses. Evidence that the charged secondary is a pion indicates that the same is probably true in the "V-particle cascades" observed in the cloud chambers at Pasadena and Manchester (12). A "constant sagitta" method of multiple scattering has been applied to the tracks of stopped K-mesons (including tau), hyperons, protons, and pions. Mass estimates for slow K mesons thus far yield values of $\sim 1{,}000 m_e$. The first known example of an emulsion tau decay found in a U. S. laboratory has been observed in the course of this study. Stripped-emulsion stacks, exposed in the stratosphere at the geomagnetic equator, have been successfully processed by methods developed at NRL (13). These stacks will yield total track lengths exceeding those now available by an order of magnitude — an improvement which should lead to better mass determinations and information on the life times and decay schemes of heavy unstable particles (14). Measurements of the cross section for the production of 'tridents' have yielded agreement with Racah's theory (15).

(3) *Radio astronomy:*

Work on solar radiation in the centimeter and millimeter bands has continued and confirmation of the predicted limb brightening of the sun has been obtained from two independent sources. The 1952 solar eclipse measurements yielded radial brightness distribution curves showing limb brightening of the kind and in the amount predicted by theory. In addition, radial brightness distribution curves taken with the 50 foot radio telescope at a wavelength of 8 mm, where the resolution is 3 minutes of arc, also show limb brightening. These results give greater weight to the model of the sun's atmosphere derived from earlier radio work and show a sharp rise in temperature at the top of the chromosphere (16). Enhanced radiation from localized regions associated with sunspots has been identified both in the eclipse records and in the drift curves taken at high resolution with the 50 foot radio telescope.

Observations at 9 cm with the 50 foot telescope have revealed 10 radio stars, 7 of which are in the galaxy and 3 are extra-galactic. Of the 7 there are 4 which are of a new type and emit more energy at 9 cm than at the longer wavelengths. This is the first detection of the radio frequency emission of "hot" hydrogen regions such as the Orion Nebula and can lead to a better knowledge of the temperature and density in the clouds. Apparatus for observing line emission from neutral hydrogen is also installed in the 50 foot radio telescope. It is intended to make use of the higher resolution obtained to make detailed studies of selected regions of the galactic hydrogen clouds.

In the studies of the sun, moon and radio stars the effect of the earth's atmosphere has been evaluated. The atmosphere is sensibly transparent at 10 and 3 cm with only the wings of the oxygen and water vapor lines playing a part. At a wavelength of 8 mm which lies between the water vapor and oxygen absorption lines, atmospheric absorption is higher although even here the atmosphere is more transparent than it is in the visible region of the spectrum. Work is in progress to extend the measurements to a wavelength of about 1 mm.

(4) *Twilight sky brightness:*

Measurements were made of the brightness and polarization of the twilight sky during clear weather at various points over the sky for altitudes of the sun from five degrees above the horizon to 15° below the horizon at two stations, one in Maryland at an altitude of 100 ft and one on Sacramento Peak, New Mexico, at an altitude of 9500 ft. The brightness of the Sacramento Peak sky was about ⅔ to ½ of that of the Maryland sky, due to lesser haze (17). Theoretical calculation showed that the brightness and color of the zenith twilight sky was controlled by upper atmospheric ozone in an important manner (18).

(5) *Solar Eclipse, February 25, 1952:*

The total solar eclipse of February 25, 1952, was observed at Khartoum, Sudan. Solar limb brightening in radio wavelengths 10 cm and 8 mm was observed and measured (19). Solar limb darkening in optical wavelengths from 3800A to 5800A and at about 8000 A was observed and measured (20).

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Part D: *National Bureau of Standards*

Studies of solar relationships to radio wave propagation has continued to be a major topic of interest to the Central Radio Propagation Laboratory of the National Bureau of Standards. Many of the results have been published in detail as research papers of the NBS, in the proceedings of the Institute of Radio Engineers, in the Journal of Geophysics and in other scientific and technical publications. A summary of important progress based upon the publications mentioned has been made for the Committee by M. Linderman Phillips, Consultant and formerly of the Central Radio Propagation Laboratory, as follows:

Analysis of diurnal, seasonal, and solar-cycle relationships of vertical-incidence ionosphere observations has been maintained for locations having data published in "Ionospheric Data" (1). Ten of these stations are maintained by CRPL. Synthesis of these trends for future times provides the basis of regularly issued world-wide predictions of useful radio frequencies (2, 3, 4). Studies of the approximately linear variations of ionospheric critical frequencies with sunspot number show that such curves are not identical for different solar cycles, and that at high sunspot numbers the critical frequencies seem somewhat less than would be given by a linear relationship (5). Statistical studies of F2-layer critical frequencies showed pronounced bias in the data from several stations due to intensity effects, and diurnal, seasonal, and solar-cycle variations in the dispersion of these data which have no simple relationship to monthly-median values (6).

Field-intensity data have similarly been analyzed for diurnal, seasonal, and solar-cycle trends in absorption (7).

Studies of variations of atmospheric radio noise with sunspot number show a nineteen-month lag of the radio-noise cycle behind the sunspot cycle, with no significant difference in this lag for different cycles, times of day, frequencies, or latitudes (8).

Observations of solar noise, 160—25 Mc, together with observations 9500—1400 Mc made at other observatories, showed progressive time appearance at the lower frequencies, according to theory, as the solar disturbances progressed from inner to outer regions of the solar atmosphere, with final computed velocities comparable with those for solar corpuscular radiation associated with ionosphere storms (9). Comparisons of broad-directivity solar-noise measurements on 25, 50, 75, and 110 Mc with radiometer measurements on 480 Mc showed greater relative increase for the former (10). The theory of excitation and growth of plasma oscillations, by multistream charge interaction of moving charged particles, has been extended, in improved explanation of abnormally great solar noise (11, 12). This theory, applied to Australian observations on 70—130 Mc gives velocity estimates of ~ 500 km/sec, and particle density $\sim 10^8/\mathrm{cm}^3$ for the moving solar material (13). The origin of "enhanced" solar radiation in the meter range of wavelengths, maintaining a high intensity for hours or days, has been given a possible explanation as due to plasma oscillations of solar electrons gyrating around the magnetic field of sunspots; the plasma oscillations are found to be unstable in the frequency bands around multiples of the gyro-frequency (14). Explanation of the apparent discrepancy between optical and radio estimates of electronic temperatures of the chromosphere (30,000°K and 10,000°K, respectively) is provided by theoretical computations of absorption and emission coefficients based upon estimated departure of particle velocities from Maxwellian distribution as a function of shock strength (15).

Forecasts of radio disturbances, based upon sunspot, coronal and radio-noise measurements, as well as upon geomagnetic and radio-transmission measurements, have been regularly maintained (16, 17). Those for the North Pacific are prepared by the Anchorage, Alaska, forecasting center, in operation since 1951 (18). Short-time forecasts are regularly broadcast by WWV, and, for the Pacific, by WWVH, since January 5, 1954. For use in making these forecasts, a solar-outburst patrol has been maintained for the past year on 160 and 480 Mc; the observatory for these measurements has been recently relocated at Boulder, Colorado.

Continued study of coronal-geomagnetic relationships corroborates previous findings of a fairly consistent lag of 3 to 4 days from coronal limb appearance to storm time for years of low sunspot number, and a weaker correlation for years of high sunspot number.

Studies of circuit outage time in auroral regions due to solar corpuscular absorption, showed general improvement in transmission for midpoint latitudes between 57° and 61° N over that anticipated from general trends, both for quiet and disturbed days (19). Further information on solar-corpuscular phenomena is provided by studies of Es and auroral appearances, made at Point Barrow, Alaska; 90 percent correspondence was found between appearances of Es and visible aurora, higher f°Es being observed for the more intense aurorae, with the shorter-range Es corresponding to zenith aurorae (20).

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Part E: *Department of Terrestrial Magnetism*

The Department of Terrestrial Magnetism of the Carnegie Institution of Washington has long been in the field of major contributions to Cosmic Terrestrial Relations, accounts of which are to be found in the Director's Reports of the Department.

Supplementing information contained in the Director's reports, Harry W. Wells states that the Department is now engaged in a program of radio astronomy using interferometers at 200 mc/s for a study of radio emission both from the sun and from active areas associated with sunspots. Measurements have been made at intervals, beginning in November, 1952, on the H-line (1420 Mc) from the gas clouds in various parts of our Galaxy. Progress has also been made toward the instrumentation necessary to measure other possible monochromatic radio frequency radiations from the Galaxy.

Part F: *Palomar and Mt. Wilson Observatories*

At the Palomar and Mt. Wilson Observatories an important advance in electronic instrumentation has been made making possible daily photographs of the magnetic field of the Sun's surface. The existence of a weak, over-all magnetic field of the sun has received definite confirmation. The intensity of the fields found is of the order of about one gauss as reported by Babcock in the Astrophysical Journal, November 1953.

Polarity measures of a sunspot appearing in latitude 30° North February 8—9, 1954, indicate a spot of the new solar cycle.

Part IV

Special Reports

Committee No. 1

Committee on Selection of Sites of New Observatories for Terrestrial Magnetism and Electricity

Report by E. Lahaye, Chairman

Membres du Comité : Prof. *Edm. Lahaye,* Président
Prof. *J. Coulomb*
Dr. *I. A. Fleming*
Dr. *V. Laursen*

Le Comité a adressé aux Institutions ayant dans leurs attributions la direction d'un ou plusieurs observatoires ou stations magnétiques, le formulaire dont le texte est reproduit en annexe. Il lui est agréable de constater que presque toutes les Institutions auxquelles le formulaire a été envoyé ont répondu et de leur exprimer tous ses remerciements. Ceci lui a permis également de constater combien considérable était l'effort de développement des observations géomagnétiques.

Le Comité s'est également préoccupé de savoir s'il devait proposer d'être maintenu ou de fusionner avec un autre Comité.

Il estime que le travail qui lui a été confié par l'Association est important et qu'il doit être poursuivi, sous une forme ou sous une autre, dans le cadre de l'Association.

Les membres n'insistent pas pour que le Comité 1 soit maintenu dans sa forme actuelle. Dans l'éventualité où l'Association déciderait de regrouper ses Comités, les membres du Comité 1 ont examiné la possibilité de fusionner son programme avec celui du Comité 11. Ils considèrent qu'une telle solution est parfaitement acceptable. Cette solution a d'ailleurs déjà été évoquée par le Président du Comité 11.

Le Comité propose à l'A.I.M.E.T. d'insister très vivement :

1° auprès du Gouvernement de Hong Kong pour que l'observatoire soit rapidement installé et rééquipé afin de pouvoir coopérer à l'Année Géophysique Internationale.

2° auprès du Gouvernement du Brésil pour que la construction de l'observatoire de *Tatuoca* soit activement poursuivie, et qu'il soit rapidement équipé et mis en service.

3° auprès du Gouvernement des U.S.A. pour qu'une station magnétique temporaire fonctionne sur l'île de Jarvis pendant l'Année Géophysique.

Grâce aux nombreux renseignements qui lui ont été communiqués, le Comité a pu dresser un état, exposé dans les pages qui suivent, des réalisations faites au cours de la période 1951—1953, des réalisations en cours ainsi que des projets qui concernent les observatoires ou stations permanents, les stations temporaires et les stations qui fonctionneront pendant l'Année Géophysique 1957—1958.

I

Observatoires et Stations Magnétiques Permanents

Allemagne.

L'observatoire de Wingst a été équipé pour l'enregistrement de dX/dt, dY/dt, dZ/dt, de deux bobines horizontales et d'une bobine verticale constituées d'un grand nombre de spires et d'un noyau à haute perméabilité.

Argentine.

La reconstruction complète de l'observatoire géophysique de Pilar (Cordoba) a été commencée à la fin de 1953.

Il est projeté d'installer un nouvel observatoire.

Australie.

Un nouvel observatoire a été installé dans *l'île Heard.* Ses coordonnées sont 53° 02′ Sud, 73° 22′ Est Gr. Il est entré en fonction en avril 1952. Il est équipé de variomètres La Cour avec enregistreurs à marche normale et compensation thermique. Le site est exempt de perturbations artificielles.

Un autre observatoire a été installé dans *l'île Macquarie.* Ses coordonnées sont 54° 30′ Sud, 158° 57′ Est Gr. Il est entré en fonction en avril 1952. Il est équipé de variomètres La Cour avec enregistreur à marche normale et compensation thermique. Des sondages ionosphériques et des mesures de rayonnement cosmique seront effectués à l'observatoire. Le site est exempt de perturbations artificielles.

L'installation de nouveaux observatoires magnétiques est projetée près de *Port Moresby, Papua* et sur le *Continent Antarctique* ainsi que le remplacement de l'observatoire de *Watheroo* par un autre près de *Perth.* Il est prévu que les stations de Port Moresby, de l'Antarctique et de Perth pourront entrer en fonction en 1955. Des sondages ionosphériques seront faits à Port Moresby et à Perth. Tout les sites sont exempts de perturbations artificielles.

Autriche.

Par suite de la construction d'une usine de transformation électrique dans le voisinage immédiat de l'observatoire Wien-Auhof celui-ci sera transféré à *Wien-Kobenzl* (48° 15',1 Nord, 16° 19',1 Est Gr.). Il entrera en fonction au cours de 1954. Il sera équipé d'un enregistreur à vitesse normale et peut-être d'un enregistreur à marche rapide. Par la suite, sera également enregistrée la dérivée dH/dt.

L'observatoire fera également des enregistrements séismiques à grande sensibilité. Le nouveau site n'est pas affecté par des perturbations artificielles sensibles.

Belgique.

Un nouvel observatoire a été construit à Dourbes. Ses coordonnées sont 50° 05',8 Nord, 4° 35',1 Est Gr. Il est entré en fonction en juillet 1952, mais ne publiera officiellement ses observations qu'à partir de 1955. Il est équipé de variomètres La Cour à sensibilité normale, compensés thermiquement, avec enregistreur à marche normale ; de variomètres La Cour à grande sensibilité pour Z et H, compensés thermiquement, avec enregistreur à marche rapide. L'observatoire fera des sondages ionosphériques, des enregistrements des champs électromagnétiques, des enregistrements de courants telluriques, des mesures de gradient du potentiel électrique, de conductibilité, de nombre des ions ; il sera également équipé d'une cave de séismologie avec enregistreurs. Le site est exempt de perturbations artificielles ; les voies ferrées qui pourraient être électrifiées sont distantes de plus de 20 km.

Brésil.

La construction d'un nouvel observatoire magnétique a été commencée sur l'île de *Tatuoca,* près de Belem (Etat de Para). Ses coordonnées sont 1° 12',3 Sud, 48° 30' 46" Ouest Gr. Il est prévu que l'installation générale pourrait être terminée au début de 1956, mais les observations ne pourront commencer que lorsqu'il sera possible de disposer de courant. La station sera équipée d'un magnétographe Ruska, avec variomètres compensés thermiquement et enregistreur à marche normale (20 mm/h). Le site est exempt de perturbations artificielles et d'anomalies locales.

En raison de la superficie considérable du Brésil, trois observatoires magnétiques pourraient y être établis. Cependant par suite des restrictions financières, il n'est pas possible d'étudier actuellement les plans d'un troisième observatoire.

Colombie.

Un nouvel observatoire est en cours de réalisation depuis 1953 à Fuquene, prés de Bogota.

Congo Belge.

Un nouvel observatoire a été construit à *Karavia* (près d'Elisabethville); il remplacera l'observatoire d'Elisabethville. Il sera en fonction au cours de 1954. Il sera équipé de variomètres La Cour compensés thermiquement avec enregistreur à marche normale. L'observatoire disposera d'un sondeur ionosphérique ; il est projeté d'y effectuer des mesures de courants telluriques. Le site est exempt de toutes perturbations artificielles.

La construction d'un autre observatoire à *Bunia,* sur l'équateur géomagnétique, sera entreprise bientôt. Il entrera en fonction en 1955 et sera équipé de variomètres La Cour compensés thermiquement, avec enregistreur à marche normale. Il comportera également un sondeur ionosphérique ; il est projeté d'y effectuer des mesures de courants telluriques. Le site est exempt de perturbations artificielles.

Danemark.

L'observatoire magnétique de *Godhavn* a été complété par une station de sondage ionosphérique qui fonctionne depuis le 1er novembre 1951.

Par suite de perturbations artificielles, non prévisibles lors de son installation, l'observatoire de *Thule* (Groenland) a cessé de fonctionner en 1952. Il sera transféré dans un nouveau site à 100 km environ vers le Nord. Les constructions nécessaires seront probablement édifiées au cours de l'été 1954.

Egypte.

En raison de l'électrification du chemin de fer Helwan—Le Caire la station magnétique d'*Helwan* sera déplacée, mais le nouveau site n'a pas encore été choisi.

Espagne.

Un observatoire nouveau a été installé à *Alméria.* Ses coordonnées sont : 36° 51′ 12″ Nord ; 1° 13′ 43″ Ouest Gr. Il est entré en fonction le 1er avril 1954. Il est équipé de variomètres La Cour compensés thermiquement avec enregistreur à marche normale. L'observatoire effectuera des observations de séismologie. Le site est exempt de toutes perturbations artificielles ; il n'y a pas de chemins de fer électrifiés.

Un deuxième observatoire nouveau a été établi à 4 km de la ville de *Logroño.* Ses coordonnées sont 42° 27′ 27″ Nord ; 2° 30′ 12″ Ouest Gr. Il entrera en fonction au cours de 1954. Il est équipé de variomètres La Cour thermiquement compensés avec enregistreur à marche normale. L'observatoire effectuera des observations de séismologie. Le site est exempt de toutes perturbations artificielles ; il n'y a pas de chemins de fer électrifiés.

La construction d'un troisième observatoire est en cours à 1 km de *Santiago de Compostela*. Ses coordonnées sont: 42° 53′ 16″ Nord; 8° 33′ 06″ Ouest Gr. Il sera mis en fonction au cours de 1955. Il sera équipé de variomètres La Cour thermiquement compensés avec enregistreur à marche normale. L'observatoire effectuera des observations de séismologie. Le site est exempt de toutes perturbations artificielles ; il n'y a pas de chemins de fer électrifiés.

France.

Un nouvel observatoire a été installé à *M'Bour* (Sénégal, A.O.F.), dont les coordonnées sont 14° 23′,5 Nord ; 343° 02′,5 Est Gr. Il est entré en fonction le 7 mars 1952. Il est équipé de 3 variomètres La Cour compensés thermiquement avec enregistreur à marche normale ; de 3 variomètres Mascart avec enregistreur à marche normale ; d'un variomètre Grenet pour dH/dt à marche rapide. Le nouvel observatoire effectuera des observations en séismologie et en gravimétrie ; le site est exempt de toutes perturbations artificielles.

La construction d'un autre observatoire a été commencée à *Bangui* (Oubangui, A.E.F.) ; il remplacera la station magnétique temporaire qui y a fonctionné du 1er mars au 21 septembre 1952. Ses coordonnées sont 4° 36′ 08″ Nord ; 18° 35′ 25″ Est Gr. Il entrera en fonction fin 1954. Il sera équipé de 3 variomètres La Cour à marche normale et compensation thermique. Le nouvel observatoire effectuera des sondages ionosphériques et peut-être des mesures de courants telluriques. Le site choisi est exempt de toute perturbation artificielle.

Finlande.

Un nouvel observatoire a été établi à *Nurmijärvi,* dont les coordonnées sont : 60° 30′ 55″ Nord ; 24° 39′ 25″ Est Gr. Il est entré en fonction en 1952, avril 20. Il est équipé d'enregistreurs à marche normale et à marche rapide, ainsi que d'un enregistreur à marche lente pour l'enregistrement des tempêtes. Les variomètres sont compensés thermiquement. Un chemin de fer à courant continu passe à 40 km environ de la station.

Grande Bretagne.

L'observatoire magnétique d'*Abinger* étant depuis plusieurs années troublé par des chemins de fer électrifiés, il a été décidé de le déplacer près de *Hartland,* dans le sud du Devon. Les coordonnées du nouvel observatoire sont : 50° 59′ Nord ; 4° 28′

Ouest Gr. La date probable de son entrée en fonction est 1957. Il sera à plus de 10 miles du chemin de fer ; le site a été choisi de façon à ne plus être perturbé, même si le chemin de fer était électrifié.

D'autre part, le Meteorological Office a préparé l'installation d'un nouvel observatoire qui sera construit par le Gouvernement des Îles Falkland dans les *Îles Argentine* : 65° *Sud ; 64°* Ouest Gr. approximativement. Il entrera probablement en fonction en 1955. Il sera équipé de deux jeux de variomètres La Cour avec enregistreurs à vitesse normale et de sensibilités différentes ; de QHM et BMZ et d'un magnétomètre Kew unifilaire. Des mesures ionosphériques sont effectuées à Port Lockroy, à 30 miles environ au nord-est des Îles Argentine.

Hong Kong.

Un projet sera soumis à l'approbation du Gouvernement de Hong Kong pour l'installation d'une station magnétique permanente, qui remplacerait la station de Au Tau détruite en décembre 1941. La station serait située à moins de 10 miles de Hong Kong ; si l'approbation était accordée, sa mise en fonction pourrait être envisagée pour 1956. Il serait possible d'effectuer des sondages ionosphériques au Royal Observatory. Le site serait exempt de perturbations artificielles.

Indonésie.

Une station magnétique permanente a été rétablie sur *l'Île Kuyper,* dans la baie de Djakarta. Elle remplace une ancienne station occupant la même position. Ses coordonnées sont: 6° 02′ Sud ; 106° 44′ Est Gr. La station est entrée en fonction depuis juillet 1953. Elle est équipée de variomètres La Cour avec enregistreur à marche normale. Elle est exempte de perturbations artificielles.

La création de deux nouvelles stations permanentes est envisagée sans que la décision en soit cependant prise. Leurs emplacements probables seraient Padang et Menado. Les dates de leurs mises en fonction dépendront de la possibilité de disposer de personnel et d'instruments.

Irlande.

L'équipement de l'observatoire magnétique de Valentia (51° 56′ Nord, 10° 15′ Ouest Gr.) a été modernisé au cours de 1952 et un enregistreur La Cour à vitesse normale a été installé. Les observations seront publiées officiellement à partir de 1954.

Japon.

Un nouvel observatoire a été installé à *Memambetsu*, Hokkaido ; il remplace l'observatoire établi à Toyohara. Ses coordonnées sont : 43° 54′,5 Nord ; 144° 11′,6 Est Gr. Il est entré en fonction le 14 janvier 1952. Il est équipé de variomètres compensés thermiquement, avec enregistreur à marche normale. L'observatoire fera également des observations de courants telluriques et d'électricité atmosphérique (gradient du potentiel et conductibilités). Le site est exempt de toutes perturbations artificielles.

Norvège.

L'observatoire magnétique de *Dombås* a été transféré à 1,5 km environ de l'ancienne station. Les nouvelles coordonnées sont : 62° 04′,4 Nord ; 9° 07′ Est Gr. ; altitude 660 m. Il est entré en fonction depuis 1951, mars. Il est équipé d'un nouveau jeu de variomètres La Cour.

Nouvelle-Zélande.

L'effort de ce pays est consacré au rééquipement des observatoires magnétiques de Amberley et Apia au moyen de magnétographes La Cour.

Pérou.

Au cours de la période 1951—1954, un observatoire pour les observations ionosphériques a été installé à Talara au Nord-Est du pays et un autre à Iquitos (région de l'Amazone) pour les observations de séismologie.

Philippines.

Un nouvel observatoire a été installé qui remplace l'observatoire d'Antipolo. Ses coordonnées sont 14° 22′,5 Nord ; 121° 00′,9 Est Gr. Il est entré en fonction en novembre 1950. Il est équipé de variomètres du type Eschenhagen, avec enregistreur à marche normale. Le site est exempt de perturbations artificielles. Des stations magnétiques temporaires (deux jours) seront installées dans l'île Balabac ; à Davao City dans l'île de Mindanao ; à Iloilo City, dans l'île de Panay.

Portugal.

L'observatoire de *Coïmbra* qui avait cessé de fonctionner depuis 1947, a été remis en fonction à partir d'octobre 1951. Il est équipé de nouveaux variomètres compensés thermiquement avec enregistreur à marche normale (20 mm/h). Des tramways électriques passent à 1 km de l'observatoire et perturbent légèrement les enregistrements. La création d'un nouvel observatoire en un site non perturbé est envisagée.

La construction d'un nouvel observatoire a été commencée dans le Mozambique. Ses coordonnées sont: 26° 18′ Sud ; 32° 12′ Est Gr. Il entrera probablement en fonction à la fin de 1954. Il sera équipé de variomètres Askania avec enregistreur à marche normale. D'autres observations géophysiques y seront effectuées. Le site est exempt de toute perturbation artificielle.

La construction d'un autre observatoire est projetée à *Luanda* (Angola). Il entrera probablement en fonction à la fin de 1954. D'autres observations géophysiques y seront effectuées. Le site est exempt de toute perturbation artificielle.

U.S.A.

Les plans et les travaux préliminaires à la construction d'un nouvel observatoire ont été établis. Il s'appellera *Observatoire de Fredericksburg* et remplacera *l'Observatoire de Cheltenham.*

Il est situé près de la ville de Fredericksburg en Virginie. Ses coordonnées sont: 38° 12′,4 Nord ; 77° 22′ Ouest Gr. Il entrera probablement en fonction au cours du second semestre de 1955. Il sera équipé de variomètres à sensibilité normale et à faible sensibilité avec enregistreurs à marche normale (20 mm/h.) ; de variomètres à sensibilité normale avec enregistreur à marche rapide. D'autres types d'enregistreurs seront également expérimentés. Tous les appareils seront thermiquement compensés. Des plans sont à l'étude pour l'établissement d'un mesureur de rayonnement cosmique, avec la collaboration de la Carnegie Institution. Le site est exempt de perturbations artificielles ; le chemin de fer électrifié le plus voisin est à plus de 50 km.

II

Stations Magnétiques Temporaires

Argentine.

Une station temporaire a été installée dans *l'Ile de la Décepcion* (Antarctique Argentin) d'avril à décembre 1951. Au cours de cette période a été effectué le levé magnétique de l'île.

Il est projeté d'installer une station temporaire dans la zone 70° Ouest Gr. et entre les parallèles 40° et 54° Sud.

Congo Belge.

Les cinq stations temporaires suivantes ont été occupées en 1953 *Rutshuru* (10—15 janvier); *Beni* (21—24 janvier); *Bunia* (27—30 janvier); *Djalasiga* (3—6 février); *Missa* (10—13 février).

Elles font partie du réseau des stations de variation séculaire.

Espagne.

Une station temporaire a été installée à *Evinayong* (Guinée Espagnole) de coordonnées 1° 26′ 16″ Nord ; 10° 33′ 40″ Est Gr., du 10 février au 19 mars 1952. Elle était équipée de variomètres Askania compensés thermiquement, avec enregistreur à marche normale. Des observations astronomiques ont été effectuées au cours de l'éclipse solaire du 25 février 1952.

France.

Une station temporaire a été établie à *Bangui* (Oubangui, A.E.F.) de coordonnées 4° 36′ 08″ Nord ; 18° 35′ 25″ Est Gr., du 1er mars au 21 septembre 1952. Elle était équipée de variomètres La Cour, compensés thermiquement, avec enregistreur à marche normale. Des sondages ionosphériques y ont été effectués.

Indes.

Des observations temporaires ont été effectuées en 1953 respectivement à *Devadanappati* (10°,2 Nord ; 77°,6 Est) les 23 et 24 février ; *Virapandi* (10°,0 Nord ; 77°,4 Est) les 26 et 27 février ; *Uttamapalayam* (9°,8 Nord ; 77°,3 Est) les 1 et 2 mars ; *Kodaikanal Road* (10°,2 Nord ; 77°,9 Est) les 4 et 5 mars ; *Palni* (10°,5 Nord ; 77°,5 Est) les 7 et 8 mars ; *Dharapuram* (10°,7 Nord ; 77°,5 Est) les 10 et 11 mars ; *Erode* (10°,3 Nord ; 77°,8 Est) les 17 et 18 mars ; *Mettun* (11°,8 Nord ; 77°,8 Est) les 20 et 21 mars ; *Bangalore* (13°,0 Nord ; 77°,6 Est) les 23 et 24 mars.

Suède.

Il est projeté d'installer une station temporaire à *Värnamo* de coordonnées 57°,2 Nord ; 14°,0 Est Gr., du 15 juin au 15 juillet 1954 pour encadrer l'éclipse solaire du 30 juin 1954 ; les éléments D, H, Z y seront observés. Au point de vue ionosphérique, il faut noter que la ligne de centralité de l'éclipse y passe à 90 km de hauteur.

U.S.A.

Il est projeté d'établir une station temporaire dans l'Etat de Floride au cours du premier semestre de 1954. Elle fonctionnera probablement en 1954 et 1955.

III

Année Géophysique Internationale 1957—1958

Australie.

En raison de la contribution considérable de ce pays au développement du programme des observations de magnétisme terrestre (voir I), il ne lui sera pas possible d'établir une station en Afrique pendant l'Année Géophysique.

Brésil.

La construction de l'observatoire de Tatuoca est en cours.

Canada.

Pendant l'Année Géophysique, ce pays maintiendra une station à Baker Lake (64° 20′ Nord ; 96° 02′ Ouest Gr.) et une station à *Resolute Bay* (74° 41′ Nord ; 94° 50′ Ouest Gr.).

Congo Belge.

Les observatoires de *Binza, Karavia* et *Bunia* seront complètement équipés pour l'Année Géophysique et disposeront de sondeurs ionosphériques et d'enregistreurs de courants telluriques.

Il est proposé en outre d'établir une station temporaire à *Malakal* (sur l'équateur magnétique) ; cette station pourrait abriter un équipement spectrographique.

Egypte.

En raison du manque de personnel et de crédit il n'est pas possible actuellement, à ce pays, de collaborer à l'Année Géophysique et de réaliser notamment le projet d'une station à Khartoum.

Espagne.

Les projets pour l'établissement de stations en Guinée Espagnole et aux îles Canaries sont à l'étude.

France.

Le développement des stations de *Tamanrasset* et *Bangui* est très probable. L'établissement d'une station à *Tahiti* est toujours envisagé. Il y a peu d'espoir de réaliser la station des *îles Kerguelen.*

Le rétablissement de la station de *Scoresby Sund* ne peut être envisagé.

Hong Kong.

Un projet sera soumis à l'approbation du Gouvernement de Hong Kong pour l'installation d'une station magnétique permanente (voir I).

Norvège.

Une station temporaire sera établie pendant l'Année Géophysique à *l'île des Ours.*

La possibilité d'établir avec la Suède une station au *Spitzberg* fait l'objet de pourparlers. La décision sera communiquée par le Comité National Suédois. Il ne sera pas établi de station à *l'île Jan Mayen,* ni par la Norvège ni par la Suède.

Pays-Bas.

Des pourparlers sont en cours pour l'installation d'un observatoire à *Paramaribo* (Surinam) et *Hollandia* (Nouvelle Guinée). Cependant en raison de l'indépendance complète (Surinam) ou quasi complète (Nouvelle Guinée) de ces territoires vis à vis des Pays-Bas, tous les efforts de ceux-ci doivent se borner à des conseils.

Suède.

Ce ne sera qu'au printemps de 1955, qu'il sera possible de savoir si les crédits nécessaires à l'établissement d'une station en *Abyssinie* et au *Spitzberg* pourront être accordés.

U.S.A.

S'il devient possible pour ce pays d'établir une station magnétique avec enregistreur sur l'île Jarvis, elle ne fonctionnera que pendant l'Année Géophysique.

Questionnaire

I. *Observatoires (ou Stations Magnétiques Permanentes)*

1 — Au cours de la période janvier 1951 — décembre 1953, avez-vous installé :
- 1 a) — Un observatoire magnétique permanent nouveau (ou plusieurs) ?
- 1 b) — Une station magnétique permanente nouvelle (ou plusieurs) ?

2 — Dans l'affirmative pourriez-vous indiquer :
- 2 a) — Si cet observatoire ou cette station se substitue à un autre observatoire ou à une autre station.
- 2 b) — Sa position géographique ;
- 2 c) — La date de son entrée en fonction ;
- 2 d) — La nature des enregistreurs qui l'équipent (enregistreurs à marche normale, à marche rapide ; compensation thermique) ;
- 2 e) — Si d'autres observations géophysiques seront faites à proximité (courants telluriques, sondages ionosphériques, etc..)
- 2 f) — Si le site choisi est exempt de toute perturbation artificielle (indiquer éventuellement la distance à la ligne de chemin de fer la plus proche électrifié en courant continu).

3 — Au cours de la période 1951—1953 avez-vous commencé la construction d'un observatoire permanent nouveau (ou d'une station magnétique) ?

4 — Dans l'affirmative pourriez-vous indiquer :
- 4 a) — Si cet établissement est destiné à remplacer un autre observatoire (ou une autre station) ;
- 4 b) — Sa position géographique ;
- 4 c) — L'époque probable de son entrée en fonction ;
- 4 d) — La nature des enregistreurs qui l'équiperont (enregistreurs à marche normale, à marche rapide ; compensation thermique) ;

4 e) — Si d'autres observations géophysiques seront faites à proximité (courants telluriques, sondages ionosphériques, etc...)
4 f) — Si le site choisi est exempt de toute perturbation artificielle (indiquer éventuellement la distance à la ligne de chemin de fer la plus proche électrifiée en courant continu).

5 — Projetez-vous d'installer un observatoire permanent nouveau (ou une station magnétique) ?

6 — Dans l'affirmative, pourriez-vous indiquer :
6 a) — L'emplacement probable de cet établissement ;
6 b) — L'époque probable de son entrée en fonction ;
6 c) — Si d'autres observations géophysiques seront faites à proximité (courants telluriques, sondages ionosphériques, etc...) ;
6 d) — Si le site choisi sera exempt de toute perturbation artificielle (indiquer éventuellement la distance à la ligne de chemin de fer la plus proche électrifiée en courant continu).

II. *Stations Magnétiques Temporaires*

7 — Au cours de la période 1951—1953 avez-vous installé une station magnétique temporaire (ou plusieurs) ?

8 — Dans l'affirmative, pourriez-vous indiquer :
8 a) — Sa position géographique ;
8 b) — La période pendant laquelle elle a fonctionné ;
8 c) — La nature des enregistreurs qui l'équipaient (marche normale, marche rapide ; compensation thermique) ;
8 d) — Si d'autres observations géophysiques ont été faites à proximité (courants telluriques, sondages ionosphériques, etc...)

9 — Projetez-vous d'installer une station magnétique temporaire ?

10 — Dans l'affirmative pourriez-vous indiquer :
10 a) — La région probable de son emplacement ;
10 b) — La période pendant laquelle elle fonctionnera ;
10 c) — Si d'autres observations géophysiques seront effectuées à proximité (courants telluriques, sondages ionosphériques, etc...)

III. *Année Géophysique Internationale 1957—1958*

11 — En annexe est reproduite une liste de stations magnétiques dont le Comité Spécial de l'Année Géophysique Internationale (C.S.A.G.I.) voudrait pouvoir recommander l'installation aux Etats intéressés. Si votre Pays figure dans cette liste, et si la station mentionnée n'est pas citée dans les parties I et II de ce formulaire, pourriez-vous faire connaître dans quelles conditions il vous serait possible de donner une suite favorable aux suggestions du C.S.A.G.I.

Annexe

1.1. Envoi de missions japonaises dans les îles du Pacifique, à déterminer d'accord avec le gouvernement des Etats-Unis.

1.2. Envoi par le gouvernement des Etats-Unis d'une mission à l'île Jarvis.

1.3. Contribution du gouvernement autrichien à l'établissement d'une station en Afrique près de l'équateur magnétique.

1.4. Etablissement par le gouvernement suédois d'une station en Abyssinie.

1.5. Etablissement de stations hollandaises à Paramaribo (Surinam) et Hollandia (Nouvelle Guinée).

1.6. Equipement par le Brésil d'un nouvel observatoire à Tatuoca.

1.7. Etablissement par le gouvernement espagnol de stations en Guinée Espagnole et aux îles Canaries.

1.8. Développement donné par le gouvernement français aux stations de Tamanrasset et Bangui ; établissement possible d'une station à Tahiti et d'une station d'enregistrement des variations aux îles Kerguelen.

1.9. Etablissement par le gouvernement de l'Islande d'une station magnétique permettant en particulier l'enregistrement des variations rapides.

1.10. Etablissement de stations magnétiques à Bunia et Lwiro au Congo Belge, en particulier pour l'étude des variations.

1.11. Remise en marche par le gouvernement du Royaume-Uni de la station magnétique de Hong-Kong.

1.12. Etablissement d'une station magnétique à Khartoum.

2. Le C.S.A.G.I. recommande l'établissement d'une station magnétique au Spitzberg et invite la Norvège et la Suède à

examiner les moyens adéquats pour assurer le fonctionnement d'une telle station.

3. Le C.S.A.G.I. demande que le réseau de stations magnétiques qui sera établi dans les régions arctiques au cours de l'AGI soit au moins aussi complet que lors de la seconde année polaire internationale 1932—1933. En particulier, il désire attirer l'attention sur la nécessité de rétablir les stations suivantes : Julianehaab, Jan Mayen, Scoresby Sund.

Committee No. 2

Committee on Aurora

Report for the period 1951—1954

by Carl Störmer, Chairman

A. Distribution of auroral cameras belonging to the Association of Terrestrial Magnetism and Electricity:
The 14 auroral cameras enumerated in the report to the Brussels meeting 1951 are now distributed as follows:
Cameras with Astro lens F 1.25:
1 at the auroral station in Lillehammer, Southern Norway
1 at the auroral station in Nordsæter, „ „
1 at the auroral station in Askim, „ „
1 at the auroral station in Kongsberg, „ „
1 at the auroral station in Holmestrand, „ „
1 at the auroral station in Oslo, „ „
2 at Tromsö, Northern Norway
1 to Professor Berkey, Colgate University, U.S.A.
2 to Professor Currie, Saskatoon, Canada
1 to Dr. James Paton, Edinburgh, Scotland
2 to the French expedition to Adelie Land, Antarctic
Cameras with Meyer lens F 1.5:
1 at the auroral station in Oslo
1 to Dr. James Paton, Edinburgh, Scotland
1 single Astro lens in a moving picture camera at the auroral station in Oslo

B. Distribution of auroral cameras belonging to "Forskningsfondet 1919" and to Professor Störmer personally:
With Astro lens F 1.25:
1 at the auroral station Oslo
1 at the auroral observatory, College, Alaska
With Ernemann lens F 2, focal distance 10 cm:
1 at the station Oslo
With Ernemann lens F 2, focal distance 5 cm:

5 at the station Oslo
1 at the observatory, Sodankylä, Finland

C. Distribution of pocket spectroscopes belonging to the Association:
The 14 spectroscopes enumerated in my report to the Brussels meeting are distributed as follows:
6 to the auroral stations Oslo, Lillehammer, Nordsæter, Askim, Holmestrand, Kongsberg
1 to myself
4 to auroral observers in Norway
1 to Dr. James Paton, Edinburgh
2 deposited at the Astrophysical Institute, Oslo.

D. Distribution of Atlasses, Supplements, Starmaps and Covers, belonging to the Association:
During the period under review a new edition of the Photographic Atlas of Auroral Forms was published, in all 250 copies. The printing costs were covered by a grant from the Temporary Commission on the Liquidation of the Polar Year 1932—33.
The following numbers of Atlasses and Supplements have been sent:

1951	*Atlasses*	*Supplem.*	
March 6	2	2	Servicio Meteorológico Nacional, Buenos Aires, Argentina.
	1		Director, Instituto de Geofisica, Mexico D.F., Mexico.
Jan. 16	1	1	J. Bull, Newcastle.
Febr. 16	1	1	M. Stahl, Strassbourg, France.
April 16	1	1	B. Meinel, Yerkes Observatory, U.S.A
July 5	5		To Dufay, Götz, Paton, Sucksdorff and Currie as members of the auroral committee.
	4		To the president, vice-presidents and secretary of the Association.
	1		Dr. Laursen, Denmark.
Aug. 13	15	15	Prof. Gartlein, Cornell University, U.S.A.
	5	5	J. W. Joyce, Washington D.C., U.S.A.
	1	1	N. J. Oliver, Shamowith Gardens, Sommerset Centre, U.S.A.
Nov. 17	5	5	Shapley, Washington D.C., U.S.A.
Dec. 13	1	1	Gerson, Waltham, U.S.A.

1952		*Atlasses*	*Supplem.*	
March	21	1	1	Laclavère, Paris.
April	24	24	24	James Paton, Edinburgh.
May	5	1	1	Library of Congress, Washington, D.C., U.S.A.
July	24	2	2	Baril, Montreal, Canada.
Dec.	11	6		Geophys. Inst. Alaska, U.S.A.
1953				
Jan.	26	1		Nat. Geogr. Soc. Washington D.C., U.S.A.
Feb.	4	2		Forsvarets Forskn. Inst. Kjeller.
	11	12		James Paton, Edinburgh.
	19	6		Geophys. Inst. Alaska, U.S.A.
	25	1		Univ. Bibl. Bergen.
	25	1		Vidensk. Selsk. Publ., Trondheim.
April	29	1		Director Morgan, New Hampshire, U.S.A.
July	30	1		Professor Bates, Belfast, Great Britain.
Sept.	14	1		Professor E. Brüche, Mosbach, Germany.

In all sent:

In 1951	43 Atlasses	32 Supplements
In 1952	34 Atlasses	28 Supplements
In 1953	26 Atlasses	0 Supplements
In all	103 Atlasses	60 Supplements

According to A. W. Bröggers Boktrykkeri A/S the stock available Dec. 31, 1953 was

163 Atlasses and 44 Supplements.

Starmaps and covers:
In 1951, 1952 and 1953 no starmaps and covers were sent.

Appendix

Account for Auroral Cameras, Atlasses etc. 1951, 1952 and 1953:
(All amounts in Norwegian crowns)

Cash, Jan. 1. 1951	kr. 5.803.22
Received for sale of Atlasses etc.	kr. 1.388.90
Sum ...	kr. 7.192.12

Paid A. W. Bröggers Boktrykkeri A/S for preparing starmaps	kr.	92.50
Mailing of Atlasses etc.	kr.	181.10
Correction of proofs of new Atlas	kr.	10.00
Help to the bureau	kr.	30.50
Repair of a camera	kr.	10.00
Paid A. W. Bröggers Boktrykkeri A/S for new stock of Atlasses	kr.	4.954.80
Sum ...	kr.	5.278.90

Cash, Jan. 1. 1954:

kr. 7.192.12 — kr. 5.278.90 = *kr. 1.913.22*

Committee No. 3

Committee on Magnetic Secular Variation Stations

Report by E. H. Vestine, Chairman

The Committee has continued to function since the time of the Brussels meeting, members now acting being Messrs. Egedal, Errulat, Fleming, Mme. Kalinowska, Messrs. Nagata, Pramanik, Prior, Slaucitajs, and Vestine (Chairman).

The Committee has solicited information respecting magnetic surveys at repeat stations of various nations. A brief summary covering surveys since 1951 is included here.

The most serious problem is the mounting uncertainty in magnetic secular changes over the oceans. Since 1929 the amount of secular change information obtained by ship or airborne magnetometer over the oceans has been quite insignificant. While the airborne surveys of Atlantic areas have greatly improved our knowledge of details of field distribution in these areas, the measurements thus far only serve to roughly check the extrapolated secular changes of earlier eras. It is necessary that these measurements at suitable check points be repeated within a few years' time and extended to world wide coverage at the earliest possible time.

The Committee has arrived at the following comments and recommendations:

1. The Committee takes much satisfaction in noting that a number of studies of geomagnetic secular change have in recent years provided valuable information respecting the earth's interior, and that most inaccessible of regions, the earth's central core. It also appears likely that the origin of secular change is beginning to be understood.

2. The Committee notes with satisfaction that secular-variation stations on land in many countries have been reoccupied, and

that consequently much valuable data useful in constructing charts for navigation and other purposes have become available. Observations are wanting in certain regions of very rapid secular change susceptible of measurement at islands such as Tristan da Cunha and Marion and many others. The attached summaries show that in general survey activities on land are in a healthy state.

3. The Committee notes the mounting deficiencies in the knowledge of secular change over the oceans, still virtually unsurveyed for such purposes particularly since the sinking of the non-magnetic ship "Carnegie" in 1929. These deficiencies have now reduced the security of traffic by air and sea, due to defective charts. The Committee strongly urges that steps be taken as soon as possible to
   (a) recover sites of Carnegie stations over all oceans by airborne magnetometer, or in other ways, such as by weather and other ships.
   (b) fly magnetic profiles across all oceans for subsequent recovery five to ten years later for purposes of secular change determination.
   (c) outfit non-magnetic ships to resurvey those areas not accessible to aircraft and to supplement estimates of secular change over all oceans where necessary. There is very grave danger that airborne surveys will not be extended as rapidly as expected over all oceans, and that the values of field measured at specific points by aircraft may be wanting in adequate precision. The Committee especially wishes to stress that both airborne and surface surveys are essential.
   (d) undertake frequent measurements, at intervals of five years at island stations, providing estimates of secular change within ocean areas remote from continental areas.
4. It is noted that magnetic observatories ordinarily yield the most reliable estimates of secular change. As in earlier reports, it is urged that selected repeat stations be reoccupied about once every two years, operating a portable magnetograph for from one to several days, at or near the previous site, giving the reduction to the mean of a Greenwich day.

The following abstract gives a short summary of magnetic survey activities of various countries responding to our request for information.

AFRICA

Angola and Mozambique.

Prof. H. Amorim Ferreira, Director-General, Serviço Meteorológico Nacional, Portugal, states that due to the great area of these territories, before starting the geomagnetic survey, two observatories are being built and installed near Luanda (Portuguese West Africa) and Lourenço Marques (Portuguese East Africa). It is expected that these two observatories will be in operation by the end of 1954 when the survey of the territory will be started.

French Africa.

Dr. J. Coulomb, Director de l'Institut de Physique du Globe de Paris, states that 39 stations were occupied in Equatorial French Africa during the period under consideration.

South Africa.

Dr. A. M. van Wijk, Officer-in-Charge, Hermanus Magnetic Observatory, reports that 44 secular variation stations established in 1938—1939 were reoccupied in 1952—1953. The addition of six stations in Southern Rhodesia in 1948, and two in South Africa in 1952 has raised the total to 52. Three stations were transferred to new locations in 1952—1953.

The possibility of establishing secular variation stations on Marion Island and on Island Tristan da Cunha is being considered. It is expected that magnetic field observations will be started in the near future in Angola by the Serviço Meteorológico de Angola.

Madagascar.

Dr. R. P. Jean Coze, Observatoire Ambohidempona, Tananarive, states that no old stations were occupied in 1951 nor were any new stations established in Madagascar. However, measurements were made at Kerguelen in the summer. There is a project planned for 1954 to make magnetic observations by airplane.

Mauritius.

Dr. E. G. Davy, Director, Vacoas Observatory, reports that at the Royal Alfred Observatory photographic records of magnetic force were not made from 1951—1953 but recording was started again in January 1954. No surveys are contemplated in the near future.

ASIA

Ceylon.

The Director, Colombo Observatory, reported that plans for establishing repeat stations have been deferred, but declination observations were obtained at Colombo Observatory for March 1951 and February 1954.

Hindustan (Portuguese).

Prof. H. Amorim Ferreira, Director-General, Serviço Meteorológico Nacional, Portugal, states that 35 stations were occupied in a survey of Portuguese Territory in the Hindustani Peninsula.

India.

Dr. B. L. Gulatee, Director, Geodetic and Training Circle, Survey of India, states that observations were carried out at 13 repeat stations in South India in 1950—1951. Detailed magnetic work has been carried out in the Rajasthan area for the Indian Air Force. Other repeat stations will probably be occupied in 1954.

Indonesia.

Prof. Ir. R. Goenarso, Director, Meteorological and Geophysical Service, Ministry of Communications, Indonesia, reported that the La Cour recording instruments were moved from Lembang (W. Java) to Kuyper in the Bay of Djakarta because of strong disturbances at Lembang. Magnetic field observations were made at Celebes and Borneo in 1952 and 1953.

As to the future, a five year plan calls for obtaining complete new magnetic instruments for a modern observatory and also for the continuation of field work and registrations.

Japan.

Dr. T. Yoshimatsu, Director, Kakioka Magnetic Observatory, reports that mean values af H, D, and Z, were obtained at Kakioka in 1951—1953 and at Memambetsu for 1952—1953. Observations were made at other observatories, namely, Katsuura Hydrographic Observatory; Aso Magnetic Observatory, Kyoto University; Onagawa Magnetic Observatory, Tohoku University; Wakkamai and Hiraiso Radio Wave Observatories; Mase (Niigata Prefecture) and Aburatsubo (Miura Peninsula, Kanagawa Prefecture) Observatories, Tokyo University, and Kakioka Branch Station, Tokyo University.

No surveys are planned for the near future.

Lebanese Republic.

Dr. P. J. Delpeut, Director, Observatoire de Ksara par Zahle, reports the Ksara Magnetic Observatory was in operation during the years 1951—1953.

Thailand.

Major General Luang Lahaw Bhumilak, Chief of Survey, Ministry of Defense, Bangkok, reported that 31 stations were reoccupied since 1951 He also stated that terrestrial magnetic surveys will be continued regularly at the locations already observed, as personnel and instruments are available.

AUSTRALASIA

Australia.

Dr. L. S. Prior, Officer in Charge, Watheroo Observatory, Bureau of Mineral Resources, Geology and Geophysics, reports that absolute magnetic field observations have been made in all

Australian states. Tasmania has been completely resurveyed and 29 stations were either reoccupied or established during 1952. A series of observations around the border of Australian mainland involving the reoccupation or establishing of 19 stations was undertaken in 1952.

Magnetic observatories at Watheroo and Toolangi have been maintained in full running order and have been supplied with new absolute magnetic equipment. Observatories at Heard Island and Macquarie Island were brought to full automatic recording in March 1952.

A resurvey of Victoria will be started shortly when between 30 and 40 stations will be reoccupied or established. At present an observer with the Australian National Antarctic Research Expedition is surveying a site for a proposed Antarctic observatory and is establishing a field station on the Antarctic Continent.

A site has been selected and surveyed for the establishment of a magnetic observatory near Port Moresby in Papua. Approximately 24,000 square miles have been surveyed with an airborne magnetometer for total force. Plans are in preparation for measurements of three components from the air.

A program has been drawn up for the reoccupation and/or the establishment of 500 absolute magnetic field stations throughout Australia and its dependencies.

New Zealand.

Dr. A. L. Cullington, Acting Director, Department of Scientific and Industrial Research, submits the following report. Observations were made in New Zealand at 24 magnetic stations eight of which were reoccupations. In 1952 magnetic survey work was extended into the Pacific where nine magnetic stations were established in Fiji, Western Samoa, Society Islands, Cook Islands, and Norfolk Islands. It is intended to carry out repeat observations at all of these stations in the future. In 1952 two magnetic stations at the Chatham Islands were reoccupied and another established nearby. In 1953 stations on Campbell Islands, Fiji and Cook Islands were reoccupied.

Additional stations designated as International Repeat Stations are Nandi and Fiji, Rarotonga in the Cook Islands and Te Roto in Chatham Islands. Another International Repeat Station is to be established north of Auckland in the North Islands. All of the International Repeat Stations are to be reoccupied every two years.

Magnetic surveys by airplane were carried out to measure total force. An area of 7860 square miles was covered in the Rotorua-Taupo thermal region of North Islands. Profiles were flown over other parts of New Zealand amounting to nearly 2300 miles.

EUROPE

Denmark and Greenland.

Dr. Helge Petersen, Director, Danske Meteorologiske Institut, states that the Danish magnetic observatories Rude Skov and Godhavn (Greenland) have been functioning during the considered time, but the Thule Observatory had been closed down in 1952 for transfer to a new site. The ten old secular variation stations in Denmark will be occupied in 1955.

Plans call for the establishment of secular variation stations at appropriate places in Greenland.

France.

Dr. J. Coulomb, Director de l'Institut de Physique du Globe de Paris, reports that 11 stations were reoccupied in France and two others established. In Corsica 98 stations were completed. All stations will be reoccupied in 1957.

Netherlands.

Dr. J. Veldkamp, Director, Koninklijk Nederlands Meteorologisch Instituut, advises that a number of stations which had been occupied for the magnetic survey of the Netherlands and reduced to 1945.0 have been reoccupied during the years 1951—1953. Reoccupation at regular time intervals is planned for the near future.

Norway.

Dr. K. F. Wasserfall, Amanuensis at Det Magnetiske Byrå, Bergen, states that 120 secular variation stations, fairly well distributed in Norway, have been reoccupied during the last two years.

Poland.

Madame Z. Kalinowska, Geophysical Observatory, Swider, reported that D, H, I, and Z were measured at seven old stations in 1951. In 1952 nine stations were reoccupied, and in 1953 D, H, Z were observed at four old stations and D only at eight other stations. A network of 24 stations including old stations and some new locations is proposed for the future.

Portugal.

Prof. H. Amorim Ferreira, Director-General, Serviço Meteorológico Nacional, reports that in the continental territory of Portugal ten repeat stations were occupied in 1952—1953. One station was reoccupied in Madeira, one in the Azores, one in Cape Verde, and two in S. Tome Islands. A plan for the geomagnetic survey of the whole Iberian Peninsula was established in collaboration with the Instituto Geográfica y Catastral of Madrid. The magnetic survey corresponds to an average of one station per 288 square kilometers and includes seven observatories and 38 secular variation stations. The survey of the Portuguese Territory will be followed by the survey of the North Atlantic Islands (Azores, Madeira, and Cape Verde). The magnetic survey of the African Islands of S. Tome and Principe, in the Gulf of Guinea was carried out in 1952.

Spain.

Dr. Jose Rodriguez-Navarro De Fuentes, Secretario de la Comisión Nacional de Geodesia y Geofisica, reports that new instruments have been installed at Observatorio Geofisico de Toledo. Construction has recently been completed on Observatorio Geofisico de Almeria in the proximity of the city. Construction has been completed on Observatorio Geofisico de Logroño, four kilometers west of the city. Construction has been started on Observatorio Geofisico de Santiago de Compostela.

Thirty-nine secular variation stations were occupied in 1951—1953 in Spain. Thirty-six stations were occupied in continental Guinea and thirteen on the Island of Fernando Poo.

A magnetic survey program will be carried out in the near future in cooperation with Portugal.

Sweden.

Dr. Nils Ambolt, Kungl. Sjökarteverket, states that in 1953 the following stations were observed together with the three observatories Abisko, Kiruna, and Lovö belonging to a sparse homogeneous magnetic net laid out in cooperation with representatives of Norway, Finland and Denmark: Launikari, Tärnaby, Vindeln, Alsen, Särna, Innersto, Limedsforsen, Gränna and Burgsvik.

It is intended to measure this net every second year.

Turkey.

Dr. O. N. Sipahioglu, Director, Observatoire de Kandilli, reports that four stations were occupied in European Turkey and four in Western Antolie. Plans for the future call for the reoccupation of 40 stations established by the Carnegie Institution of Washington in the survey of Turkey in 1909—1911.

NORTH AMERICA

Canada.

Dr. R. Glenn Madill, Chief, Division of Terrestrial Magnetism, Department of Mines and Technical Surveys, reported that during 1951—1953, 237 magnetic stations were occupied of which 147 were new and 90 were repeat stations. A Universal Airborne Magnetometer designed by the Dominion Observatory was used for the first time on magnetic survey operations during September, 1953. Continuous registration of D, H, and Z was accomplished throughout a 15,000 mile flight which followed approximately the perimeter of Canada.

The ground magnetic surveys will be continued for the purpose of deriving secular change data and filling in gaps in the network of stations where data are either sparse or lacking.

It is hoped that the airborne magnetometer will be in use each season in the future and that in 1954 airborne surveys over ocean areas adjacent to the eastern coast of Canada from the Arctic Islands to Newfoundland may be carried out. It is hoped, also, that a return flight may be undertaken between Canada and England as a Canadian contribution to a general survey over ocean areas.

Greenland — See Denmark.

United States.

The U.S. Coast and Geodetic Survey summarized the magnetic repeat stations occupied by agencies of the United States, July 1951 to December 1953, as follows: United States, seven new, 67 old; Great Lakes (U.S. and Canada), one new, 26 old; Mexico 30 new; Central America, six new, 16 old; Caribbean area, 15 new, seven old; South America, 49 new, 35 old; totals 108 new, 151 old.

British West Indies.

The Director of Surveys, Port of Spain, Trinidad, states that the Division de Geodesia, Venezuela, occupied three stations in Trinidad and one in Tobago in 1952. The Department of Lands and Survey of Trinidad plans to have several repeat stations occupied in 1955.

SOUTH AMERICA

Argentina.

Capitan de Fragata (R) Guillermo O. Wallbrecher, Director, Servicio Meteorológico Nacional, states that 80 stations were reoccupied, including Isla Decepcion (Antartida Argentina) in 1951—1953.

A survey has been started along the Patagonic Argentine Coast, including ten magnetic stations, six of which are reoccupations of former stations and four are new stations. About the middle of 1954, some measurements will be made along the 64° West Meridian between the parallels of 30° and 40° South.

Brazil.

Dr. Lelio I. Gama, Director, National Observatory, Rio de Janeiro, reports that during the period July 1952 to December 1953, 56 stations have been established or reoccupied. The complete network of stations comprises about 120 localities and includes all stations previously established by expeditions. The magnetic survey work is being carried out under the sponsorship of the National Research Council of Brazil.

Two buildings for absolute observations and photographic recording for the new Tatuoca Observatory have already been erected on the Island of Tatuoca, near the mouth of the eastern branch of the Amazon River. Funds have been granted by the Brazilian Government for the building program to which the National Research Council of Brazil has also contributed.

Colombia.

Dr. Jose Ignacio Ruiz, Director, Instituto Geográfico de Colombia, reported that eleven stations were reoccupied in collaboration with Inter American Geodetic Survey. Twenty-six repeat stations will be occupied in the near future.

A magnetic observatory has been established in collaboration with IAGS on the Island of El Santuario.

Peru.

Dr. Albert A. Giesecke, Jr., Director Tecnico, Instituto Geofisico de Huancayo, reports that observations af D, H, and Z were made at 43 repeat stations and observations of D only were made at 14 other stations.

Committee No. 4
Committee on Magnetic Charts

Report by Nils Ambolt, Chairman

Through the secretary of IATME, Mr. V. Laursen, the Committee was asked to express its opinion whether the epoch of magnetic charts should be the beginning or middle of the year (.0 or .5). No definite decision was arrived at, and thus the Committee at first only recommended that such charts always should be furnished with a clear indication as to whether they are referred to epoch .0 or .5.

The International Hydrographic Bureau has considered the same subject, and that Bureau has decided to recommend the use of epoch .0. Therefore in order to avoid confusion:

1. The Committee recommends for the future the epoch .0 to be used for magnetic charts.

Three of the members of the Committee viz. Mr. Kjaer for Norway, Dr. Keränen for Finland and Dr. Ambolt for Sweden formed a Subcommittee in co-operation with Mr. Egedal for Denmark to produce common magnetic charts for their countries. They published in 1953 a D-chart with isogonic lines based on mean values of observations from areas of 1° longitude and ½° latitude. Extreme values were excluded when forming the means. For regions where the magnetic conditions are disturbed (as for instance is the case with Finland, Norway and Sweden) such a chart must be preferred especially by mariners and aviators to charts whose isogonic lines are based on single values.

2. The Committee recommends that, additionally to magnetic charts representing as many details as possible (which may be constructed if the observational net is dense enough), construction of magnetic charts based on mean values (disregarding extreme values) for areas of suitable size be discussed at the Rome meeting.

Capt. Roberts, U.S.A., has proposed that Committee No. 1 on Sites of New Observatories, No. 4 on Magnetic Charts and No. 6 on Methods of Observatory Publication should be in some way combined.

3. The Committee recommends that Capt. Roberts' proposal should be taken up at the Rome meeting for discussion and decision.

It has recently been proposed by the Hydrographer of the Navy and Sir Harold Spencer Jones, Great Britain, that the weather-ships make determinations of magnetic declination at regular intervals. The collection of such material — if it can be accurate enough — will be of great interest especially for the construction of world magnetic charts.

4. The Committee recommends that the authorities responsible for the maintenance of weather-ships should be urged to arrange for observation of magnetic declination (compass variation) to be made at monthly intervals for controlling the declination and its secular change.

5. The Committee recommends that declination observations on board weather-ships should be discussed at the Rome meeting.

Committee No. 5

Committee on Registration of Giant Pulsations

Report by J. Olsen, Chairman

As recommended at the Brussels Assembly 1951 a complete Quick-Run (Q.R.) magnetograph from the Polar Year stock was placed at the disposal of the Magnetic Observatory at Kiruna in Dec 1951, and 3 variometers from the same stock were sent to the Auroral Observatory at Tromsø in October 1952.

Since the 1. of January 1951 G.P.s have been rather frequent at the four stations: Tromsø (Abbrev. Tr.), Sodankylä (So.), Abisko (Ai.), and Kiruna (Ki.) all in northern Scandinavia, and many of these G.P.s have been recorded simultaneously at more of the stations as the following table shows:

Total number of G.P.s recorded at					Number of G.P.s simultaneously at least at		
Year	Tr.	So.	Ai.	Ki.	2 stations	3 stations	4 stations
1951	12	6	17	17	17	10	5
1952	21	12	20	20	20	15	10
1953	11	5	7	7	7	5	5
Sum	44	23	44	44	44	30	20

The distance between Abisko and Kiruna is only 60 km and during the whole period under review every G.P. occurring at Abisko was found also at Kiruna. From January 1952 both of these stations had Q.R. and it has been established that in each single case the oscillation periods found at the two stations were practically identical. Also the time for the maximum amplitude of each G. P. turned out to be the same for the two stations.

The table shows that the G.P. phenomen is widely extended in northern Scandinavia. 30 out of the 44 G.P.s occurring at Abisko and Kiruna appear simultaneously also at Tromsø or at Sodankylä, and 20 out of 44 are common for all four stations. In 5 of these cases the G.P. phenomenon extended so far south as to Lovö near Stockholm and in 4 cases even to Rude Skov near Copenhagen. But none of these G.P.s occurred at Nurmijärvi, 800 km south of Sodankylä, where a magnetic observatory was established in April 1952.

The oscillation period for the above mentioned G.P.s common to all 4 stations has been determined independently at Tromsø and Sodankylä. As Sodankylä was using 15 mm/hour records until a Q.R. magnetograph was set up in June 1953, and as Tromsø was using 15 mm/hour during the whole period this determination is more inaccurate than at Abisko. Nevertheless the results seem very promising. In 12 cases the periods found at the two stations differ less than 5 secs from that found at Abisko, in one case the difference is between 5 and 10 secs, in 4 cases between 10 and 15 secs, in one case between 15 and 20 secs and in two cases about 25 secs. One of the last mentioned periods was as high as 332 secs. The shortest period found was 74 secs. In 20 out of 30 cases where G.P.s were simultaneous for the three stations Tromsø, Abisko and Kiruna the time for the maximum amplitude fell within the same ten minutes interval.

For the time being Q.R.s are established at Abisko, Kiruna and Sodankylä and the Q.R. at Tromsø will probably be established during the coming summer.

To judge from the results already obtained it may be expected that a further study of the results from the 4 Q.R. stations will give interesting information as to the character of the G.P. phenomenon.

The records from Nurmijärvi show that no perfectly regular

G.P. occurred there during the period April 1952 to December 1953. Forms rather much like G.P.s were found 6 times in May—July 1952 and once in November 1953. Short-living oscillations with a period of about 100 secs were frequently found, often recurring again and again during several hours. The diurnal variation of this type is, however, quite different from that found for ordinary G.P.s.

The Committee has been informed that there is some interest in Iceland for the establishment of a magnetic observatory there, one purpose of which would be the study of G.P.s

The Committee is strongly in favour of a continuation of the study of the Giant Pulsations, also with a view to the interesting results which may be expected from the coming International Geophysical Year. It is felt, however, that on the base already established such a study may very well be carried on within the frame of the IATME Committee on Characterization of Magnetic Disturbances, and if this can be properly arranged there seems to be no absolute necessity for the maintenance of the G.P. Committee as a Special Committee of the Association.

Committee No. 6

Committee on Observatory Publications

Report by E. B. Roberts, Chairman

The Committee has functioned actively, with the following composition:

Dr. Julius Bartels	— Germany
Dr. J. A. Fleming	— U.S.A.
Mr. G. Madill	— Canada
Dr. E. Selzer	— France
Dr. B. Trumpy	— Norway
Dr. J. Veldkamp	— Netherlands
Capt. E. B. Roberts	— U.S.A. (Chairman)

Matters considered by the Committee have been submitted also to some of the officers of the Association and to outside experts.

During 1952, the Committee considered the publication program of the Wingst Observatory. The Director had requested advice as to whether the publication of magnetogram reproductions, following the U.S. example, would be a satisfactory substitute for conventional hourly values. After consideration, the Committee gave Professor Errulat a digest of the opinions received, without specific recommendations upon the original question, but tending to deplore the abandonment of hourly values. The subsequent publication program of the Wingst Observatory was designed, in accordance with the trend of opinions, to include both types of publication. This progressive decision is noted with gratification by the Committee.

The Committee feels that its study of publication procedures should be based upon comprehensive information about existing practices. It, therefore, started its work by circularizing 64 available observatories with a questionnaire on existing practices. The 59 responses contained detailed answers, with many supplementary remarks. This afforded a broad view of existing conditions. A list of observatories and a digest of their responses is appended hereto. In general, it may be said that the level of performance is unexpectedly high.

Subsequent inquiries were made to members of the Committee and others for their views about a desirable publication program. It was asked that consideration be given to the substantial labor involved, to the existing arrears in many observatories, and to the possibility of using labor-saving devices, such as punch-card methods. It was suggested that generally useful details be included but that the observatories be relieved of burdensome details of interest only to occasional users. The resulting recommended schedule is derived from the Committee deliberations in this matter.

The new schedule referred to does not differ vastly from previously existing standards. It will be noted that the last previous formal statement of this matter was published in the Transactions of the Washington Assembly (1939). A slightly modified statement was contained in the Report of this Committee at Oslo (1948) although is was not formally promulgated by the Association. To eliminate uncertainty, the new recommended schedule is placed before the Association as a proposed Resolution sponsored by this Committee. A copy is appended to this Report.

Various suggestions were received relating to an old question of establishing centralized processing and computing agencies. Opinions varied as to the value of such establishments. It is, however, likely that they will find at least some use when their effectiveness is more widely appreciated. Practical difficulties, however, exist with no clear solution in sight. The Committee has arranged to have an informational report presented by a representative of the United States at the Rome Assembly on the experience and benefits realized by the United States in using machine processing methods for the publications of its seven observatories and in the work of magnetic cartography.

The very active work of Committee No. 6 continues to be of sufficient importance to justify continued functioning.

Appendices:
List of Observatories
Digest of Questionnaire Responses
Resolution on Publications Schedule

Committee No. 6
Magnetic Observatories Responding to Questionnaire Inquiry

Observatory	*Country*	*Observatory*	*Country*
Abinger	Great Britain	Lerwick	Great Britain
Abisko	Sweden	Lovö	Sweden
Agincourt	Canada	Macquarie Is.	Australia
Amberley	New Zealand	Manhay-Uccle	Belgium
Baker Lake	Canada	Mauritius	Great Britain
Bangui	Africa	Meanook	Canada
Barrow	Alaska	Memambetsu	Japan
Chambon la Forêt	France	Muntinlupa	Philippine Is.
Cheltenham	United States	M'Bour	F. W. Africa
Coimbra	Portugal	Nantes	France
College	Alaska	Pilar	Argentina
Ebro	Spain	Resolute Bay	Canada
El-Abiod-Siki-Cheikh	Algeria	Rude Skov	Denmark
Elisabethville	Belgian Congo	San Fernando	Spain
Eskdalemuir	Great Britain	San Juan	Puerto Rico
Godhavn	Greenland	San Miguel	Azores
Heard Island	Australia	Sitka	Alaska
Helwan	Egypt	Sodankylä	Finland
Hermanus	Union of South Africa	Tamanrasset	Sahara
Honolulu	Hawaii	Teoloyucan	Mexico
Huancayo	Peru	Thule	Greenland
Istanbul-Kandilli	Turkey	Toledo	Spain
Kakioka	Japan	Toolangi	Australia
Katuura	Japan	Tromsö	Norway
Kerguelen Is.	Australia	Tucson	United States
Kodaikanal	India	Valentia	Ireland
Ksara	Lebanon	Vassouras	Brazil
La Quiaca	Argentina	Watheroo	Australia
Laurie Island	Argentina	Wingst	Germany
		Witteveen	Netherlands

Summary of Questionnaire Responses
to
Observatory Questionnaire 1953

Query in Essence	*Yes*	*No*	*Abstaining or doubtful*	*Remarks*
Do you scale hourly values?	54	1	4	
Are they values of D, H, and Z?	52	2	5	1 obsy. records D only, another D & H only, another D, X Y, and Z.
Are they hourly means?	42	12	5	"No" means instantaneous values scaled.
Are they centered on the half-hour?	37	17	5	17 obsys. read values centered, on whole hour, including 5 that read hourly means.
Does first tabulated value pertain to the first Greenwich hour?	34	16	9	"No" means zone time used. Of the 34 yeses, only 11 come from obsys. situated more than 2 hrs. east or west of the zero meridian.
Are your scalings in mm?	38	16	5	Of the 16 that use direct scalings, 10 read hourly means.
Are scalings reduced to absolute values?	52	1	6	
Do you publish hourly values?	45	11	3	
Are hourly values available?	52	1	6	
Do tabulations give daily means?	50	1	8	
Daily sums of hourly values?	21	25	13	
Do tabulations give monthly means by separate hours?	53	1	5	
Monthly sums by separate hours?	23	25	11	
Are monthly & annual means derived from the scalings?	53	1	5	
Would a computing laboratory be desirable in your view?	25*	21	13	
Would you use services of such a computing laboratory?	14	18	27	

* Includes the seven observatories of the Coast and Geodetic Survey which are already benefiting by a computing service operated at the Washington Office.

Proposed resolution.

Standard Schedule of Magnetic Observatory Publications:

The Association recommends the publication, by magnetic observatories through the media of year books or other publications, of the following, in order of significance:

I. *Of Primary Importance:* —

(a) Hourly values of three elements, with notations regarding interpolated values. If mean values are scaled, they should be centered upon the half-hour.

(b) Yearly and monthly means, at earliest availability.

(c) K-indices, also C-figures if previously reported.

(d) Information bearing on the reliability of the values. This refers, for example, to absolute observations or consequent base-line determinations, scale-value determinations, performance of absolute and variation instruments, orientation and interaction of magnets, temperature coefficients, and calibration of the instruments used for absolute observations.

(e) Reproduction of magnetograms for all days; or failing this, individual daily maxima, minima, and ranges, plus reproductions of selected magnetograms for stormy intervals.

(f) With (a) or separately, daily sums and means, and sums and means by hours for each whole month, and the corresponding means for the selected five quiet and five disturbed days thereof.

(g) The times of sudden commencements of magnetic disturbance, and as far as practicable, of crochets, pulsations, and of similar changes and other remarkable phenomena not followed by magnetic disturbance, together with the amount and movement in each magnetic element recorded.

II. *Desirable Additional Data:* —

(h) Composite daily variation or hour-by-hour departures of the general and selected-day means by months, Lloyd's seasons, and years, including also noncyclic changes as appropriate.

(i) Descriptions of magnetic activity, supplementing (c) and (g) above.

(j) Harmonic analysis of daily variations.

(k) Accounts of equipment and records available, including statements of intervals for which special records were obtained, such as rapid-run magnetograms, rate-of-change records, etc.

Committee No. 7

Committee on Comparisons of Magnetic Standards

Report by V. Laursen, Chairman

During the three years since the Brussels Assembly 1951, the Committee has continued its activity for the purpose of organizing comparisons between the standard values of horizontal force at magnetic observatories by means of QHM-instruments circulated by mail. It is most encouraging to note how the increasing interest in the comparison programme is reflected in the fact that while during the three-year period 1948—51 all the comparisons carried out were more or less arranged on the initiative of the Committee, a good many of the observations made during 1951—54 have been organized at the request of the participating observatories.

UNESCO grants-in-aid have made it possible to acquire some additional QHM's so that in the future comparisons can in most cases be made by means of instruments adjusted approximately for the horizontal field to be measured. Most of the older instruments have deflection angles giving maximum accuracy at Rude Skov and other stations in fairly high latitudes, but already at South European stations the angle becomes too small to give a satisfactory accuracy, unless a torsion of 3π or 4π is used, which means of course a certain complication of the observations. A new set of QHM's, the numbers 228, 229 and 230, has been adjusted just for South European horizontal fields, and these instruments have recently been used for a successful circulation to Coimbra, Ebro and Chambon-la-Forêt.

The following comparisons have been completed during the period 1951—1954:

(a) Comparisons by means of QHM-magnetometers Nos 34 and 50 between the observatories of Rude Skov (Denmark), South Orkneys, Pilar and La Quiaca (Argentina), Huancayo (Peru) and Cheltenham (U.S.A.).

(b) Comparisons by means of QHM-magnetometers Nos 33, 51 and 52 between the observatories of Rude Skov, Ebro (Spain) and Chambon-la-Forêt (France).

(c) Comparisons by means of QHM-magnetometers Nos 132 and 133 (property of the Manhay observatory, Belgium) between the observatories of Manhay, Hermanus (South Africa), Elisabethville (Belgian Congo) and Rude Skov.

(d) Comparisons by means of QHM-magnetometers Nos 90, 91 and 92 between the observatories of Rude Skov, Amberley (New Zealand), Apia (Western Samoa), Toolangi and Watheroo (Australia).

(e) Comparisons by means of QHM-magnetometers Nos 32, 33 and 34 between the observatories of Rude Skov and Fürstenfeldbruck and Wingst (Germany).

(f) Comparisons by means of QHM-magnetometers Nos 5, 7 and 12 between the observatories of Rude Skov and Vassouras (Brazil).

(g) Comparisons by means of QHM-magnetometers Nos 50, 51 and 52 between the observatories of Rude Skov, Kakioka and Memambetsu (Japan) and Cheltenham.

(h) Comparisons by means of QHM-magnetometers Nos 90, 91 and 92 between the observatories of Rude Skov, Niemegk (Germany) and Wingst.

(i) Comparisons by means of QHM-magnetometers Nos 228, 229 and 230 between the observatories of Rude Skov, Coimbra (Portugal), Ebro and Chambon-la-Forêt.

(j) Comparisons by means of QHM-magnetometers Nos 32, 33 and 34 between the observatories of Rude Skov, Pilar and La Quiaca.

The results of the comparison observations have been very satisfactory. The circulation mentioned above under (a) revealed the necessity of determining the induction coefficient for each individual QHM instead of adopting, as it had been done previously, a standard value valid for all instruments made from that special sort of steel. In connection with the comparisons Dr. O. Meyer, Wingst, has drawn attention to the fact that the results obtained by means of a QHM may be seemingly affected by the relative humidity of the surrounding air. This effect is now being studied at Rude Skov, and it has in several cases been possible to confirm — at least qualitatively — the observation made by Dr. Meyer.

The Committee wishes to express its appreciation of the very careful manner in which the instruments have been treated by the observers. Although the QHM's have been travelling a total distance equivalent to several round-the-world trips not a single quartz fibre has been broken during the three years under review. The observations have in all cases been carried out with the utmost care and the results presented in the form recommended by the Committee.

For practical reasons the Rude Skov magnetic observatory has continued to serve as centre for the comparisons, and the installations of the observatory as well as its scientific staff have most generously been placed at the disposal of the Committee for this special work. Under these circumstances and at the present stage of the programme all results are given as differences in gammas between the Rude Skov standard value and the standard value of the observatory where the observations are made. The stability of the Rude Skov standard, based on the Bamberg theodolite No. 1973, becomes therefore a matter of obvious interest to all the observatories which through the QHM comparisons have got their H-standard linked up with that of Rude Skov. It is thought that the stability is fairly well illustrated by the following summary of the results of all the comparisons which have so far been carried out between Rude Skov and Cheltenham by means of QHM's. The Cheltenham standard value is based on Sine Galvanometer No. 1.

1948, April, (QHM 33, 51, 52)	Rude Skov — Cheltenham =	3.0 γ
1949, Dec., (QHM 90, 91, 92)	Rude Skov — Cheltenham =	—0.6 γ
1949, Dec., (QHM 29, 58)	Rude Skov — Cheltenham =	3.1 γ
1951, March, (QHM 34, 50)	Rude Skov — Cheltenham =	4.6 γ
1953, May—Sept., (QHM 50, 51, 52)	Rude Skov — Cheltenham =	2.5 γ

The detailed results of all the comparisons mentioned above under (a)—(j) are given below:

Pilar:

1950, February—July:	QHM 34 — Pilar =	3,4 γ
	QHM 50 — Pilar =	1,4 γ
	Mean	2,4 γ

South Orkneys:

1950, February:	QHM 34 — South Orkneys =	—24,4 γ
	QHM 50 — South Orkneys =	—25,0 γ
	Mean	—24,7 γ

La Quiaca:

(Standard values based on the Dover—Kew magnetometer No. 138)

1950, June—July:	QHM 34 — La Quiaca =	—21,0 γ
	QHM 50 — La Quiaca =	—23,9 γ
	Mean	—22,5 γ

Huancayo:

(Standard values based on C.I.W. magnetometer No. 10)

1951, February:	QHM 34 — Huancayo =	1,3 γ
	QHM 50 — Huancayo =	—0,9 γ
	Mean	0,2 γ

Cheltenham:
1951, March:

QHM 34 — Cheltenham = 4,1 γ
QHM 50 — Cheltenham = 5,1 γ

Mean 4,6 γ

Ebro:
1951, January:

QHM 33 — Ebro = —1,8 γ
QHM 51 — Ebro = —4,3 γ
QHM 52 — Ebro = —7,2 γ

Mean —4,4 γ

Chambon-la-Forêt:
(Standard values based on magnetometer Chasselon No. 192).
1951, March:

QHM 33 — Chambon-la-Forêt = —19,2 γ
QHM 51 — Chambon-la-Forêt = —18,0 γ
QHM 52 — Chambon-la-Forêt = —19,4 γ

Mean —18,9 γ

Manhay:
1951, July—Sept.:

QHM 132, 133
Rude Skov — Manhay = —1,9 γ

Hermanus:
1951, March:

QHM 132, 133
Rude Skov — Hermanus = 0,4 γ

Elisabethville:
1951, April:

QHM 132, 133
Rude Skov — Elisabethville = 2,3 γ

Amberley:
1952, February:

QHM 90 — Amberley = —0,4 γ
QHM 91 — Amberley = —1,9 γ
QHM 92 — Amberley = —2,8 γ

Mean —1,7 γ

1952, July:

QHM 90 — Amberley = —3,1 γ
QHM 91 — Amberley = —2,2 γ
QHM 92 — Amberley = —2,7 γ

Mean —2,7 γ

Apia:
1952, June:

QHM 90 — Apia = —6,4 γ
QHM 91 — Apia = —7,0 γ
QHM 92 — Apia = —10,3 γ

Mean —7,9 γ

Toolangi:
1952, August:

QHM 90 — Toolangi = 6,8 γ
QHM 91 — Toolangi = 8,5 γ
QHM 92 — Toolangi = 8,7 γ
Mean 8,0 γ

Watheroo:
1952, November:

QHM 90 — Watheroo = 13,7 γ
QHM 91 — Watheroo = 16,1 γ
QHM 92 — Watheroo = 15,2 γ
Mean 15,0 γ

Fürstenfeldbruck:
1952, June—July:

QHM 32 — Fürstenfeldbruck = —5,8 γ
QHM 33 — Fürstenfeldbruck = —6,0 γ
QHM 34 — Fürstenfeldbruck = —5,5 γ
Mean —5,8 γ

Wingst:
1952, July—Sept.:

QHM 32 — Wingst = —4,0 γ
QHM 33 — Wingst = —5,5 γ
QHM 34 — Wingst = —4,5 γ
Mean —4,7 γ

Vassouras:
1951, December —1952, May:

QHM 5 — Vassouras = 17,8 γ
QHM 7 — Vassouras = 18,0 γ
QHM 12 — Vassouras = 15,6 γ
Mean 17,1 γ

(Pending the determination of a pier difference at the Vassouras observatory the values must be considered provisional).

Kakioka:
1952, December —1953, March:

QHM 50 — Kakioka = —8,7 γ
QHM 51 — Kakioka = —8,8 γ
QHM 52 — Kakioka = —8,8 γ
Mean —8,8 γ

Memambetsu:
1953, February:

QHM 50 — Memambetsu = —14,5 γ
QHM 51 — Memambetsu = —22,8 γ
Mean —18,6 γ

Cheltenham:
1953, May—Sept.:

QHM 50 — Cheltenham = 2,9 γ
QHM 51 — Cheltenham = 2,6 γ
QHM 52 — Cheltenham = 1,9 γ
Mean 2,5 γ

Niemegk:

1953, November —1954, February:	QHM 90 — Niemegk = 6,0 γ
	QHM 91 — Niemegk = 6,1 γ
	QHM 92 — Niemegk = 4,8 γ
	Mean 5,6 γ

Wingst:

1954, January:	QHM 90 — Wingst = —5,1 γ
	QHM 91 — Wingst = —5,7 γ
	Mean —5,4 γ

Coimbra:

1953, September:	QHM 228 — Coimbra = —7,0 γ
	QHM 229 — Coimbra = —5,0 γ
	QHM 230 — Coimbra = —4,3 γ
	Mean —5,4 γ

Ebro:

1954, January:	QHM 228 — Ebro = 8,4 γ
	QHM 229 — Ebro = 9,0 γ
	QHM 230 — Ebro = 9,0 γ
	Mean 8,8 γ

Chambon-la-Forêt:

1954, April:	QHM 228 — Chambon-la-Forêt = —29,6 γ
	QHM 229 — Chambon-la-Forêt = —29,5 γ
	QHM 230 — Chambon-la-Forêt = —29,4 γ
	Mean —29,5 γ

Pilar:

1954, May:	QHM 32 — Pilar = 0,4 γ
	QHM 33 — Pilar = —1,1 γ
	QHM 34 — Pilar = —2,2 γ
	Mean —1,0 γ

La Quiaca:

1954, May:	QHM 32 — La Quiaca = —41,9 γ
	QHM 33 — La Quiaca = —37,4 γ
	QHM 33 — La Quiaca = —38,2 γ
	Mean —39,2 γ

Committee No. 8

Committee on Observational Technique

Report by E. Thellier, Chairman, and J. Olsen, Secretary

Créé à l'Assemblée de Washington en 1939, le "Committee on Observational Technique" a été maintenu aux Assemblées d'Oslo et de Bruxelles. Sa mission est de renseigner et de conseiller les responsables et les exécutants des mesures magnétiques tant sur le choix des méthodes et des appareils que sur les soins à apporter dans le détail de ces mesures.

Il apparaît de plus en plus aux membres du Comité qu'ils doivent travailler en centrant leur attention sur un certain nombre de questions urgentes et en provoquant à leur sujet un examen étendu. Pour chacune, après discussion au sein du Comité, une enquête générale doit être ouverte auprès de tous les services intéressés et un rapport détaillé établi et largement distribué ; les observations provoquées par cette diffusion pouvant donner lieu à un rapport additif. Ce programme a été suivi en ce qui concerne les mesures sur les variations très rapides, ou pulsations, du champ magnétique terrestre et il est amorcé pour d'autres questions.

1°. — *Enquête sur les procédés d'enregistrement des pulsations.*

Le principe de cette enquête a été posé par le Comité pour l'Année Géophysique Internationale 1957—1958 lors de sa réunion de Bruxelles (1953) et une lettre circulaire du 28 Juillet 1953 a été adressée à tous les services géophysiques par le Secrétaire de l'I.A.T.M.E. Cette circulaire contenait un questionnaire sur les dispositifs actuellement employés pour l'enregistrement des variations magnétiques rapides et elle demandait d'adresser les réponses au Président de notre Comité. L'enquête a eu un succès remarquable : les réponses sont venues rapides, nombreuses, certaines très documentées. Partant de là, une étude détaillée a été entreprise pour tenter de faire le point des méthodes possibles, de leurs qualités, de leur état actuel d'utilisation mondiale ; elle constitue le Rapport Technique N° 1 du Comité, écrit volontairement de manière à rester accessible aux chercheurs qui ne sont pas des physiciens confirmés. Le Comité espère profiter des réactions que ce rapport pourra provoquer pour en tirer des recommandations de standardisation sur l'équipement des observatoires qui vont se trouver engagés dans l'étude des pulsations durant l'Année Géophysique (see p. 357).

2°. — *Amélioration des observations magnétiques dans les régions polaires.*

Dans les régions polaires, on se trouve dans des conditions très spéciales au point de vue des observations magnétiques, d'où résultent plusieurs inconvénients graves pour la détermination du champ horizontal.

Une première série d'inconvénients vient de l'extrême faiblesse de ce champ horizontal lorsqu'on travaille, comme on le fait généralement, avec des variomètres à aimant, D-mètre et H-mètre, et, précisons bien, lorsqu'on extrait des magnétogrammes les valeurs de D et H.

— D'une part, on sait que la théorie des variomètres de D et H suppose plusieurs conditions qui sont satisfaites suffisamment bien hors des régions polaires : faibles variations de D, faibles variations relatives de H ; mais dans les régions polaires magnétiques, ces approximations ne valent plus du tout : le D-mètre, nécessairement plus ou moins insensibilisé, a une sensibilité (en déclinaison) qui varie fortement avec H ; l'aimant du H-mètre n'est plus approximativement perpendiculaire au méridien magnétique à tout instant (non pas à cause des rotations de l'aimant qui restent faibles, mais à cause des rotations fortes de H). Au total, même à température constante, les lignes de base des variomètres de D et de H ne correspondent plus à des valeurs définies de ces éléments et les sensibilités ne sont plus constantes ; il en résulte, ou bien que l'on commet des erreurs fortes en dépouillant les magnétogrammes comme on le fait habituellement, ou bien qu'il faut se livrer à un travail pénible et presque inextricable pour tenir compte des valeurs de H dans le dépouillement de l'enregistrement du D-mètre et des valeurs de D dans celui du H-mètre.

— D'autre part, hors des régions polaires, on calcule le champ moyen pendant un intervalle de temps donné en définissant ce champ par la moyenne des déclinaisons et la moyenne des valeurs de H observées pendant ce temps. Il y a là aussi une approximation qui n'est plus valable si la déclinaison varie beaucoup.

— D'autre part, enfin, s'il existe des anomalies magnétiques appréciables entre le pilier des mesures absolues et celui des variomètres, il peut en résulter, à cause toujours de la faiblesse de H, des différences importantes entre les valeurs de D et de H aux deux endroits ; c'est là une situation fréquente dans les stations polaires. Il n'est plus alors correct d'admettre que les variations de D et de H sont les mêmes aux deux endroits (ce qui serait au contraire exact pour des composantes suivant des directions fixes) et la détermination des valeurs correspondant aux lignes de base s'en trouve encore faussée.

Ainsi on se trouve dans une situation difficile en ce qui concerne le champ horizontal et d'autant plus que la station est plus proche du pôle magnétique d'inclinaison. Or, il est un moyen simple d'éviter pratiquement tous ces inconvénients, c'est d'enregistrer les variations de deux composantes suivant des axes horizontaux rectangulaires fixes, c'est-à-dire de travailler non en coordonnées polaires comme on le fait avec D et H, mais en coordonnées rectangulaires. Les variomètres sont alors identiques à des H-mètres dans lesquels les aimants sont amenés sensiblement perpendiculaires à chacune des deux directions choisies. Il faut remarquer ici qu'on peut considérer l'ensemble habituel comprenant un D-mètre et un H-mètre comme un dispositif enregistrant deux composantes du champ horizontal, suivant une direction X_m qui est sensiblement celle du champ moyen et suivant la direction perpendiculaire Y_m; on pourrait déterminer les sensibilités correspondantes et dépouiller les enregistrements, non en valeurs de D et H, mais en composantes X_m et Y_m. Cependant, de tels axes sont en fait des plus arbitraires ; ils sont mal définis lorsqu'on s'installe en une station nouvelle, et si on veut leur garder leur qualité d'être liés au champ moyen il faudrait les changer d'année en année. Il est beaucoup plus logique et plus simple de choisir des directions fixes de caractère non local et non fonction du temps. L'idée la plus naturelle est d'adopter les composantes géographiques X et Y; mais les études magnétiques dans les régions polaires portant de plus en plus sur les composantes géomagnétiques X′ et Y′ (Carnegie Institution, publications 578 et 580, par exemple) il est sans doute plus intéressant de choisir ces axes de façon que les tableaux de résultats correspondent directement à X′ et Y′. Encore une fois le choix des axes est sans importance, l'essentiel étant d'enregistrer des composantes suivant des directions fixes. Après discussion, le Comité pense unanimement que ce procédé doit être recommandé. Le problème est évidemment résolu d'avance pour la composante verticale qui est d'ailleurs toujours forte dans les régions polaires. On remarquera encore que l'abandon des enregistrements de D et de H au profit de deux composantes de directions fixes pourrait être généralisé à tout le globe ; il n'y aurait plus ainsi à changer progressivement l'orientation des appareils à cause de la variation séculaire. Bien entendu, le contrôle de l'orientement correct des aimants resterait à faire de temps en temps.

Une deuxième série d'inconvénients, atteignant d'ailleurs les trois composantes, est relative à la détermination des lignes de base. A cause de la rapidité et de l'ampleur des variations, surtout dans la zône aurorale, cette détermination demande des mesures absolues très brèves ; d'autre part ces mesures doivent être synchrones pour les deux composantes définissant le champ horizontal lorsqu'on ne mesure pas directement les composantes enregistrées, par exemple si l'on enregistre X et Y et mesure D et H.

A priori, il semble que les appareils électriques à compensation (bobine de compensation et appareil de zéro), utilisant des sondes à saturation, devraient bien convenir aux mesures polaires. En effet, les déterminations peuvent être très brèves et, comme il est facile de mesurer une composante quelconque avec ces appareils, on peut toujours faire porter les mesures directement sur les composantes enregistrées, y compris la composante Z. Au contraire si l'on utilise le Q.H.M. comme on le fait généralement, il faut faire des déterminations synchrones de D et H et la mesure peut paraître trop lente ; de plus il faut un autre appareil pour mesurer Z. Cependant, considérant la difficulté d'entretenir en bon état, dans les régions polaires, l'ensemble de l'appareil électrique et surtout son potentiomètre, le Comité estime que la mesure au Q.H.M., avec mesure synchrone de D et H au moyen de deux appareils, reste la plus simple et la plus sûre pour le champ horizontal ; il recommande cette mesure partout où elle est possible.

En conclusion, le Comité aimerait que l'ensemble de la question des mesures magnétiques polaires soit discuté à l'Assemblée de Rome et il est prêt à ouvrir ensuite une enquête à ce sujet auprès de tous les services magnétiques.

3°. — *Questions relatives aux matériaux constituant les appareils magnétiques.*

Depuis sa création, le Comité, dans chacun de ses rapports, a fait d'importantes recommandations à ce sujet. Les matériaux entrant dans la constitution des appareils magnétiques se classent évidemment en 3 groupes : les matériaux amagnétiques, les ferromagnétiques à grande perméabilité (noyaux), les ferromagnétiques à grand champ coercitif (aimants).

Pour les matériaux amagnétiques, le Comité actuel ajoute aux rapports antérieurs les deux remarques suivantes :

— S'il est intéressant de rechercher des matériaux vraiment amagnétiques (susceptibilités de l'ordre de 10^{-6} u.e.m.) pour les pièces proches des parties actives de l'appareil, sur lesquelles agit le champ à mesurer, il est inutile de rester aussi sévère pour des pièces plus éloignées. Par exemple, l'emploi d'un bronze au glucinium dont la susceptibilité serait de quelques dizaines d'unités 10^{-6} (on peut obtenir beaucoup mieux d'ailleurs) est tout à fait admissible dans l'embase de la partie théodolite des appareils pour constituer des paliers ou des billes de roulement.

— Lorsqu'on effectue au moyen d'un magnétomètre ou d'un Q.H.M. le contrôle des qualités amagnétiques d'une partie métallique d'appareil, il faut se souvenir que, dans la pièce en mouvement dans le champ terrestre, il se développe des courants de Foucault capables de produire d'importantes déviations transitoires du magnétomètre.

Pour les matériaux à haute perméabilité dont l'usage se répand dans les appareils géomagnétiques, une enquête inventaire sera ouverte. Le Comité fait remarquer dès maintenant que ce n'est pas tant de très fortes valeurs de la perméabilité vraie qu'il faut rechercher, la perméabilité effective des noyaux droits généralement utilisés ne dépendant presque que de la géométrie de ces noyaux, mais de bonnes qualités mécaniques et une fidélité aussi grande que possible.

Pour les aciers à aimants une enquête inventaire est en cours portant surtout sur des aspects généralement négligés dans les études habituelles parce que sans intérêt industriel. D'une part sont étudiés des alliages comme le Pt-Fe ou Pt-Co, dont le prix n'est pas prohibitif pour les minuscules aimants des variomètres, ou les Mn-Al-Ag. D'autre part l'accent est mis sur la recherche de faibles coefficients de température des moments permanents, de faibles susceptibilités (coefficient d'induction), de grande stabilité des moments et des procédés de vieillissement l'assurant au mieux.

4°. — *Amélioration des appareils de mesure.*

Le Comité a discuté de changements possibles sur le Q.H.M. permettant d'en faire un appareil mesurant D avec précision. Il espère provoquer des essais prochains dans ce sens.

Le but de nos Comités spécialisés est de susciter des améliorations dans les recherches, de coordonner les efforts dans les observations et d'aider à standardiser les méthodes sur l'ensemble du Globe. Or, l'équipement des observatoires est en continuel devenir, l'homogénéité du réseau magnétique mondial est encore très imparfaite : il semble que le "Committee on Observational Technique" a devant lui une tâche quasi permanente et importante, à la fois par son ampleur et par son intérêt. Ce Comité nous paraît devoir être maintenu et constituer un des organismes permanents de l'I.A.T.M.E. à condition, évidemment, qu'il soit actif et que tous les chefs de services magnétiques reconnaissant son utilité l'aident dans ses enquêtes et dans l'application de ses recommandations.

Committee No. 9

Committee on Characterization of Magnetic Disturbances (C.C.M.D.)

Report by J. Bartels, Chairman.

Members: J. Egedal, Copenhagen, Denmark
H. F. Johnston, Washington, USA
Sir Harold Spencer Jones, Great Britain
E. Lahaye, Brussels, Belgium
E. Sucksdorff, Helsinki, Finland
J. Veldkamp, De Bilt, Holland
J. Bartels, Göttingen, Germany (Chairman)

Abstract: It is described how the instructions given to the Committee at the Brussels Assembly 1951 were carried out. In addition to the current work, Kp-indices were derived for the three years 1937 to 1939, so that the Kp-series, including 1932/33, is now running into its 19th year. The system of three-hour amplitudes, or ranges, ap is explained with its daily average, Ap, and its local analogues, ak and Ak. The correlation between Kp and K, which is the basis of the conversion tables, may also serve to study the distribution of geomagnetic activity at various levels, throughout the day as well as geographically. Samples are given of such results from extended computations for 31 stations with long series of K, showing the great differences of sensitivity to solar corpuscular radiation varying with day-time and location. Proposals are made for the future work of the Committee.

1. Brussels 1951. The Committee's work was thoroughly discussed at an open meeting held during the Brussels Assembly, on 27 August 1951. Some criticism was expressed showing an aversion against measures of magnetic activity which are quasi-logarithmic, such as the K-index; or against the daily Cp-character (see IATME Bulletin No. 12e, for 1950) proposed to standardize and to continue the old series of the international character-figure, Ci. The principle of the Kp-index, however, was adopted, but is was suggested to broaden its basis by standardizing the K-indices of more observatories beyond the original 11 stations.

Considering that the success of the Committee's work depends on the collaboration of the observatories, the introduction of any schemes that have not the whole-hearted assent of the majority should be avoided. The Committee dropped therefore its proposal for the international adoption of the Cp-character as a successor to Ci, and asked the IATME for the following *instructions* (given by the Assembly on 28 August 1951):

a) To continue the present Ci-scheme of daily characters for 3 years.

b) To introduce, for a trial period, a system of describing the level of magnetic activity for daily intervals by equivalent ranges, in particular by the planetary range Ap for the earth as a whole, and to derive a long series for Ap on the basis of older data (please note the misprint — twice saying Kp instead of the correct Ap — in the IATME Preliminary Trans. Brussels Meeting p. 15);

c) To broaden the possible basis of the Kp-index by calculating conversion tables to standardize K into Ks for as many observatories as possible;

d) To invite the cooperation of observatories in lower latitudes in developing schemes to derive, from magnetic time-variations, current measures of solar wave-radiation, W, and the intensity of the equatorial ring-current, ERC;

e) To provide for the proper functioning of the K-scheme.

These instructions were followed as set forth in the following sections.

2. *The equivalent amplitudes.* The meaning of the equivalent range (or "*amplitude*", to explain the use of the letter a) Ap will become clearer if the "weights" g, introduced in Bulletin No. 12e, p. 111, are re-named. They will be called, henceforth, "three-hourly equivalent planetary amplitudes", ap, coordinated to each planetary three-hour-range index Kp by the following table:

Table 1: Relation Kp . . . ap

Kp =	0_0	0+	1-	1_0	1+	2-	2_0	2+	3-	3_0	3+	4-	4_0	4+
ap =	0	2	3	4	5	6	7	9	12	15	18	22	27	32
Kp =	5-	5_0	5+	6-	6_0	6+	7-	7_0	7+	8-	8_0	8+	9-	9_0
ap =	39	48	56	67	80	94	111	132	154	179	207	236	300	400

At a standard station, with 500 γ as lower limit for K = 9, the average range of the most disturbed of the three force components, in three-hour-intervals with Kp, can be taken as 2.ap; for instance, for Kp = 5_o, as 96 γ. This is meant if ap is described as an equivalent range expressed in the unit 2 γ.

Since "amplitude" is the same word in all languages, it might be preferable to talk of ap and Ap as of *amplitudes,* rather than of ranges.

Ap is simply the daily average for the eight values ap per day. A complete, though unnecessarily long term for Ap would be "equivalent planetary daily average three-hour amplitude". As explained for ap, Ap may be conceived as expressed in the unit 2 γ, for a standard station.

Averages of ap may, of course, be computed for any number of three-hour-intervals, for instance, for months, years, the five quiet days per month, etc.; the significance of these averages is subject to the limitations explained in IATME Bull. No. 12e (for 1950), p. 135.

Tables with daily values Ap for 1932/33 and 1940/51 have been published in Bull. No. 12f (for 1951), pp. 90—97. Ap. for 1937/39, and for 1952 will follow in Bull. 12g (for 1952). Current monthly tables for Ap are furnished with the Kp-diagrams distributed from Göttingen about 3 weeks after the end of each month (§ 5). Bulletin No. 12g, for 1952, will give, for the first time, a table showing, for each day, the eight Kp-indices, the eight ap, and Ap and Cp. The character Cp, not adopted internationally, is given merely to check the standard of Ci, and to allow comparisons with the old series of Ci.

In the 18 years for which Ap is available, it ranged between 0 and 230 (1941 Sept. 18); if intervals of 24 hours not necessarily divided by Greenwich midnight are also considered, the quietest interval, with Ap = 0, began 1944 Nov. 24d 09 UT, and the most disturbed day began 1941 Sept. 18d 09 UT, with Ap = 350.

Every observatory may derive, from its own K-indices, a *local analogon* to ap or Ap, as follows: Each K-index is replaced by a local equivalent three-hourly amplitude, ak, as follows:

Table 2: Relation K . . . ak

K =	0	1	2	3	4	5	6	7	8	9
ak =	0	3	7	15	27	48	80	140	240	400

In order to express ak in gammas, these values must be multiplied by a factor f depending on the lower limit for K = 9 at that station; f is obtained by dividing that limit by 250. For a standard station, for which the lower limit for K = 9 is 500 γ, f = 2, just as for ap (see above). For Sodankylä, with 1500 γ as lower limit for K = 9, the factor f is 6, so that, for K = 3, the equivalent amplitude is 90 γ: In other words, ak for Sodankylä corresponding to Table 2 expresses equivalent amplitudes in the unit 6 γ.

For days or other combinations of three-hour-intervals, the average of the ak, called Ak, is the local equivalent to Ap.

For characterization of days, the daily Ap (planetary) or Ak (local) is recommended in preference to the sum of the indices Kp or K, for reasons given in Note 1, Bull. No. 12e (for 1950), p. 130.

For those years prior to 1937 for which Kp and Ap are not yet available, an approximate value for Ap may be derived from the international character figure Ci according to the following table (derived from Bull. No. 12e, p. 111):

Table 3. — Approximate relation Ci . . . Ap

Ci =	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
Ap =	2	4	5	6	8	9	11	12	14	16	19
Ci =		1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0
Ap =		22	26	31	37	44	52	63	80	110	160

3. *Relationships between K and Kp.* As explained in Bull. No. 12b (for 1948), Appendix B, Kp is the average of the standardized indices, Ks, for the original 11 Kp-observatories: Lerwick, Meanook, Sitka, Eskdalemuir, Rude Skov, Agincourt, Wingst, Witteveen, Abinger, Cheltenham, Amberley. These are situated between about 50 end 63° geomagnetic latitude.

When in 1952, Kp-indices for 1937—1939 could be derived, it appeared that no K-indices for Rude Skov for those years would be forthcoming. Instead, Lovö, which had furnished a series of K-indices going back to 1930, offered itself, and conversion tables were prepared. With these tables available, since the beginning of 1953, Lovö and Rude Skov have been used together for the computation of Kp; the average Ks for the two stations is introduced with the weight of one station only. The change against the old standard is hardly perceptible, because the Ks for the two stations differ very little.

The southern hemisphere is, in Kp, represented by Amberley only, in geomagnetic latitude 48°. With the start of the two Australian-operated observatories on the sub-Antarctic islands Macquarie Island and Heard Island, both in 61° geomagnetic

Table 4

Macquarie Island, 1952 and 1953, four equinoctial months, MASO. Correlation tables Kp ... K, giving the numbers of three-hour-intervals observed for each combination of the three-hour-range indices, planetary Kp and local K, for the two intervals 00 .. 03 UT and 12 ... 15 UT. 00 UT = 10.6 local time for Macquarie Island. — Lower limit for K = 9 is 1500 γ.

Interval 00 .. 03 Univ. Time, 10.6 ... 13.6 Local Mean Time

K=	0	1	2	3	4	5	6	7	8	Sum
Kp=0_0	1	4	1	.	.	.	.	.	.	6
0+	4	1	1	.	.	.	.	.	.	6
1-	5	6	.	.	.	.	.	.	.	11
1_0	.	5	.	.	.	.	.	.	.	5
1+	1	12	1	.	.	.	.	.	.	14
2-	1	6	1	1	.	.	.	.	.	9
2_0	1	7	5	.	.	.	.	.	.	13
2+	.	8	6	1	.	.	.	.	.	15
3-	2	4	7	3	.	.	.	.	.	16
3_0	1	4	9	2	.	.	.	.	.	16
3+	.	2	8	4	.	.	.	.	.	14
4-	.	.	5	11	.	.	.	.	.	16
4_0	1	1	4	9	.	.	.	.	.	15
4+	.	.	.	4	3	1	.	.	.	8
5-	.	.	1	2	7	1	.	.	.	11
5_0	.	.		2	4	1	.	.	.	7
5+		.	.	1	3	.	.	.	.	4
6-	.	.	.	.	3	1	.	.	.	4
6_0	.	.	.	.	2	1	3	.	.	6
6+	.	.	.		1	1	1	.	.	3
7-	.	.	.	.	.	3	.	.	.	3
7_0	.	.	.		.	.	.	.	.	.
7+	.	.	.	.	.	1	1	.	.	2
8-	.	.	.	.	.	.	.	.	.	.
8_0	.	.	.		.	.	.	.	.	.
8+	.	.	.	.	.	.	.	.	.	.
Sum	17	60	49	40	23	10	5	.	.	204

Interval 12 ... 15 Univ. Time, 22.6 ... 1.6 Local Mean Time

K=	0	1	2	3	4	5	6	7	8	Sum
Kp=0_0	.	.	1	.	.	.		.	.	1
0+	3	4	.	.	.	.		.	.	7
1-	.	5	1	2	.	.		.	.	8
1_0	.	6	4	3	1	.		.	.	14
1+	1	2	5	4	.	.		.	.	12
2-	.	5	4	5	1	2	.	.	.	17
2_0	.	1	2	3	6	3	1	.	.	16
2+	.	2	1	6	7	3	.	.		19
3-	.	1	.	5	3	5	3	.		17
3_0	.	.	.	2	2	8	9	1	.	22
3+	.	.	.	.	3	5	5	.	.	13
4-	.	.	.	.	.	6	6	2	.	14
4_0	.	.	.	.	.	3	11	1	.	15
4+	.	.	.	.	.	.	4	4	.	8
5-	.	.	.	.	.	.	2	3	.	5
5_0	.	.	.	.	.	.	1	2	.	3
5+	.	.	.	.	.	.	4	2	1	7
6-	.	.	.	.	.	.	.	1	.	1
6_0	.	.	.	.	.	.	.	1	1	2
6+	.	.	.	.	.	.	.	.	1	1
7-	.	.	.	.	.	.	.	.	.	.
7_0	.	.	.	.	.	.	.	.	.	.
7+	.	.	.	.	.	.	.	.	.	.
8-	.	.	.	.	.	.	.	.	.	.
8_0	.	.	.	.	.	.	.	.	.	.
8+	.	.	.	.	.	.	.	1	.	1
Sum	4	26	18	30	23	35	46	18	3	203

latitude, the opportunity has come for a better representation of southern hemisphere conditions. Although the two available years with K-indices for MI and HI, 1952/53, are not yet sufficient to yield reliable conversion tables, especially for the higher degrees of activity, a few samples on the relations betweens K and Kp may be of interest:

Table 4 (on page 315) shows the relation between the K-index as reported by Macquarie Island, and the simultaneous Kp-index, in the equinoctial months March, April, September, October, 1952/53, by the number of three-hour-intervals having the indicated combinations Kp . . . K. The correlation table at the left is for the three-hour-interval around local noon, that at the right for the interval around local midnight. It is clear at once that, around local midnight, MI reacts much more to solar corpuscular radiation than around noon: for instance, at a planetary level of activity expressed by Kp = 3_o, the typical K-index at Macquarie Island is K = 2 around noon, but K = 5 or 6 around midnight. Expressed in ranges, the level Kp = 3_o yields, at MI, at noon, ranges around 40γ only, but, at midnight, around 350 γ. Another indication of the great systematic change in "sensitivity" of MI in the course of a day is the result that, around noon, no index K = 7 or higher has been assigned in the two years, while, around midnight, about one interval out of every ten has had K = 7 or 8. — It should, however, be remembered that even at a time of day that is usually very inactive, there may be rare occasions of K = 9, perhaps once in 50 years (see Frequency table for Potsdam, Bull. No. 12b, p. 96, month April, interval 06 . . . . 09 UT, the K = 9 that occurred on 1938, April 16!).

Table 4 is a sample of hundreds of similar tables evaluated, and ready for publication, for all stations with long series of K-indices.

In the evaluation of correlation tables like Table 4, the next step is shown in Table 5 (page 317). In Table 4, left, there are, in the noon-interval, 5 observed intervals with Kp = 4^-, K = 2, and 11 intervals with Kp = 4^-, K = 3. Applying the equivalent amplitudes (from Table 2) ak = 7 and 15, and the factor f = 6 applicable for the scale used at MI, this yields $(5 \times 7 + 11 \times 15)$ times 6/16, or a = 75 γ as the average local amplitude for the level Kp = 4^- in the interval 00 . . . 03 UT. That value is entered in its proper place in Table 5, as well as other values which could be calculated with reasonable certainty, that is, wherever enough intervals with each degree of Kp had been observed, namely, from about 1_o to 5^+. By combining the three thirds of each Kp-degree (e.g., Kp = 2^-, 2_o, 2^+ into a common Kp =2), the last six lines of Table 5 were obtained. At the right of Table 5, the average for all eight three-hour-intervals are given, and the ratios r of the highest and lowest ranges for each value of Kp.

Table 5 contains quantitative information about the geographical and time-distribution of the effects of solar particle radiation on geomagnetic activity, material which could be assembled for the first time by means of the Kp- and K-indices.

Similar tables, based on much longer series of available K-indices, have been computed for 31 stations. A sample is given in Table 6, which shows the average three-hour-amplitudes a, in γ, for the activity level Kp = 4_0 around the equinoxes (see page 318). The stations are arranged according to geomagnetic latitude, but it is clear (for instance, in the case of the two sub-Antarctic stations at the end of the table) that geomagnetic latitude is certainly not the only governing factor. It may be that a few discrepancies will eventually be cleared up as due to a local conception of measuring K not quite agreeing with the standard practice; but, on the whole, the table gives a clear and striking picture.

A few features in Table 6 may be mentioned: At polar stations, the "sensitivity" to solar corpuscle radiation changes considerably in the course of the day, as indicated in the high ratios r,

Table 5

Macquarie Island, 1952 and 1953, four equinoctial months, MASO. Average local amplitudes a, in gammas, for each degree of Kp from 1_0 to 5+, and for each eighth of the day, intervals 00 . . . 03UT etc. (00 UT = 10.6 local time). Mean = Average for the day; r = ratio of highest to lowest value in the line.

Kp	00...03	...06	...09	...12	...15	...18	...21	...24	Mean	r
									γ	
1_0	18	19	12	23	50	26	16	13	22	
1+	19	28	13	51	37	34	16	13	26	
2−	26	38	34	121	85	44	25	20	49	
2_0	26	37	54	112	142	81	24	20	62	
2+	32	50	65	175	138	91	55	22	79	
3−	40	62	75	220	225	108	59	29	102	
3_0	40	74	135	337	362	150	46	47	149	
3+	52	85	127	377	331	274	59	50	170	
4−	75	119	175	327	449	341	127	68	210	
4_0	67	139	235	490	466	310	117	80	238	
4+	142	239	517	680	660	408	224	106	372	
5−	149	242	406	631	696	644	198	99	383	
5_0	160	238	513	660	720	628	412	119	431	
5+	144	284	340	760	720	514	337	159	407	
Averages (for Kp=1−, 1_0, 1+ taken together as Kp=1, etc.)										
										r
1	15	23	14	29	42	26	13	12	22	3.5
2	28	42	51	136	122	72	35	21	63	6.5
3	44	74	112	311	306	177	55	42	140	7.4
4	95	166	309	499	525	353	156	85	273	6.2
5	151	255	420	684	712	595	316	126	407	5.7
6	282	366	544	1008	1140	939	453	194	616	5.9

up to 5 or 6. Thus, from 9 . . . 12 UT, Lerwick is less disturbed than Abinger, 8.5° further south, from 18 . . . 21 UT. — Stations in lower latitudes have small average amplitudes, and small changes in the course of the day (ratios r less than 2). Since, near the equator, Z rarely contributes to K, one may infer that, at the

Table 6

Average three-hour ranges, in gammas for the planetary activity level $Kp = 4_0$, for 31 stations, around the equinoxes (four months group MASO). — The first column gives the geomagnetic latitude, the second column gives the local time of Greenwich midnight; then follow the eight average ranges for the three-hour-intervals 00 ... 03, 03 ... 06, ..., 21 ... 24 UT, and their mean for the day. The last columns give the ratio r of the highest to the lowest of the eight ranges, and, finally, the estimated local time of the highest range. For Macquarie Island, and for Heard Island, the average ranges for Kp = 4-, 4_0, and 4+ combined are given

	Geo-magn. latit.	00 UT at	UT 00...03	...06	...09	...12	...15	...18	...21	..24	Mean	r	t max.
	°	h									γ		h
Tromsö	+67.1	01.3	403	275	160	154	214	285	420	486	300	3.2	23.8
College	+64.5	14.1	163	190	418	710	600	445	200	132	357	5.4	1.1
Sodankylä	+63.8	1.8	326	127	88	134	182	229	385	450	240	5.1	0.0
Lerwick	+62.5	23.9	126	77	62	55	73	93	117	139	93	2.5	22.9
Dombås	+62.3	0.6	116	59	40	51	76	93	112	135	85	3.4	23.5
Meanook	+61.8	16.4	131	187	404	410	269	132	79	99	214	5.2	1.5
Sitka	+60.0	15.0	62	92	163	251	186	102	59	51	121	4.9	1.2
Eskdalemuir	+58.5	23.8	59	44	46	46	62	71	76	75	60	1.7	20.5
Lovö	+58.1	1.2	116	82	68	92	116	148	164	144	116	2.4	20.9
Rude Skov	+55.8	0.8	54	39	37	39	48	70	74	67	54	2.0	20.0
Agincourt	+55.0	18.7	83	76	80	74	57	41	48	62	65	2.0	20.9
Wingst	+54.5	0.6	52	36	31	38	47	63	78	63	51	2.5	20.1
Witteveen	+54.2	0.4	39	31	27	30	39	50	66	51	42	2.4	20.0
Abinger	+54.0	0.0	47	35	36	39	49	52	62	57	47	1.8	20.0
Cheltenham	+50.1	18.9	56	53	50	43	36	30	37	48	44	1.9	21.3
Ebro	+43.9	0.0	26	21	17	24	31	33	37	33	28	2.2	19.5
San Fernando	+41.0	23.6	40	30	30	34	40	36	43	47	38	1.6	19.7
Tucson	+40.4	16.6	36	38	39	35	28	25	25	30	32	1.6	23.2
San Juan	+29.9	19.6	21	20	17	14	15	13	20	19	17	1.6	21.1
Kakioka	+26.0	9.3	16	20	25	34	33	25	20	19	24	2.1	21.0
Honolulu	+21.1	13.5	14	16	24	23	16	12	14	15	17	2.0	22.2
Alibag	+ 9.5	4.9	12	14	17	21	22	24	22	13	18	2.0	21.4
Huancayo	— 0.6	19.0	34	33	26	30	71	87	66	32	47	3.3	11.3
Apia	—16.0	12.5	20	20	23	23	18	11	18	21	19	2.1	21.5
Pilar	—20.2	19.7	26	27	16	15	23	23	27	27	23	1.8	19.7
Hermanus	—33.7	1.3	19	18	19	26	28	23	25	24	23	1.6	14.2
Watheroo	—41.8	7.7	24	22	26	36	39	38	28	24	30	1.8	21.9
Toolangi	—46.7	9.7	35	39	46	57	56	44	36	33	43	1.7	21.5
Amberley	—47.7	11.5	34	37	46	48	41	28	30	30	37	1.7	21.2
Macquarie I.	—61.1	10.6	95	166	309	499	525	353	156	85	273	6.2	23.0
Heard Isl.	—61.2	4.9	169	67	56	99	117	180	278	254	152	5.0	1.3

level Kp = 4_o, the current-densities in the ionosphere in the auroral zone are, at the height of the sensitivity of polar stations, more than 50 times greater than at the times of lowest sensitivity of equatorial stations.

Huancayo, on the magnetic equator, shows the well-known discrepancy, namely, much higher ranges (in H) around local noon; but even at night Huancayo has higher ranges than other tropical stations.

The incidence of the highest sensitivity, indicated in the last column of Table 6, varies considerably with the geographical location. The Western American stations (College, Meanook, Sitka) as well as Heard Island have their highest activity well after midnight, in contrast to the European and Eastern American stations.

The material, of which Tables 4 to 6 are samples, will be published in full and discussed.

4. *Wave-radiation and Equatorial ring-current.* The fundamental series of daily values for W, derived from the daily Sq-amplitudes in Huancayo H, (see Note 36 in Journal of Geophysical Research *56,* p. 616, 1951) ends with the published tables of hourly values, at the end of 1947. According to advice received from Dr. A. A. Giesecke, Director, Huancayo Observatory, the magnetograms since 1948 will eventually be reduced. The W-series will then be continued.

Dr. W. Kertz, Göttingen, spent considerable effort on the study of the "post-perturbation" changes in the level of H, in comparison with the level of solar corpuscular radiation as indicated by Kp-indices. Results are not easily interpreted, beyond the well-known after-effects of some great storms. The aim, namely, a current measure of the equatorial H-level, has not yet been satisfactorily achieved.

5. *K-scheme and compilation of special effects.* In 1952, monthly reports on C-figures and special disturbances were sent by 52 observatories. 41 observatories scaled K-indices in 1952. All collaborators received short guides "Hints for scaling K-indices" (by J. Bartels), and "Hints for the diagnosis of sudden commencements (s.c.) and solar-flare effects (s.f.e.)" (by J. Veldkamp). Quite a number of questions pertaining to the work of the CCMD were discussed in individual correspondence.

The current work runs as follows: At the end of each month, each observatory sends the sheet giving the K-indices, the daily characters C, and data about special effects (storm sudden commencements ssc, polar or pulsational commencements psc, sudden impulses si, solar-flare effects sfe) to the C + K-center at De Bilt. The observatories collaborating in the Kp-scheme send their monthly K-lists as fast as possible to Göttingen also, where the planetary Kp-indices, also Cp and Ap are derived. A 27-day recurrence diagram for the Kp-indices is plotted, supplemented by standardized Ks-indices from Wingst and Göttingen records; this diagram is printed and mailed, together with the monthly list of Kp, Cp, Ap, to about 160 addresses, usually between the 20th and the 25th of the following month. This material arrives in time to be used in 27-day prediction of recurrent M-regions, if such are existing. — At De Bilt, the selection of the 5 quiet, 10 quiet, and 5 disturbed days of the month is made, and a list is sent monthly, together with the Ci-table, to those who want these data fast. A wider list of addresses receives, from De Bilt, Quarterly Tables showing Kp, Ci, the dates of quiet and disturbed days, and the times of observed ssc, psc, si, sfe, This material is printed in the "Journal of Geophysical Research".

For the preparation of the annual Bulletin, De Bilt sends out check-lists with all times of ssc etc., asking each observatory to inspect their magnetograms and to enter their observations. These check-lists serve as the basis of the final lists of these events given in the annual C+K-Bulletins. These Bulletins contain, in addition to the regular tables, short discussions on topics of interest for the work of the CCMD, for instance, data and discussions on solar-flare effects, by J. Veldkamp.

6. Future work. The CCMD proposes to be instructed by the General Assembly as follows:

a) To continue the current schemes of K, Kp, Ap, Ci, ssc, psc, si, sfe;

b) To provide for further correlation studies of K . . . Kp, to be used in conversion tables (K into Ks) and for discussions on the geographical and time distribution of geomagnetic activity;

c) To encourage the scaling of K-indices for years before 1937 by stations with long series of magnetograms;

d) To study the question of indices of activity for shorter intervals than three hours, to supplement the K-scheme at the time of the International Geophysical Year;

e) To make further studies on current measures of solar wave radiation, W, and the equatorial H-level (ERC).

7. Acknowledgements: The work of the CCMD depends for its success on the never-failing collaboration of all observatories. It is a pleasure to record that the spirit of cooperation has been excellent, for which the Committee thanks all directors and observers. The Committee notes with satisfaction the increasing use, made by research workers in other fields of geophysics and astrophysics, of the fundamental geomagnetic data offered in the daily URSIgrams, and in the monthly, quarterly, and annual publications of the CCMD.

Committee No. 11

Committee to Promote Observations of Daily Magnetic Variations in Low Latitudes (1951—1954)

Report by J. Egedal, Chairman

The Members of the Committee are: Berlage, Coulomb, Egedal (Chairman), Giesecke, Gulatee, Herrinck, Lützow-Holm, Madwar, Martyn, Rayner, Roberts and Romañá.

In the considered period the character of the work of the Committee has been changing. In the period 1948—51 observations of the range of the daily variation of H were made using absolute measurements. Such measurements have been continued in the period 1951—1954, but the Committee more and more has aimed at the establishment of recording magnetic stations.

It has been possible to reveal the main feature of the daily variation of H in the region near the magnetic equator, but in order to get more detailed information of changes of the daily variation of all magnetic elements under different physical conditions it will be necessary to obtain magnetic records from this region.

Observations

Father J. O. Cardús carried out observations of H in Bata, *Spanish Guinea* in 1951.

Father A. Romañá and J. O. Cardús established in 1952 a provisional magnetic observatory at Niefang (1° 51′ N; 10° 15′ E) in Spanish Guinea. Registrations of all three elements were obtained in the period from March 5—March 20.

Besides the observations of the daily variation of H arranged in *India* by B. L. Gulatee, observations have been arranged during February and March 1951 by Dr. S. K. Pramanik and S. Yegnanarayanan at further three stations: Cape Comorin (8° 05′ N; 77° 30′ E), Palamcottah (8° 44′ N; 77° 44′ E) and Sankaranainarkoil (9° 10′ N; 77° 32′ E). Also observations of Z were made.

In February—March 1953 further observations of H and Z were arranged by Dr. S. K. Pramanik and P. S. Hariharan at nine stations in South India.

Dr. M. R. Madwar carried out observations of H in a chain of stations in *Sudan* in 1952. Dr. Madwar with the support of A. W. Ireland, Director of the Sudan Meteorological Service, arranged observations of H at the magnetic equator before, during and after the *solar eclipse* of February 25, 1952. Mr. Mathews carried out these observations in the central zone of the eclipse. In the spring of 1952 Lélio I. Gama, Director, Observatorio Nacional, Rio de Janeiro, arranged observations of H during two weeks on the island *Fernando de Noronha.*

Finally, A. A. Giesecke in the spring of 1953 has arranged observations in *South America* extending the long chain of stations occupied in the autumn of 1949 further to the south.

Results

In Bata, *Spanish Guinea,* latitude 1°.8 N, Father J. O. Cardús found a mean range of the daily variation of H of 73 γ.

From the registrations at the provisional observatory at Niefang a mean range of H of 50 γ was found for the period of observations. The mean ranges for Z and D were 39 γ and 2′.0, respectively.

To the mentioned ranges of the daily variation of H in Spanish Guinea no reductions have been applied.

The ranges of H for the three stations in *India* are calculated to be 155 γ, 130 γ and 125 γ, respectively, for the period of observation. The ranges are relatively large and indicate contrary to the result of Gulatee's observations the line of maximum range to be south of Cape Comorin; however, the two series of observations are made in different seasons.

The results from the observations at the nine stations in South India have been published in India Journal of Meteorology and Geophysics (1953) vol. 4., p. 353—358. The main conclusion is: The maximum diurnal range of H occurs near the magnetic equator. All the mentioned results from India will be of much interest at the planning of the AGI.

In *Sudan* M. R. Madwar*) made observations in a chain of stations. The ranges of the daily variation of these observations of H, reduced for lunar and annual variations, are given in the following table:

Station	Latitude	Red. range (H)	Magnetic conditions
Khartoum	15°36′.2 N	124 γ	disturbed
Dueim	13 59.0	83	disturbed
Gebellin	12 35.8	64	quiet
Meitiemer	10 59.5	81	quiet
Kubbo	10 07.3	105	disturbed
Malakal	9 33.5	119	quiet
Waw	7 31.0	102	rather disturbed
Juba	4 52.0	95	disturbed

The latitude of the magnetic equator in Sudan is about 10.1° N.

For the station Kubbo at the magnetic equator observations are used from the day before and the day after the solar eclipse

*) M. R. Madwar: Magnetic observations in the Soudan, January to February 1952. Bulletin de l'Institut de l'Égypte, Tome XXXVI (1953—1954).

of February 25, 1952. On this day the mean values of H for certain intervals of time were observed, and in the below table these values of H and the mean value of the time of the corresponding intervals are given.

Kubbo, 1952, February 25. 30° E meridian time. Mean values of the horizontal force:

6^h50^m	34532 γ	11^h28^m	34576 γ
9 47	605	12 14	562
10 33	589	17 44	556

At Kubbo the eclipse began about 9^h27^m and ended about 12^h16^m, the total eclipse occurred at 10^h49^m.

Dr. D. F. Martyn is examining these observations from a theoretical point of view.

The observations at Kubbo on the day of the solar eclipse were carried out under rather quiet magnetic conditions while the observations made in the chain in Sudan in many cases were carried out under unfavourable magnetic conditions.

The result of the observations at *Fernando de Noronha* is given in the below table:

Date			Range of daily variation (H)	Date		Range of daily variation (H)
1952	March	25	117 γ	1952 April	3	120 γ
		26	131		5	159
		27	109		6	102
		29	135		7	109
		31	150		8	144
	April	1	100		9	106
		2	156			

The observations are taken 4° south of the geographic equator, and there seems hereafter to be little doubt that the zone of large daily variations of H is extending round the whole earth.

Other activities of the Committee

The Committee has corresponded with Dr. R. W. H. Wright, University College, Ibadan, Nigeria, who intends to establish a magnetic observatory at Ibadan, 2° south of the magnetic equator. As very valuable magnetic records may be obtained at that place the Committee has supported Dr. Wright in his efforts. It has been discussed with the Association to lend Dr. Wright variometers and a recorder belonging to the Association, and the Committee has offered to pay the expenditures for repair and adjustment of the mentioned instruments. No final decision has been made.

Method of observation

The Committee has used measurements with QHM's for the determination of the daily variation of H and its range, but as variation of all magnetic elements should be examined a great interest has been shown to the application of a combined DHZ portable variograph. One of the Members of the Committee, P. Herrinck, has made registrations by means of such an instrument at 5 stations near the geographic equator in Congo, 8 days at each station, and he has given a report on his experiences. The registrations of D and H are excellent while that of Z on account of the smallness of the variation is less satisfactory.

At the start of the registration the base-line values of H and Z during a couple of days are changing 0.3 and 1.6 γ per hour, respectively. Another Member of the Committee, E. B. Roberts, recently has used a variograph of the same type and had no such difficulties. Further experiences concerning the variograph are desirable.

Geophysical Year 1957—1958

As magnetic measurements near the magnetic equator are a main point in the geomagnetic programme of the Geophysical Year, the experiences of the Committee may be of interest to the work of the Geophysical Year, and after discussion with Prof. Coulomb the problem of making these experiences useful has been considered by the Committee.

In a memorandum the Chairman has made some personal remarks on the question.

The future of the Committee

The majority of the Committee vote for an amalgamation of Committees No. 1 and No. 11, but other possibilities have also been proposed, so that the question need further consideration.

Finances

The Committee on Dec. 31, 1950, possessed 981,86 Danish Crowns. A part of the expenditures in the period 1951—1953 has been paid by the Secretary of the Association, and the Committee has received no other financial support. The cash balance on Dec. 31, 1953, was 96.16 Danish Crowns.

Proposed resolution

The Association of Terrestrial Magnetism and Electricity expresses its thanks

(a) to Observatorio del Ebro for magnetic measurements made in Spanish Guinea;
(b) to Dr. M. R. Madwar for magnetic measurements at a chain of stations in the Sudan;
(c) to the Sudan Meteorological Service for magnetic measure-

ments at the magnetic equator in connection with the solar eclipse of February 25, 1952;

(d) to the Observatorio Nacional, Rio de Janeiro, for magnetic measurements on the island Fernando de Noronha; and

(e) to the Geophysical Institute of Huancayo for magnetic measurements in South America.

Committee No. 12

Committee on Magnetic Airborne Surveys

Report by J. W. Joyce, Chairman

Steady progress has been reported in the development and uses of airborne magnetometers during the period since the Brussels Meeting of the International Union of Geodesy and Geophysics in 1951.

From Canada, the Dominion Observatory reports the first flight tests of its three-component airborne magnetometer in September 1953. Based on 15,000 miles of flight traverse, probable errors of observation are estimated as 70 gammas in declination, 70 gammas in horizontal intensity, 10 gammas in vertical intensity, and 6 miles in geographical position.

In France, under the sponsorship of Centre National de la Recherche Scientifique, a "magnétomètre à fer tournant" has been developed by Mr. H. Gondet, the Director General of the Laboratoires de Bellevue. This instrument utilizes detecting elements consisting of an air-driven rotating cylindrical core of ferrites between two fixed cylindrical cores. It has been tested on the ground and in flight. In the flight tests, no stabilized platform was used, although development of such a platform is now being accomplished. The instrument has been designed primarily for prospecting surveys, but can also be used for mapping operations.

In Great Britain, the Ministry of Supply is developing an improved airborne instrument which it is hoped may be test flown early enough in 1954 to permit the presentation of results at the Rome Assembly of the International Union of Geodesy and Geophysics.

In New Zealand, extensive flights were made up through late 1951 with AN/ASQ-1 type airborne submarine detectors, modified for surveying purposes in England. The instrument measures total force. The principal areas studied were the thermal regions on the North Island, although some long range traverses were run and tied in to the Amberley Magnetic Observatory near Christchurch.

In Sweden and Finland, regional exploration surveys have been made by commercial companies using airborne instruments.

In Norway, construction of fluxgate magnetometers is proceeding at two places.

In the United States, airborne surveys have been flown for both prospecting and mapping purposes. The U. S. Geological Survey has continued to operate the total intensity magnetometer in about the same form it had in 1951. Flight traverse miles have been surveyed at a rate of about 25,000 a year. Emphasis has been placed on major geological features such as the Appalachian Geosyncline and the Boulder Batholith. Interpretation techniques have been improved and models have been utilized to aid in making such interpretations.

Commercial companies in the United States have surveyed areas on a speculative basis, selling results in the same way that aerial photographs are sold.

The mapping operations are the results of joint efforts by the U. S. Coast and Geodetic Survey, the U. S. Naval Ordnance Laboratory, the U. S. Naval Hydrographic Office, and the U. S. Air Force. Progress to date includes the development of successively improved instruments, designated as Airborne Vector Magnetometers VAM-1A and VAM-2A. The first of these instruments was reported on at Brussels, and a descriptive paper on the second is now in preparation. The VAM-2A has been flight tested to the extent of about 40,000 miles of traverse, and based on these tests, probable errors in the elements F, I, D, H and Z are estimated to be 15 gammas, 3 minutes, 5 minutes, 40 gammas, and 30 gammas (for a dip angle of 60°) respectively. It is expected that improved magnetic compensation of the aircraft will further reduce errors, particularly for the elements F, H and Z. Flights were usually made at an altitude of 10,000 feet. Plans are now being made to fly at 20,000 feet to take advantage of smoother air as soon as pressurized aircraft become available.

In conclusion, it can be said that despite relatively high costs of instrument development and construction, as well as the rather extensive ancillary equipments needed to properly locate the magnetic profiles geographically, airborne magnetic surveys are being performed at increasing rates in many areas, and instrumental performance and data reduction techniques are being steadily improved.

Committee No. 13

Committee on the Study of Lunar Variations in Meteorological, Magnetic and Electrical Elements

Report by K. Weekes, Secretary

The Committee was originally appointed at the Oslo Assembly as a joint committee of the Association of Terrestrial Magnetism and Electricity and the Association of Meteorology. It was reappointed at Brussels as a Committee of the Association of Terrestrial Magnetism and Electricity only. On each occasion a grant was made to the Committee and this has been expended mainly on work carried out at Cambridge by the Secretary and Mr. Wilkes. A financial statement is given at the end of this report.

Meteorological Reductions

A determination was made at Cambridge of the lunar atmospheric tide at Oslo using 40 years of observations. A similar determination was made for Valencia using 57 years. The data were punched onto cards and the reduction was carried out by a method equivalent to that described by Chapman and Miller. The results were reported on briefly at Brussels. A certain amount of final checking remains to be done before they can be published.

Since the Brussels Assembly the analysis of seven decades of data from Copenhagen has been completed at Cambridge. The cards were punched in Copenhagen under arrangements made by Mr. Egedal and sent to Cambridge where the tabulation and final stages of analysis were carried out. In this and later reductions use was made of the electronic computer in the University Mathematical Laboratory (the EDSAC). It was found that the results for a single decade were not significant but that the whole period gave a determination which was just significant, the amplitude of the pressure oscillation being about 13 microbars. As is found at most other stations the maximum amplitude was reached about 1½ hours later in December than in June.

In determining the lunar atmospheric tide it is usual to exclude days of high daily range. A careful study was made at Cambridge of the effect of doing this and it was found that contrary to expectations no large decrease in standard error resulted nor was there any significant change in the phase and amplitude of the lunar tide. It thus appears that with the method of analysis used the gain in significance obtained by excluding days of high daily range is not sufficient to justify the labour of selection. It is suggested that this is because in the Chapman-Miller method allowance is made for the non-periodic component of the daily variation.

An analysis of the air tide at Säntis and at Zürich (stations close together but at very different heights) is being undertaken by Prof. J. Bartels. This project is receiving financial support from the funds of the Committee.

Harmonic Analysis of Magnetic Observations at Cambridge

The following data have been punched onto cards,

Eskdalemuir	1911—1931,	X, Y, Z;		1932—1948,	H, V, D.
San Fernando	1911—1948,	H, D.			
Lerwick	1926—1948,	H, D, V.			

As in the case of the meteorological observations the first stage of the reduction is being done by means of Hollerith punched card equipment, and the second stage which consists of the evaluation of four solar and four lunar harmonics together with an estimate of the standard error is being done on the EDSAC.

A certain amount of preliminary work was first undertaken using Eskdalemuir data to get an idea of the dependence of the harmonics on the magnetic character figure. A number of trial analyses were made from which all days with magnetic character figure greater than a critical value C_c were excluded. This was done for a number of values of C_c. The dependence of the results on C_c was not as marked as had been anticipated and it was decided to take $C_c = 0.5$ for the main bulk of the reductions. Enough work with other values of C_c will be done, however, to enable the effect of magnetic activity on the solar and lunar harmonics to be adequately discussed.

So far analyses for Eskdalemuir and San Fernando have been completed with the following subdivision into years:

1911—14; 1922—24 (low solar activity)
1915—16; 1920—21; 1925; 1930—31 (medium solar activity)
1917—19; 1926—29 (high solar activity)
1932—34; 1943—44 (low solar activity)
1935; 1940—42; 1945 (medium solar activity)
1936—39; 1946—47 (high solar activity)

Each group of years has been further divided into three seasonal groups as follows: November, December, January, February; March, April, September, October; May, June, July, August. The total number of individual analyses (four solar and four lunar components with standard errors) so far made, including some designed to test the dependence on magnetic activity, is about 100. Examination of these results will take a little time but it is hoped to present a full discussion at Rome.

When the work was planned it was considered that the above division of the data into years of high, medium, and low sunspot activity would provide a suitable way of investigating dependence on solar activity. It is now thought that a method of sorting based on daily sunspot numbers would have advantages and accordingly daily sunspot numbers (divided by 5) have been added to the information punched on the master cards. These will be transferred to the cards for San Fernando and the whole reduction for that station will be repeated with the data divided into several sunspot groups based on the daily sunspot numbers. It is planned also to divide the data into monthly groups with a view to enabling the dependence of the solar harmonics on season to be investigated more fully. When the results of the second analysis of the San Fernando data are available it will be possible to decide whether to repeat the reduction for Eskdalemuir and also what treatment to apply to the data from Lerwick.

The Committee is indebted to the British Tabulating Machine Company for the supply of Hollerith equipment and to the British Meteorological Office both for making available unpublished magnetic records and for lending volumes of published records from their library.

Other Work Reported by Members of the Committee

In addition to the above work which has been financed partly from the funds of the Association and partly (in respect of the British data) by a grant from the Royal Society, the work mentioned below has been reported by members of the Committee.

Dr. J. Egedal has made a study of the lunar daily variation of magnetic declination at Rude Skov for the years 1908—1951 (Danish Meteorological Institute, Comm. magnétiques, etc. No. 21, Copenhagen 1953).

Mr. M. Hasegawa reports that in Japan Mr. Hirono has investigated the theory of diurnal magnetic variations in equatorial regions and conductivity of the ionosphere E region (II, Journ. Geomag. Geoelect., *5*, 22, 1953). A semi-diurnal lunar variation has been detected by S. Matsushita in the E_s region of the ionosphere (Journ. Geomag. Geoelect., *4*, 39, 1952).

The Geophysical Institute, College, Alaska, under a contract with the Geophysics Research Division of the Air Force Cambridge Research Center, Boston, U.S.A., and under the technical supervision of Professor Chapman is making a detailed study of the lunar daily geomagnetic variation in all three elements of the field at Sitka. The punching and tabulation has been completed in the United States and the final harmonic analysis will be done on the EDSAC at Cambridge.

The Rev. J. O. Cardús S. J. is completing an analysis of the lunar variation in declination at Tortosa by the direct method. Work has also been done in Tortosa on the harmonic analysis of earth-currents and a comparison was made between values calculated by the direct method and values calculated by the Chapman-Miller method. The agreement in the amplitude of the second harmonic was good but the phase showed a discrepancy which is being investigated. The Chapman-Miller method is also being applied to investigate the lunar variation in the observations of H obtained during the last polar year at Moka (Fernando Poo) very near the magnetic equator. It is doubtful, however, whether the observations were continued for a sufficiently long period to give a significant result.

Dr. Otto Schneider has demonstrated during the course of a research on the solar diurnal variation in H at Pilar that the lunar variation is not wholly eliminated from the so-called quiet day variation S_q if this is based upon the five international quiet days. Accidental grouping of selected quiet days around similar lunar ages favours the "survival" of detectable lunar residuals in S_q. It is expected that a brief report on this work will be published in 1954. A paper describing some work on the residual lunar effects in K indices which was reported on at Brussels has now been published (Meteoros, Chapter III, No. 2/3, page 135, 1953: also published in Publicacion No. 8, Serie Geofisica, del Servicio Meteorológico Nacional, Buenos Aires, Argentina).

Dr. S. K. Pramanik has investigated the lunar atmospheric tide at Trivandrum and Agustie (Ind. Jour. Met. & Geophys. Vol. 2, No. 1, 1951). Mr. A. P. Mitra has published a paper on tides in the ionosphere (Ind. Jour. of Phys., Vol. 24, No. 9, 1950).

Mr. C. H. Cummack and Miss J. M. Bullen, of the Geophysical Observatory, Christchurch, New Zealand, using five years data (1931—5) for all three elements at that observatory, have determined the first four harmonics of the lunar daily variations, by the earlier method employed by Chapman (Phil. Trans, Royal Soc. London, A, 1919, *28*. 1—118). The most remarkable feature of the results is an abnormally large value for the second (main) harmonic component of the lunar variation of the vertical force. The results are being published in the New Zealand Journal of Science & Technology, and a summary will appear in the Journal of Geophysical Research. An analysis of the lunar daily variation of the vertical magnetic force at Amberley (Christchurch) from the whole available data (1929—1953) using the Chapman-Miller method is in progress, also a less extensive lunar reduction of the H data for Apia, using the earlier method.

Mr. R. Turajlic, working under Professor Chapman, has made an analysis of the semi-diurnal variation of cosmic ray intensity observed at Huancayo; this was based on published data and data supplied by Dr. M. A. Tuve, Director of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington. The Hollerith machines at Cambridge were used for the tabulation and the EDSAC was used for the latter stages of the analysis.

The Secretary has noted the following recent publications in the field of interest of the Committee.

O. Burkard: Studie zum ionosphärischen Gezeiteneffekt, J. A. T. P. *1*, 349, 1951.

J. H. Chapman: A study of winds in the ionosphere by radio methods. (Reports a determination of the lunar semi diurnal wind). Canadian J. Phys. *31*, 120, 1953.

S. Chapman: The calculation of the probable error of determination of lunar daily harmonic component variations in geophysical data — A correction. Aust. J. Sc. Res. A *5*, 218, 1952.

R. Eyfrig: Une influence lunaire sur l'altitude du centre de la couche ionosphérique F_2. C. R. Acad. Sci. *235*, 736, 1952.

S. Matsushita: Lunar tidal variations in the sporadic-E region. Rep. Ionosphere Res. Japan 7, 45, 1953.

B. W. Osborne: Lunar variations in F_2 region critical frequencies at Singapore. Nat., *169*, 661, 1952.

G. J. Phillips: Measurements of wind in the ionosphere. J. A. T. P. *2*, 141, 1952.

U.R.S.I. Special report no. 2. Tidal phenomena in the ionosphere, Bureau General Secretariat, Brussels.

Theory of Geomagnetic Tides

N. G. Baker & D. F. Martyn: Electric currents in the ionosphere. Phil. Tran. Royal Soc., *246*, 281—320, 1953.

J. A. Fejer: Semi diurnal currents & electron drifts in the ionosphere. J. A. T. P. *4*, 184, 1953.

M. Hirono: On the influence of Hall current to the electrical conductivity of the ionosphere. Rep. Ionosphere Res. Japan *6*, 44, 1952.

A theory of diurnal magnetic variations in equatorial regions and conductivity of the ionosphere. J. Geomag. Geolect. *4*, 7, 1952.

K. Maeda: Dynamo theoretical conductivity and current in the ionosphere. J. Geomag. Geoelect. *4*, 68, 1952.

Financial Statement

After the Brussels meeting the Secretary held £393.1.0 d. on behalf of the Committee. This has been expended as follows:

	£.	s.	d.
Purchase of cards for Mr. Turajlic (cosmic ray reduction)	12.	0.	0.
Postage etc. (cosmic ray reduction) ...	1.	0.	0.
Travelling expenses & postages	15.	11.	0.
Salary of Computer Sept. 51—Dec. 52	355.	0.	0.
National Health Insurance Contribution	9.	10.	0.
	£ 393.	1.	0.

The grant ($ 1000) made at Brussels has been paid out as follows:

Prof. J. Bartels (Säntis & Zürich Reduction)	$ 250
M. V. Wilkes (Director, University Mathematical Laboratory, Cambridge) (San Fernando & Lerwick Reductions) ...	$ 750
	$ 1000

Note

The following error has been noted in Prof. S. Chapman and Dr. J. C. P. Miller "The Statistical Determination of Lunar Daily Variations in Geomagnetic and Meteorological Elements", Monthly Notices of R.A.S., Geophysical Supplement, *4*, pages 649—669, 1940.

Table of d_{mps} on page 665.

n = 3, p = 1 for —0.0098 read —0.0118

p = 2 —0.0412 —0.0495

The table given by Chapman and Miller was quoted by K. K. Tschu in "Australian Journal of Scientific Research", 2, page 1, 1949.

Appendix to the Report of Committee No. 13

Report on work done by J. Bartels, Göttingen

1. *New reduction of L and S in magnetic horizontal intensity at Huancayo, 1922—1947.*

The ranges of Sq(H) at Huancayo have been shown to vary from day to day with the relative sunspot-number R in such close correlation that those ranges, freed from the influence of L, could serve as a current measure of the changes of solar ionizing wave-radiation, W. Since L will behave similarly, the usual subdivision of the material according to solar activity (namely, according to the *averages* of R for months or years) appears questionable. Therefore, in the new reduction, every day was classified according to the value of R on that day. — Another new feature is the restriction to the day-time, 04 to 21 standard time, using the experience that L(H) at Huancayo is very small during the night. This restriction to intervals of 17 hours makes it easier to select "quiet intervals", judged by the international daily character-figures as well as by three-hour range indices (Niemegk K up to 1936, then Kp). K-indices proved useful in sorting out short disturbed intervals, as well as in retrieving days which are only disturbed outside the 17-hour interval considered. — The division by calendar months was replaced by a sub-division according to the Sun's mean longitude, with 24 parts of the year, starting at December solstice. — Finally, the separation of S, $L(M_2)$ and $L(N_2)$ was performed by a process of successive elimination avoiding the difficulty introduced by the small number of days in each sub-group: By interpolation and smoothing between adjacent sub-groups (adjacent with respect to season or sunspot-number), the "best" value for S in each subgroup was obtained. It was subtracted from the original hourly changes for each day to obtain an estimate for $L(M_2+N_2)$ for that day. Again, when $L(M_2)$ had been computed, smoothed values were subtracted to obtain estimates for $L(N_2)$. Attempts to calculate geomagnetic effects of diurnal partial tides, $L(O_1)$, were made. — Results for S, $L(M_2)$ and $L(N_2)$ are available. The seasonal change is radically different in S and L: While S changes in a double seasonal wave, with maxima at the equinoxes and nearly equal minima at the solstices, the solstitial minima in the amplitudes of L differ so much that L nearly vanishes around the June-solstice. This confirms and extends earlier results by Bartels and Johnston, and agrees with the seasonal change in L(fF2) as indicated in the change of fF2 from 11 to 18 standard time by Bartels.

2. *Lunar variation of atmospheric pressure at Zürich and on Säntis.*

The Schweizerische Meteorologische Zentralanstalt has published tables of hourly values of pressure for these two stations (475 m and 2500 m above sea-level) for 1894—1936; handwritten tables were made available on micro-films for 1937—1949. A new lunar reduction is under way, using the experience gained with the series of pressure readings taken at Magdeburg, 1881—1900.

3. *An ionospheric current diagram* showing L at the phase "first eighth" of the moon is being constructed, to supplement the well-known diagram showing L at full or new moon.

Special Report on Palaeomagnetism

By Takesi Nagata

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1. Historical Review.

The permanent magnetization of igneous rocks has been known in Italy since the middle of the 19th Century, being described, for example, by Melloni (1853), Gherardi (1862) and Folgheraiter (1890). Since then, a large number of investigators have attempted to measure the direction and intensity of the natural remanent magnetization of igneous rocks. The main purpose of these works was to find the direction of the geomagnetic field in remote epochs under the assumption that the remanent magnetization of examined rocks was produced into the direction of the geomagnetic field by cooling down *in situ* from a high temperature. Indeed, it has been observed that lavas newly ejected from volcanoes have remanent magnetization, the direction of which is just in agreement with that of the geomagnetic field around them. Thus, Mercanton (1906), Nakamura (1912), Chevallier (1925) and others examined rather systematically the magnetic orientation of lavas ejected in historic epochs, and attempted by using their results to trace the secular variation of the direction of geomagnetic field in those historic epochs.

It was verified by Königsberger (1930) that the remanent magnetization of igneous rocks *in situ* can mostly be attributed to a fairly stable magnetization of fine grains of ferromagnetic minerals contained in these rocks, which is reproducible in laboratory by cooling down in a weak magnetic field from a temperature higher than their Curie point, and which is named by him *thermo-remanent magnetization.* It was also pointed out by Königsberger that remanent magnetization of some igneous rocks is so anomalous that the magnetization can not be attributed to their thermo-remanent magnetization. Studies on the thermo-remanent magnetism were extended later by Thellier (1938), chiefly for bricks, pottery and other baked earth, and by Nagata (1941, 1943), chiefly for rocks, and its various characteristics have been revealed in fair detail, the anomalously high stability of thermo-remanent magnetization at the atmospheric temperature being especially confirmed. At present there still remain a number of unsolved problems in rock-magnetism, but recent progress in physics of magnetism seems to approach towards establishment of a solid scientific basis for the origin and the anomalously high stability of thermo-remanent magnetization of rocks.

On the other hand, the usability of remanent magnetization of sediments was pointed out by McNish and Johnson (1938) and also by Ising (1943). Since then, this method has been examined in some detail by many investigators, owing to the universality of distribution of sedimentary layers to be examined. The remanent magnetization of sediments is frequently unstable, but it has been proved that certain sedimentary rocks have sufficiently stable magnetization for the palaeomagnetic purposes (Graham, 1949). Palaeomagnetic studies by means of sediments are based on the assumption that their magnetization results from statistical alignment of magnetic dipoles of ferromagnetic grains under the influence of the geomagnetic field while these grains were deposited together with the other non-magnetic grains. The above should be the primary reason for correlating the direction of sediment's magnetization with the geomagnetic field.

Thus, the palaeomagnetic studies on igneous, sedimentary and metamorphic rocks have been carried out at various localities over the world. Among the results of these studies, many specimens have a magnetic orientation which is not much different from that of the present geomagnetic field, but others showed to have a magnetization whose direction is almost opposite. The significance of this peculiarity had frequently been ignored, and the anomalous magnetic orientation of igneous rocks had been assumed to be attributable only to some heterogeneous magnetization other than the thermo-remanent magnetism.

However, recent detailed and careful studies on the remanent magnetization of rocks have revealed that the reversely magnetized rocks spread uniformly and widely in many localities and are distributed rather systematically in various geologic epochs. This fact may suggest that the reversed magnetization of the rocks does not result from some accidental reasons, but from a certain general cause. The possible cause will be either the reversed direction of the geomagnetic field at the time when these rocks were formed or a certain mechanism capable of producing magnetization generally opposite in direction to that of the geomagnetic field affecting the rocks. This problem concerns the question whether the geomagnetic field has kept almost the same direction as at present throughout the whole period of the earth's history or whether it was reversed once or more in the past. This may be the most important problem in palaeomagnetism at present.

2. *Origin of Natural Remanent Magnetization of Rocks.*

The palaeomagnetic studies by means of the remanent magnetization of igneous and thermally metamorphosed rocks are always based upon the assumption that the magnetization is due to stable thermo-remanent magnetization. No other origins of the remanent magnetization of these rocks can represent the direction or intensity of the geomagnetic field in remote epochs when these rocks were formed. Magnetic minerals responsible for the magnetization of rocks are mostly titanomagnetites, which are solid solutions of magnetite (Chemical composition = Fe_3O_4: Curie point Θ = 580°C: Saturation magnetization σ = 92 emu) and titan-spinel (Chemical composition = Fe_2TiO_4, non magnetic), having crystal structures of spinel type. The Curie point and intensity of magnetization of the titanomagnetite decrease with increase in its content of titanium from zero which corresponds to pure magnetite. (Pouillard, 1950).

Another magnetic mineral which frequently appears in rocks is hematite (Chemical composition = Fe_2O_3, Θ = 680°C) having a rhombohedral crystal structure. Its intensity of magnetization is very small compared with that of titanomagnetites, the saturation magnetization σ being about 0.5 emu in order of magnitude, but the coercive force of its small grains is exceedingly high, being larger than 7000 *Oe.* (Roquet, 1947). It has been proved in the laboratory that both titanomagnetite and hematite are fairly stable, and their fine grains can have the thermo-remanent magnetization by cooling in a weak magnetic field. Actually in most cases, they are the origin of remanent magnetization of igneous and metamorphic rocks and baked earths. The capability of rocks for acquiring the thermo-remanent magnetization in a weak field H is usually represented by the ratio (Q) (Königsberger, 1938) of its intensity to the strength of induced magnetization of the same sample in the same field. In proportion as the grain size of the ferromagnetic minerals decreases, the coercive force (Hc) and the Q value increase rapidly.

It has recently been found that ferromagnetic solid solutions of hematite and ilmenite ($FeTiO_3$) are occasionally present in rocks and their small grains can acquire the thermo-remanent magnetization. Systematic studies of this Fe_2O_3-$FeTiO_3$ system have not yet been completed, but it seems likely that the composition around $Fe_2O_3 \cdot 2FeTiO_3$ is the most magnetic, its Curie point being about 230°C. It must be noticed that all examples so far found of rocks which acquire reversed thermo-remanent magnetization, (i. e. the direction of thermo-remanent magnetization acquired being opposite to that of the magnetic field affecting them during their cooling process), contain this Fe_2O_3-$FeTiO_3$ phase. (Nagata et al, 1953, Balsley and Buddington, 1954).

Maghemite (Chemical composition = Fe_2O_3) having a cubic crystal structure is also occasionally the origin of the magnetic properties of rocks. The intensity of magnetization of maghemite is much larger than that of hematite, but the former is unstable at high temperature, being unable to bear the production of thermo-remanent magnetization. There are several other magnetic minerals, but their presence is very rare in rocks.

Magnetism of sedimentary rocks is also due, in most cases, to either titanomagnetite or hematite contained in them. The remanent magnetization of sediments is due to the statistical alignment of a large number of small magnetic grains having permanent magnetization. Frequently the permanent magnetization is spontaneous magnetization of the ferromagnetic component, if the grain size is so small as to consist of a single domain. In such a case, the remanent magnetization of the sediments is exceedingly stable. Sometimes the permanent magnetization of the ferromagnetic grains is the thermo-remanent magnetization, which they acquired when they were contained in igneous rocks. The remanent magnetization of sediments in this case seems to be fairly stable, provided that the grain size is sufficiently small for the coercive force to be large. However, the permanent magnetization of the magnetic grains in sediments is very frequently due to the *isothermal remanent magnetization*, which is produced at the atmospheric temperature during a long period under the influence of the geomagnetic field. In such a case, the remanent magnetization of sediments is by no means a fossil of the geomagnetic field in remote epochs, and therefore these sediments must be excluded from palaeomagnetic studies.

3. *Proposed Methods of Testing the Reliability of the Remanent Magnetization of Rocks for Palaeomagnetic Purposes.*

There will be several different methods of testing reliability of remanent magnetization of rocks for the purposes of palaeomagnetism. They are in principle an identification of remanent magnetization of igneous and metamorphic rocks with their stable thermo-remanent magnetization acquired in the process of cooling in the geomagnetic field, or an identification of remanent magnetization of sediments with their resultant magnetization caused by the statistical alignment of many small grains having sufficiently stable magnetization in the direction of the geomagnetic field at the time of their deposition. No other possibility can be considered at present concerning a direct relation between the direction of the remanent magnetization of rocks *in situ* and that of the geomagnetic field at the time of their formation.

(a) Field evidence.

If horizontally stratified geologic layers such as sedimentary layers or lava flows and conglomerates of the same materials and the same age co-exist in the same locality, we can test the stability of remanent magnetization of the stratified layers by comparison with the distribution of direction of remanent magnetization of the conglomerates (Graham, 1949). If the direction of magnetization is uniform throughout the layer and that of the conglomerates is completely at random, we may conclude that the magnetization of these rocks has been sufficiently stable during the period since these conglomerates were formed. If, on the contrary, the direction of the magnetization of the conglomerates has the tendency to converge around the direction of the geomagnetic field, we may consider that the magnetization is unstable, being influenced by the present geomagnetic field. Examples of such a case where the directions of magnetization of the layer and the conglomerates are identical and nearly the same as that of the present field have frequently been found. These cases can not be used for palaeomagnetic purposes.

The same criterion can also be applied for the remanent magnetization of folded sedimentary layers (Graham, 1949). If the direction of magnetization corrected for the tilt of the layer, i. e. reduced to the direction with respect to the original horizontal stratification, is uniform everywhere in the folded layer, then this is satisfactory evidence that this rock has retained its direction of magnetization since a time prior to its folding. If the direction of magnetization of a folded layer is approximately uniform and parallel to that of the geomagnetic field, then the magnetization is unstable. It must be remembered however that the deformation of a layer owing to a shearing movement can keep the direction along the shear plane invariant.

It is fundamentally important for palaeomagnetic purposes that the direction of remanent magnetization should be substantially uniform at every part of undisturbed strata or bodies of rocks. Fisher's new method (Fisher, 1953) of statistical treatment is most helpful for this examination. (Hospers, 1953).

When thermally metamorphosed parts of sediments near a lava flow or a dyke have the remanent magnetization whose direction is the same as that of the igneous rock body, the reliability of rock-magnetism as an indicator of the geomagnetic field at the time when this igneous rock was cooled may be emphasized. (Roche, 1953).

(b) Laboratory tests of the remanent magnetization of igneous and thermally metamorphosed rocks.

The causes of the natural remanent magnetization of igneous and thermally metamorphosed rocks may be classified into following four groups:

(i) Stable normal thermo-remanent magnetization;
(ii) Stable reverse thermo-remanent magnetization;
(iii) Unstable thermo-remanent magnetization;
(iv) Remanent magnetization owing to other causes than the thermo-remanent magnetism.

Here only the stable thermo-remanent magnetization can be used for the palaeomagnetic studies. The proposed methods of laboratory tests of remanent magnetization therefore concern the identification of the magnetization with thermo-remanent magnetization and the examination of its stability.

The identification of a natural remanent magnetization with the thermo-remanent magnetization can only be actually made with an experimental demonstration that the reproduction of the magnetic properties of the former is the same as those of the latter. The degree of reproducibility can be estimated by the degree of resemblance of modes of decay of the natural remanence with temperature to those of the thermo-remanence newly produced in the laboratory, and also by the coercivity of the natural remanence against alternating demagnetizing field. If the dependency of the natural remanence of a rock sample upon temperature change and the demagnetizing field is quite the same as that of the thermo-remanence in their mode and intensity, there may be very little room for doubt that the natural remanent magnetization of the rock is due to its thermo-remanent magnetization which was produced when it was cooled down *in situ*.

The stability of the natural remanent magnetization can be examined by demagnetizing magnetically and thermally. It must be remembered here that the coercivity of the thermo-remanence is exceedingly larger than that of the isothermal remanence acquired at the atmospheric temperature. This exceedingly high coercivity of the thermo-remanence holds true against both magnetic and thermal demagnetization.

Identification of the ferromagnetic minerals responsible for the natural remanence is most helpful for estimating its stability. Their chemical and X-ray analyses, microscopic observation and measurements of their magnetic properties, such as Curie point, intensity of saturation magnetization and coercive force, are practical procedures for this purpose. Ti-poor titanomagnetites and hematites may be trustworthy ferromagnetic minerals for the palaeomagnetic purpose, and small ferromagnetic grains less than 20∼30 μ in mean diameter alone can keep their magnetization stable because of their high magnetic coercivity.

Thus, a stable natural remanent magnetization owing to thermo-remanent magnetization of igneous and thermally metamorphosed rocks can be distinguished from other unstable and ambiguous magnetizations. From such stable normal or reverse thermo-remanent magnetization of rocks, we can presume the direction of the geomagnetic force at the time when these rocks were formed. As for unreproducibility of natural remanence of some rocks as their thermo-remanence, several possible interpretations have been proposed for individual cases. (Graham, 1953, Nagata et al, 1954). But the best possible way at present in palaeomagnetism by means of igneous and thermally metamorphosed rocks may be to deal only with the stable thermo-remanent magnetization and exclude such rocks, the origin and stability of whose remanent magnetization are by any means ambiguous.

(c) Laboratory tests of the remanent magnetization of sedimentary rocks.

The origin of the natural remanent magnetization of sediments may be classified in the following two groups:

(i) Stable remanent magnetization caused by statistical alignment of a large number of magnetic grains at the time of their deposition under the influence of the geomagnetic field;

(ii) Remanent magnetization owing to other causes, such as the isothermal remanent magnetization under the present geomagnetic field, etc.

Among the above two groups, the rock samples belonging to the first group alone can be used for palaeomagnetic studies.

The test of magnetic coercivity and the identification of ferromagnetic minerals are desirable methods of testing the stability of the natural remanent magnetization of sediments. The criterion in this case should be the same as in the case of igneous and thermally metamorphosed rocks.

In the case of sediments, unstable remanent magnetization has been experienced much more frequently than in the case of igneous rocks. When such unstable magnetized rocks are left in the laboratory so that the direction of their remanent magnetization makes a large angle with that of the geomagnetic force there, the former changes appreciably within only a month, generally approaching the latter. (Kawai and Kume, 1953, 1954. Creer, Irving and Runcorn, 1954). It is desirable in palaeomagnetic studies that the remanent magnetization of sediments is substantially stable in the above-mentioned test during a possible period for actual experiments, say a year or more. Otherwise, the remanent magnetization of sediments is unreliable.

Since there is no direct method of proving the identification of natural remanent magnetization of sediments with the assumed reasonable origin described in (i), the field evidence discussed in (a) is especially important in the palaeomagnetic studies by means of sedimentary rocks.

(d) General remarks on laboratory tests.

The test methods proposed here are useful only for detecting the rocks which are not reliable for the palaeomagnetic purposes. In other words, no perfectly satisfactory method has been found of proving positively that a rock has kept its remanent magnetization undisturbed since production under the influence of geomagnetic field. Under such circumstances, we may postulate some ambiguity about the origin and stability of natural remanent magnetization of rocks, and may be able to actually examine its evidence in the field or in the laboratory. If the ambiguity is removed by adequate examination, we may consider that the rock is reliable for palaeomagnetic purposes. Some actual methods of examination are discussed in Appendix I of this report. The best possible way at present in palaeomagnetic studies may be to deal only with the rock samples which are quite free from any considerable ambiguity about the origin and stability of their remanent magnetization.

4. *A Summary of the Results of Palaeomagnetic Studies and Reversal of the Geomagnetic Field.*

Based on the criteria discussed in the preceding sections, the results of recent palaeomagnetic studies made by various investigators will be reviewed. The palaeomagnetic studies referred to in this review are chiefly those by the following authors: Creer, Graham, Griffiths, Hospers, Irving, Kawai, Nagata et al, Roche, Runcorn, Thellier and Vincenz. As the most important problem in present palaeomagnetism seems to be the question whether or not the geomagnetic field was reversed in the past this review will mainly deal with the reverse remanent magnetization of rocks and its reliability for palaeomagnetic purposes.

The criteria for reliability of rock's magnetization used by various investigators are summarized as follows:

(Field evidence).

1. Direction of the natural remanent magnetization referred to the present geomagnetic force *in situ*.
2. Uniform distribution of remanent magnetization throughout a rock body or stratum.

3. Statistical test of the uniformity of the remanent magnetization. (Nagata et al, 1949, Vincenz, 1952).
4. Randomness of the direction of magnetization of individual pebbles in conglomerates. (Graham, 1949; Hospers, 1953; Greer et al, 1954; Kawai, 1954).
5. Correction for movement of layer (folding, slumping etc.). (Graham, 1949, Hospers, 1953, Griffiths, 1954, Creer et al, 1954).
6. Comparison of the direction of remanent magnetization of lavas and dykes with that of neighbouring sediments thermally metamorphosed by these igneous rock bodies. (Roche, 1953, Kato et al, 1954).

(Laboratory tests).

7. Comparison of the remanent magnetization of an igneous rock with its thermo-remanent magnetization. (Jn/J_{Tc}). (Vincenz, 1952, Nagata et al, 1954).
8. Modes of decay of the remanent magnetization of an igneous rock by thermal demagnetization process. (Modes of $(Jn)_T$). (Roche, 1953, Hospers, 1953, Nagata et al, 1954).
9. The same procedure for thermo-remanent magnetization of the same sample. (Modes of $(J_{Tc})_T$). (Hospers, 1953, Nagata et al, 1954).
10. Ratio of the intensity of natural remanent magnetization to that of reversible magnetization acquired in the geomagnetic field. (Determination of Qn). (Hospers, 1953).
11. Characteristics of partial thermo-remanent magnetization of igneous rocks. (Hospers, 1953, Nagata et al, 1954).
12. Effect of thermal demagnetization by heating up to 200°C. (Thermal demagnetization of the isothermal remanent magnetization). (Vincenz, 1952, Roche, 1953).
13. Tests of stability of the remanent magnetization against increase in temperature in vacuum and in the atmosphere by means of magnetic method or X-ray analysis. (Nagata et al, 1954).
14. Change in the remanent magnetization of rock samples which are left in the geomagnetic field in laboratory. (Vincenz, 1952, Roche, 1953, Kawai, 1954, Creer et al, 1954).
15. Effect of mechanical shocks on the remanent magnetization. (Vincenz, 1952, Roche, 1953).
16. A.C. demagnetization of the natural remanent magnetization and the thermo-remanent magnetization. (Graham, 1953).

17. Determination of the intensity of magnetic force, which produces the isothermal remanent magnetization equivalent to the natural remanent magnetization in intensity. (Vincenz, 1952).

18. Laboratory experiments of re-deposition of sediments in the present geomagnetic field. (Nagata et al, 1943, Griffiths, 1954).

19. Identification of ferromagnetic minerals in rocks by magnetic, chemical and X-ray analyses. (Nagata, 1953).

The meaning of the above-mentioned tests is discussed briefly in Appendix I of this report, and their details can be found in the original papers by individual investigators, which are listed in Appendix II.

The following tables are the results of palaeomagnetic studies of remanent magnetization of those rocks whose reasonable origin and stability could be proved by some criteria. The methods of examination made for individual examples are noted in respective results by their number referred to in the list of criteria described above. As shown in these tables, some rock specimens were so carefully examined that the reasonable origin and the stability of their remanent magnetization could be proved with a high degree of certainty. In some other rocks it seems unlikely that the examination of the origin and stability is sufficient for palaeomagnetic purposes, but even these rocks seem to be free from ambiguity about the origin and stability of their magnetization as far as the examined data are concerned.

The direction of the natural remanent magnetization of these rocks whose reliability was proved is classified here into either "normal" (N) or "reverse" (R). The "normal" means that the direction of the natural remanence lies within 30° from that of the present geomagnetic force, while the "reverse" indicates that the natural remanence is directed within 30° from the opposite direction of the present geomagnetic force. When the direction of the natural remanent magnetization of rocks is not included in the above-mentioned two categories, its declination is noted for reference.

It is noted in these tables that no evidence of a reversal of the geomagnetic field has been found in Holocene throughout the world, while the stable reverse magnetization was found in rocks of Pleistocene, especially in those of early Pleistocene.

For the Tertiary period, stable normal and reverse magnetizations appear in the rocks of each epoch, i. e. Pliocene, Miocene, Oligocene and Eocene. It seems likely in data of igneous rocks that the normal and the reverse magnetization take place alternatively with geologic time in a rather regular sequence. For Mesozoic and Paleozoic eras data of rock magnetization have

	Japan	Scotland, Mull (Vincenz)	Auvergne, Velay, France (Roche)	Iceland (Hospers)
Holocene			Puy de Dôme N dômite Puy Sarcouy N dômite Puy de Clierzou N dômite Coulée de Beaumont N basalte 12,14,15	Mt. Hekla historic lava flows. A. D. 1729-1948 N basalt Post glacial lava flows N basalt Interglacial lava flows N basalt S. W., W. and N. W. Iceland (15.000 yrs) 1,2,4,5,10
Pleistocene	Kawaziri-misaki R basalt " N " 7,8,9,13,16 Suwa R andesite 7,8,9,11,13,16 Mikasa (N 72°E) N dolerite 4,14 Kinumakiyama (Osaka) R basalt 4,14 Toei (Aomori) R andesite 4,14 Sigi (Nara) R andesite 4,13,14		Coulée de la Malouteyre R basalte Coulée de Sinzelles R basalte 12,14,15	Paragonite Formation N S. Iceland (50,000 yrs) 1,2,4,5,10 Early quaternary lava W., S. W. and N Iceland R basalt 1,2,4,5,8,9,10 (500,000—1,000,000 yrs)
Pliocene	Ozima (Hukui) R andesite 13 Odake (Osaka) N sanukite 4,14 near Sendai R basalt 7	Irish Centres R basic dykes North England R tholeiite Loch Bà, Mull N felsite ring dyke 3,7,12,14,15,17	Coulée du Mont Coupet R basalte 6,8,12,14,15 Coulée de Dolaizon R basalte 6,12,14,15 Coulée de Pontfarein R basalte 6,12,14,15 Coulée de la Roche Noire R téphrite 6,12,14,15 Coulée de Murols & Saignes R basalte 12,14,15 Coulée chez Rigaud N basalte Coulée Saint Sauves N basalte Coulée de Cuzeau N andesite Coulée de la Serre N andesite Coulée du Puy de Bessolles R basalte Coulée de la Roche Romaine R basalte 12,14,15	1,2,4,5,8,9,10,11 Pliocene lava flows N. Iceland {N basalt / R} 1,2,4,5,10,11 (2—12,000,000 yrs.)
Miocene		Dishig R dolerite, basalt Glen More N basalt, altered dolerite 3,7,12,14,15,17	Coulée supérieure du Puy de Var R basalte 12,14,15 Coulée de Vernines R basalte 8,12,14,15 Coulée de Rochefort Montagne R basalte 12,14,15 Dôme de Thiézac N trachyte 12,14,15 Coulée de Puy Courny N basalte 12,14,15 Coulée B_2 Gergovie N basalte 12,14,15	Tertiary lava flows probably Miocene N. Iceland {R / N / R} basalt 1,2,4,5,10
Oligocene		Glen More N quartz-gabbro granophyre 3,7,12,14,15,17	Dyke principal Gergovie R basalte Sill principal Gergovie R basalte Gd. Turburon de Billom R basalte 12,14,15	
Eocene		Mull R Olivine gabbro Mull R Olivine gabbro 3,7,12,14,15,17		

STABLE REMANENT MAGNETIZATION OF SEDIMENTARY ROCKS.

	Japan	Sweden (Griffiths)	U. S. A. (Graham)	England (Runcorn, Creer, Irving)
Holocene		Prästmon, Ångermanland A.D. 1900-1300 N varved clay Undrom, Ångermanland A.D. 1000-0 N varved clay Ångerman River A.D. 500-B.C. 500 N varved clay 5,18		
Pleistocene	Bôso, Narita-bed N 3,18,19 Osaka-basin Azuki tuff R 2,14,19		Middletown, Connecticut N varved clay 5	
Pliocene	Bôsô, Amatu, Nokogiriyama Tuffacious sediment R 4,14			
Miocene	Bôsô, volcanic sediment R 14 Bôsô shale N 14		Selah, Washington lake deposited sediments N 4	
Oligocene				
Eocene				
Cretacious				
Jurassic				
Triassic				Keuper Marl series, Sidmouth (S 34°W) R N 14 14
Permian				Exeter volcanic series R 14
Carboniferous				
Devonian				Anglo-Welsh cuvette Bristol-Ludlow Pembrokeshire-Gloucester old red sandstone } 5,14 R N (N 34°E)
Silurian			Pinto, Maryland sandstone R 5	Ludlow series, Pembrokeshire R 14
Cambrian				Caerfai series, Pembrokeshire R 14
Pre-Cambrian				(Longmyndian) sandstone (S 69°E) R 5,14 N.W. Scotland sandstone (N 56°W) N 4,5,14

been available only in sedimentary rocks. These data show that the stable reversed magnetization can be found in the rocks of Mesozoic and Paleozoic eras and also in Pre-Cambrian rocks.

Summarizing these results, we may consider that the geomagnetic field which influenced the remanent magnetization of the stable rocks was reversed in various geologic epochs. Even if the data for discussions are restricted to those rocks whose reliability was proved with an especially high degree of certainty, we may still be able to conclude that the earth's magnetic field was reversed many times in the past.

Unfortunately, exact comparison of the ages of reversely magnetized rocks at a locality with those at distant places is hardly possible at present. Therefore it seems difficult to find the exact epochs when the reversal of the geomagnetic field took place. Some investigators (Hospers, Runcorn and others) have extended their studies on palaeomagnetism to discussing a periodic inversion of the geomagnetic field and a possibility of the polar wandering of the earth (Hospers, 1953, Creer, Irving, Runcorn, 1954). In this special report, however, the reporter would like to take a rather conservative stand, but still conclude that *we have obtained evidence with a reasonable degree of certainty for repeated reversals of the earth's magnetic field in the past; and that the data for this evidence obtained at various localities are fairly consistent with each other within the limit of accuracy of the present geologic time scaling.*

Appendix I

Proposed Methods of Laboratory Tests of Remanent Magnetization of Rocks and Baked Earth

(A) *Laboratory tests of the remanent magnetization of igneous and thermally metamorphosed rocks.*

The reliability of identification of the natural remanent magnetization of igneous and thermally metamorphosed rocks and baked earths with their thermo-remanent magnetization can be actually examined by the following methods.

(i) *Heat experiment.*

(*) Changes in the natural remanent magnetization, Jn, with increase in temperature, T, are measured in non-magnetic and vacuum space, Jn(T) being expressed as a function of T. By cooling in the geomagnetic field, the thermo-remanent magnetization, J_{Tc}, of the same specimen is produced, and then changes of J_{Tc} thus produced with increase in T are measured also in non-magnetic and vacuum space. If the direction of J_{Tc} is parallel to that of the geomagnetic field and if the Jn(T) curve is similar to the $J_{Tc}(T)$ curve, i.e. if $Jn(T)/J_{Tc}(T)$ is almost constant at any temperature, we may consider that the natural remanent magnetization is the normal thermo-remanent magnetization, which is reproducible in the laboratory. If the ratio $Jn(T)/J_{Tc}(T)$ is not much less than unity, being, say, 0.5—1, then we may presume, under the assumption that the ancient geomagnetic force is approximately the same as at present, that the thermo-remanent magnetization produced in a remote epoch has been not much demagnetized during the long period since then, and that the magnetic properties of the rock sample have remained with only little change since the time of its formation.

(**) The above-mentioned heating experiment can be replaced in most cases by an alternative procedure as follows. Heat a rock specimen having a remanent magnetization J up to T in temperature, and then cool down to the atmospheric temperature in non-magnetic space. The residual magnetization is denoted by $(J)_T$ (Königsberger, 1938; Hospers, 1953; Roche, 1953; Nagata et al., 1954). This procedure is called a thermal demagnetization at temperature T. When T is successively increased, $(J)_T$ disappears completely at higher than a critical temperature Tc. We can thus obtain $(Jn)_T$ and $(J_{Tc})_T$ of the same specimen as functions of T. If the ratio $(Jn)_T/(J_{Tc})_T$ is approximately constant and not much less than unity at any temperature below Tc, there is no room for doubt that the natural remanent magnetization of the rock is the residue of the thermo-remanent magnetization. Such rock samples can be used reliably for the purpose of determining the direction of geomagnetic field in remote epochs.

(***) It is not always necessary to carry out the above-mentioned heat treatments in high vacuum, but the same procedures in the atmosphere are almost sufficient for testing stable rock-samples which are changed only a little by heating in the atmosphere. Some other rocks, however, are apt to be changed appreciably owing to oxidation by heating in the atmosphere (Nagata et al., 1954). Although such a change in the rocks can be avoided in their heat treatments in vacuum, it seems better to exclude them as objects of palaeomagnetic studies, since the question may arise whether these rocks have been stable against oxidation at the atmospheric temperature during a long period.

(****) Occasionally magnetic and petrological characteristics of some rocks are changed appreciably even in high vacuum by heat treatments. Magnetism of such rocks is due to unstable ferromagnetic minerals, and therefore these rocks must be excluded in palaeomagnetic studies (Graham, 1953; Akimoto, 1954).

(ii) *Possible interpretation of the results of the heat experiments.*

(*) Sometimes the ratio Jn/J_{Tc} is very small, being less than say, 0.1, although it is approximately constant throughout the range of temperature below Tc. There may be little room for doubt that this Jn is due to the thermo-remanent magnetization. Since however the small value of Jn/J_{Tc} suggests that the natural remanent magnetization has been much reduced during a long period, it seems better to exclude such samples as objects of palaeomagnetic studies.

(**) The transition temperature of thermo-remanent magnetism, which is approximately equal to the Curie point, is higher than 450°C in most igneous rocks, indicating that the ferromagnetic minerals responsible for the magnetization are chiefly Ti-poor titanomagnetites (Akimoto, 1954). But there are some other cases where the transition temperature is less than 200°C, the ferromagnetic minerals consisting chiefly of Ti-rich titanomagnetites (Chevallier, 1932; Nagata et al., 1954). Since the stability of thermo-remanent magnetization decreases rapidly nearer the transition temperature (Curie point), and further since temperature of rocks could be raised up to 100°C or more at a moderate depth within the earth's crust owing only to the geothermal gradient, it seems better to exclude such rocks having low transition temperatures from present palaeomagnetic studies.

(***) It has been found that some particular rocks can have reversed thermo-remanent magnetization by the ordinary cooling procedure in a weak magnetic field (Nagata, 1951). Their natural remanent magnetization shows also a self-reversal in the heat experiment, Jn/J_{Tc} being almost constant and not much less than unity at any temperature below Tc. Then it is quite certain that the direction of the natural remanent magnetization is opposite to that of the geomagnetic field affecting the rock during its cooling.

As for the mechanism of self-reversal of thermo-remanent magnetization, Néel has proposed two different possibilities; (Néel, 1951) i.e. (1) reversal of spontaneous magnetization with change in temperature caused by difference in temperature gradients of magnetizations of two mutually opposed sites in a ferrimagnetic crystal, (N- or V- type ferrimagnetics according to Néel's definition), and (2) reversal of resultant magnetization of two different constituents which are so strongly interacted that their direction of magnetization is opposite to each other. The first case has not yet been found in rocks, but the presence of the second case has been ascertained in rocks in Japan (Nagata, Akimoto and Uyeda, 1953) and U.S.A. (Balsley and Buddington, 1954). In the Japanese rocks, a constituent which has a magnetization parallel to the direction of the applied field is Ti-poor titanomagnetite, while another which is reversely magnetized is a magnetic solid solution of ilmenite and hematite. It seems likely that the U.S.A. rocks are also composed of similar constituents.

(****)If the $(Jn)_T$ curve is much different in its form from the $(J_{Tc})_T$ curve of the same specimen, (or if the $Jn(T)$ curve differs from the $J_{Tc}(T)$ curve), we may presume that the natural remanent magnetization is due to some other cause than the thermo-remanent magnetization, such as, for example, the isothermal remanent magnetization resulting from a temporary appearance of a fairly strong magnetic field, or to some chemical change in the ferromagnetic minerals during a long period. Such samples must be avoided in present palaeomagnetic studies.

(iii) *Test of magnetic coercivity.*

(*) The thermo-remanent magnetization of rocks is very stable against a demagnetizing procedure by alternating field (i.e. A.C. demagnetization). The thermo-remanent magnetization acquired in the geomagnetic field can maintain more than half of the original strength after an A.C. demagnetization up to 200 Oe. in field intensity. In magnetically stable rocks it decreases only slightly even after an A.C. demagnetization up to 300 Oe. On the contrary, the isothermal remanent magnetization acquired in a magnetic field of say, 200 Oe, can be almost completely demagnetized by an A.C. demagnetization up to 100 Oe. Hence, we can distinguish the stable thermo-remanent magnetization from other unstable magnetization such as the isothermal remanent magnetization with the aid of experiments of A.C. demagnetization on naturally magnetized rocks.

(**) It has been reported that some rocks have a very large value of coercive force, being, for example, larger than 2000 Oe (Balsley and Buddington, 1954). Such a high coercivity takes place only under the condition that individual magnetic grains are so small as to consist of single magnetic domains. The remanent magnetization owing to the thermo-remanent magnetization of such grains of single domain must be extremely stable, being fully reliable for the palaeomagnetic purposes.

(iv) *Examination of magnetic, chemical and crystallographic properties of ferromagnetic minerals in rocks.*

(*)Determination of ferromagnetic minerals responsible for the magnetization of rocks is helpful in judging the reliability of magnetization. Generally speaking, ferromagnetic minerals of single phase is much more stable than those of poli-phases. When the ferromagnetic minerals in a rock are composed chiefly of Ti-poor titanomagnetites, we may consider that these minerals have been fairly stable. If they are mainly hematites, there will be a choice between two possibilities, i.e. that these hematites are the results of oxidation of other ferric-ferrous oxides (such as magnetite) during a long period since their mother rocks were formed; or that these hematites were present when their mother rocks (or the baked earth containing them) were formed and magnetized, and since then they have been chemically stable. The first case can not be used, but the second can be used with sufficient reliability for palaeomagnetic purposes. Ti-rich titanomagnetites are frequently unstable, so that careful attention must be paid to the stability of their magnetization. Maghemites (γ-Fe_2O_3) are unstable and the origin of remanent magnetization in these minerals has not yet been understood (Nagata and Watanabe, 1950). Hence the remanent magnetization owing to them must be avoided in present studies of palaeomagnetism.

(**) The intrinsic magnetic properties of ferromagnetic minerals can be represented by the curve of relation between saturation magnetization Js and temperature T. The Js-T curve of rocks of ferromagnetic minerals can be determined with a magnetic balance with a heater in high vacuum (Akimoto, 1954). The Curie point Θ thus determined is a characteristic quantity representing the constitution of the ferromagnetic minerals.

(***) The composition of ferromagnetic minerals in rocks can be approximately determined with the aid of chemical analysis and X-ray analysis of the ensemble of ferromagnetic minerals separated from the rocks by a magnetic separator.

(****) Microscopic and electron-microscopic observation of rocks are helpful to determine the average grain size of the ferromagnetic minerals, which is significant for the magnetic coercivity, and also to find the mineralogical constitution of individual grains when they consist of two or more phases.

(*****) Occasionally, ferromagnetic minerals are changed by heating. Such changes can be detected by analyzing the minerals by X-ray spectrograms obtained before and after the heat treatment, provided that the changes are remarkable.

(B) *Laboratory tests of the remanent magnetization of sedimentary rocks.*

(i) *Test of magnetic coercivity.*

(*) It seems that measurement of coercivity is the most significant test for the natural remanent magnetization of sediments. The method of A.C. demagnetization is the same as that proposed for igneous rocks. When the natural remanent magnetization of sediments results from stable magnetization of ferromagnetic minerals such as their spontaneous and thermo-remanent magnetizations, it is demagnetized much less than that due to isothermal remanent magnetization.

(**) In order to test the stability, changes in the remanent magnetization of specimens of sediments, which are left in the geomagnetic field in the laboratory, are observed (Kawai, 1954; Creer, Irving, Runcorn, 1954). The specimens must be so set that their initial direction of magnetization makes a rectangle or more with that of the magnetic field in the laboratory. Under such circumstances, some unstable rocks change their direction of magnetization with time towards that of the geomagnetic force, the change amounting to observable quantities within some days. It may be assumed that the sediment's magnetization whose direction does not change at all during a period of one year and more is fairly stable. But the above-mentioned tests are carried out only for the purpose of eliminating rock samples having unstable remanent magnetization. Even if a rock's magnetization is sufficiently stable during a year or so, this fact may be an insufficient proof for its stability during an enormously long geologic period.

(ii) *Heat experiments.*

The rate of change in the remanent magnetization of rocks with time can be increased when the rocks are kept at a temperature a little higher than the atmospheric one, say at 100°C. (Kawai, Kume, 1953). The influence of temperature and time upon the relaxation of the remanent magnetization of rocks has not yet been fully understood. Therefore no quantitative formula has been established about a possibility of reproducing in the laboratory the effect of time on the rock at the atmospheric temperature during a long geologic time. According to experience, however, some rocks can acquire a remanent magnetization as intense as the strength of their natural remanent magnetization after being kept at 100°C in the geomagnetic field for some hours. It seems unlikely that the remanent magnetization of such rocks is satisfactory for palaeomagnetic purpose.

(iii) *Identification of ferromagnetic minerals.*

Identification of ferromagnetic minerals which are responsible for the remanent magnetization of sediments is very helpful for the palaeomagnetic studies as in the case of igneous and thermally metamorphosed rocks. The method of magnetic analysis, such as measurement of Curie point, coercive force etc., seems to be the most convenient for the said purpose. X-ray and chemical analyses of the ferromagnetic minerals are also desirable (Creer, Irving and Runcorn, 1954).

(C) *General Remarks.*

Several hypotheses on the possibility of self-reversal of remanent magnetization of rocks have been proposed, but it seems to me that such a hypothesis becomes plausible only with some evidence from the field or from laboratory experiments. For example, Néel has proposed, beside the two hypotheses dealt with in (A) (ii) (***), two other alternatives: i.e. that an originally inferior magnetization of the inverse B sub-lattice in anti-ferromagnetic configuration of minerals becomes predominant by subsequent demagnetization or change of the originally predominant A sub-lattice, or that an originally inferior reversed magnetization of a mineral of lower Curie point becomes dominant after the destruction or demagnetization of the other normally magnetized mineral. Graham has also proposed a similar but somewhat modified hypothesis (Graham, 1953). It seems however that no definite evidence of these hypotheses has yet been found in the reversely magnetized rocks. Detailed studies on this problem are now under work. It is expected therefore that the reversed magnetization of some rocks may be identified to certain self-reversals of magnetization, the mechanism of which has not yet been confirmed.

The best possible way in palaeomagnetic studies at present may be to exclude, as objects of our palaeomagnetic studies, such rock samples the origin and the stability of whose remanent magnetization are in any way ambiguous viewed from present knowledge of magnetism, mineralogy and chemistry.

Appendix II

List of Publications on "Rock-Magnetism" from 1941 to 1954

* A complete list of literature on rock-magnetism before 1937 is given in Königsberger's summary (Terr. Mag. *43*, 119, 299, 1938).

** A list of selected literature on rock-magnetism published before 1952 is given in Nagata's "Rock-Magnetism" (1953).

(1941)

Kato, Y.: Investigation of the magnetic properties of rocks constituting the earth's crust (2nd report). On the susceptibility of the rock Part I and Part II. Sci. Rep. Tohoku Imp. Univ., *29*, No. 4, 602, 629 (1941).

McNish, A. G.: The significance of fossil magnetism. Proc. Amer. Phil. Soc., *84*, No. 2, 225 (1941).

Nagata, T.: The mode of causation of thermo-remanent magnetism in igneous rocks. Preliminary note. Bull. Earthq. Res. Inst., *19*, 49 (1941).

Nagata, T.: Measurement of changes in magnetic susceptibility of igneous rocks with temperature in a weak magnetic field. Bull. Earthq. Res. Inst., *19*, 579 (1941).

Patterson, R. G.: Determination of magnetic susceptibilities of rocks in situ. Amer. Inst. Min. Metall. Eng. Tech. Pub., No. 1298, 9 pp. (1941).

Puzicha, K.: Der Magnetismus der Gesteine als Funktion ihres Magnetit-Gehaltes. Beitr. angew. Geophysik, *9*, 158 (1941).

Reich, H.: The magnetic properties of rocks and ores and problems of ore deposits connected with them. Berlin. Zs. D. Geol. Ges., *93*, 445 (1941).

Reich, H.: Über die natürliche Magnetizierung von Gesteinen auf Grund von Messungen an Bohrkernen. Beitr. angew. Geophysik, *9*, 40 (1941).

Thellier, E.: Sur les propriétés de l'aimantation thermorémanente des terres cuites. C. R. Acad. Sc., *213*, 1019 (1941).

Thellier, E. and Thellier, O.: Sur les variations thermiques de l'aimantation thermorémanente des terres cuites. C. R. Acad. Sc., *213,* 59 (1941).

(1942)

Grenet, G.: L'influence de l'altération des roches volcaniques sur la stabilité de leur aimantation. Cahiers de Physique, No. 7, 41 (1942).

Haalck, H.: Der Gesteinmagnetismus. Becker und Erler Kom. Ges., Leipzig.

Nagata, T.: The mode of development of thermoremanent magnetism in igneous rocks. Bull. Earthq. Res. Inst., *20,* 192 (1942).

Thellier, E. and Thellier, O.: Sur l'intensité du champ magnétique terrestre en France, 3 siècles avant les premières mesures directes. C. R. Acad. Sc., *214,* 382 (1942).

(1943)

Benedikt, E. T.: A method of determination of the direction of the magnetic field of the earth in geological epochs. Amer. J. Sci., *2,* No. 241, 124 (1943).

Coulomb, J.: Sur l'aimantation des roches due à des grains disséminés. C. R. Acad. Sc., *216,* 351 (1943).

Herroun, E. F. and Hallimond, A. F.: Laboratory experiments on the magnetization of rocks. Proc. Phys. Soc., *55,* 214 (1943).

Ising, G.: On the magnetic properties of varved clay. Ark. Mat. Astr. Fys., *29,* A. I. No. 5 (1943).

McNish, A. G.: Fossil magnetism. Sci. Amer., *168,* No. 4, 166 (1943).

Nagata, T.: The natural remanent magnetism of volcanic rocks and its relation to geomagnetic phenomena. Bull. Earthq. Res. Inst., *21,* 1 (1943).

Nagata, T., Rikitake, T. and Akasi, K.: The natural remanent magnetism of sedimentary rocks (preliminary note). Bull. Earthq. Res. Inst., *21,* 276 (1943).

Nagata, T.: The magnetic hysteresis curve of volcanic rocks. Bull. Earthq. Res. Inst., *21,* 354 (1943) (in Japanese).

(1944)

Althausen, O. N.: Determination of the magnetic field of the earth acting in different geological epochs. Moscow Bull. Acad. Sci., Ser. Geog. Geophys. *8,* No. 6, 385 (1944) (in Russian).

Thellier, E. and Thellier, O.: Recherches géomagnétiques sur des coulées volcaniques d'Auvergne. Ann. de Géophys, *1,* 37 (1944).

(1945)

Grenet, G.: Quelques mesures d'aimantation permanente de roches du massif central et remarques sur les méthodes de détermination de la valeur du champ magnétique terrestre dans le passé. Ann. de Géophys, *1,* 256 (1945).

Nagata, T., Harada Y. and Hirao, K.: Natural remanent magnetization of sedimentary rock. Part II. Bull. Earthq. Res. Inst., *23,* 79 (1945) (in Japanese).

(1946)

Duffin, R. J.: Measurement of magnetic susceptibility with the Hughes induction balance. Terr. Mag., *51,* 419 (1946).

Roquet, J.: Sur les propriétés magnétiques de sesquioxyde de fer faiblement magnétique. C. R. Acad. Sc., *222,* 727 (1946).

Roquet, J. and Thellier, E.: Sur les lois numériques simples, relatives à l'aimantation thermorémanente du sesquioxyde de fer rhomboédrique. C. R. Acad. Sc., *222,* 1288 (1946).

Thellier, E. and Thellier, O.: Sur l'intensité du champ magnétique terrestre en France à l'époque gallo-romaine. C. R. Acad. Sc., *222,* 905 (1946).

(1947)

Nagata, T., Harada, Y. and Okada, A.: Measurement of natural residual magnetization of sediment by means of a new type magnetometer. Geophys. Notes, Tokyo Univ., Vol. 1, No. 13 (1947).

Roquet, J.: Sur l'aimantation rémanente isotherme du sesquioxyde de fer. C. R. Acad. Sc., *224*, 1418 (1947).

(1948)

Bossolasco, M.: Suscettivita magnetica di alcuni minerali di magnetite. Geofisica pura e appl., *12*, Fasc. 1—2, 52 (1948).

Bruckshaw, J. McG. and Robertson E. I.: The measurement of magnetic properties of rocks. Journ. Sci. Instr., *25*, 444 (1948).

Johnson, E. A., Murphy, T. and Torreson, O. W.: Pre-history of the earth's magnetic field. Terr. Mag., *53*, 349 (1948).

Nagata, T.: Local geomagnetic anomalies in volcanic regions and their interpretation. Comm. au Congres d'Oslo de l'U.G.G.I. 1948, l'A.T.M.E.

Petrova, G. N.: Ideal magnetization as one of the causes of high remanent magnetism in rocks. Izvest. Akad. Nauk. SSSR. Ser. Geg. Geofiz., *12*, No. 5, 475 (1948).

Schneider, E., Thellier, E. and Thellier, O.: Contribution géophysique à l'étude du Trias ophitique pyrénéen. Ann. de Géophys, *4*, 15 (1948).

(1949)

Bruckshaw, J. McG. and Robertson, E. I.: The magnetic properties of the tholeiite dykes of North England. M.N.R.A.S. Geophys. Suppl., *5*, 308 (1949).

Graham, J. W.: The stability and significance of magnetism in sedimentary rocks. Journ. Geophys. Res., *54*, 131 (1949).

Johnson, E. A., Murphy, T. and Michelsen, P. F.: A new high sensitivity remanent magnetometer. Rev. Sci. Instr., *20*, 429 (1949).

Manley, H.: The thermo-magnetic properties of igneous rocks. Thesis, London University 1949.

Nagata, T., Hirao, K. and Yoshikawa, H.: Remanent magnetization of pleistocene deposits. Journ. Geomag. Geoel., *1*, No. 2, 52 (1949).

Néel, L.: Théorie du traînage magnétique des ferromagnétiques en grains fins avec application aux terres cuites. Ann. de Géophys, *5*, 99 (1949).

Thellier, E. and Thellier, O.: Sur les propriétés magnétiques des roches éruptives pyrénéennes. C. R. Acad. Sc., *228*, 1958 (1949).

Torreson, O. W., Murphy, T. and Graham, J. W.: Magnetic polarization of sedimentary rocks and the earth's magnetic history. Journ. Geophys. Res., *54*, 111 (1949).

Torreson, O. W., Murphy, T. and Graham, J. W.: Rock magnetism as a clue to earth's magnetic history. Phys. Rev., *75*, 208 (1949).

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Bruckshaw, J. McG. and Rao, B. S.: Magnetic hysteresis of igneous rocks. Proc. Phys. Soc., B *63*, 931 (1950).

Godard, L.: Etudes sur les propriétés magnétiques des coulées de lave. Thèse, Strasbourg (1950).

Kato, Y.: On the magnetic moment of the residual magnetism of the rock. Journ. Geomag. Geoel., *2*, 81 (1950).

Kumagai, N., Kawai, N. and Nagata, T.: Recent progress in palaeomagnetism in Japan. Journ. Geomag. Geoel., *2*, 61 (1950).

Nagata, T.: Natural remanent magnetism of igneous rocks and its mode of development. Nature, *165*, 245 (1950).

Nagata, T. and Akimoto, S.: Magnetic transition points of volcanic rocks. Journ. Geomag. Geoel., *2,* 29 (1950).

Nagata, T. and Watanabe, T.: Magnetic properties of the rocks containing maghemite (γ-Fe_2O_3). Geophys. Note, Tokyo University, *3,* No. 21 (1950).

Pouillard, E.: Sur le comportement de l'alumine et de l'oxyde de titane vis-a-vis des oxydes de fer. Ann. de Chim., *5,* 164 (1950).

Roche, A.: Sur les caractères magnétiques du système éruptif de Gergovie. C. R. Acad. Sc., *230,* 113 (1950).

Roche, A.: Anomalies magnétiques accompagnant les massifs de pépérites de la Limagne d'Auvergne. C. R. Acad. Sc., *230,* 1603 (1950).

Roquet, J.: Sur la décroissance des aimantations thermorémanente et rémanente isotherme des terres cuites par action de champs opposés croissants. C. R. Acad. Sc., *230,* 1939 (1950).

Roquet, J.: Sur la décroissance des aimantations thermorémanente et rémanente isotherme des terres cuites par réchauffements successifs à températures croissantes. C. R. Acad. Sc., *230,* 282 (1950).

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Akimoto, S.: Magnetic susceptibility of ferromagnetic minerals contained in igneous rocks. Journ. Geomag. Geoel., *3,* 47 (1951).

Hospers, J.: Remanent magnetism of rocks and the history of the geomagnetic field. Nature, *168,* 1111 (1951).

Kato, Y.: On the magnetic moment of the residual magnetism of the rock. Sci. Rep. Tohoku Univ., Ser 5. Geophysics, *3,* No. 1, 45 (1951).

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Special Report on the Equatorial Jet Current

by D. F. Martyn

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(1) *Introduction.*

The equatorial jet current was discovered as a result of the establishment of the magnetic observatory at Huancayo, Peru, by the Carnegie Institution of Washington, (Department of

Terrestrial Magnetism). It appeared that the Sq magnetic variation in H at this site was some two or three times greater than that at other low latitudes. In 1948 the International Association of Terrestrial Magnetism and Electricity set up a committee under Dr. Egedal to further the study of these large variations in other parts of the world. It soon became apparent that the equatorial jet current was observable in the data obtained at many observatories prior to the establishment of Huancayo, although unremarked by previous observers. (There appears to be an important moral to be drawn from this, one particularly relevant with the Geophysical Year imminent; it is important to set up observatories to obtain new geophysical data, *but equally important to devote much effort and time to the study of the data so obtained.* C.S.A.G.I. has already commented on the importance of this).

The most comprehensive and thorough study of the equatorial jet, as evidenced in the data of the "Polar Year" 1932—33, has been made by A. T. Price and G. A. Wilkins (J. Geophys. Res.*56,* 259, 1951). They conclude that the jet is a maximum "between the magnetic and dipole equators in South America and Africa, but occurs to the south of both these equators in the Far East". This conclusion appears to be thoroughly sound for S.America and Africa, but rests on slender evidence, as these authors admit, for the Far East. Unfortunately this is the region in which Committee 11 has thus far failed to obtain new evidence. The brief but widely dispersed important observations made at the instigation of the Chairman of Committee 11 tend to confirm the findings of Price and Wilkins. In most cases these observations have been made by absolute methods on a very few days; what is wanted now is the establishment of magnetic recording at a few key positions during the A.G.I. Uncertainty remains about the position of the jet in the equatorial regions north of Australia and New Zealand.

(2) *Theory of the Equatorial Jet.*

In 1948 it became apparent that the conductivity of the ionosphere was inadequate for the purposes of the dynamo theory of the magnetic variations (Cowling & Borger; Nature, *161,* 515, 1948). Martyn (Nature *162,* 142, 1948) suggested that the conductivity of the ionosphere might be enhanced by inhibition of the Hall current. Later Baker and Martyn (Phil. Trans. *246,* 281, 1953) developed the dynamo theory in detail, taking account of Hall conductivity. They found that the conductivity of the ionosphere was generally enhanced over the globe, and especially enhanced in a narrow zone, a few degrees wide, at the geomagnetic equator, which they assumed to coincide with the geographic equator. Thus it appears that the equatorial jet is directly attributable to the complete (vertical) polarization of the Hall current.

In a recent paper (in course of publication) Baker has considered the case where the geomagnetic equator does not coincide with the geographic equator. He finds that "the electrojet lies in a great circle intersecting the geomagnetic equator in geomagnetic longitudes 60° and 240°, and departs from this equator by a maximum of 2° (north) in geomagnetic longitude 330°". The electrojet is a minimum when it crosses the geomagnetic equator and a maximum when the two equators are furthest apart. The total variation of the electrojet current (for uniform conductivity over the earth) is however less than 1 %.Baker's findings in these respects differ somewhat from earlier calculations due to K. Maeda (Japan).

There remains of course the complex problem of evaluating the effect of non-coincidence of the geomagnetic equator with the equator of zero dip, and of the non-uniform distribution of conductivity over the globe.

Nevertheless it may be said that the origin of the equatorial jet is now understood, though details of the exact position and magnitude remain to be settled.

(3) *Eclipse Effects on the Electrojet.*

Observations of the diurnal magnetic variation in H were made by M. R. Madwar during the solar eclipse of 1952, Febr. 25, and on the two days immediately adjacent. They were made at Kubbu in the Sudan, (lat. 10° 07.3′ N., long. 26° 37.0′ East) almost exactly on the magnetic equator. Here the eclipse began at 9h.27m. and ended at 12h.16m. local time, totality occurring at 10h.49m. All available measurements are given in the table on p. 357.

Although the data on the two control days is rather fragmentary, and statistical analysis impossible, there is little doubt that the eclipse reduced the daily variation of H to almost half its normal value. This appears to be the first direct evidence of the effect of a solar eclipse upon Sq. Certainly no more favourable location for the detection of such an effect could have been chosen; an eclipse effect *ought* to be readily detected *anywhere* under the electrojet at the time of the eclipse. The world-wide effect of an eclipse on Sq by reducing the conductivity of the ionospheric *sheet* is relatively small, as Chapman has shown; the total current in the sheet is little affected, since it tends to bypass the poorly conducting region. Even within this region the current *tends* to be maintained at is normal level by the development of a polarization field on its boundary.

Matters are very different for the electrojet, which is essentially a line current, its breadth being much smaller than the size of the sun's shadow. Moreover we know with some certainty

(Baker and Martyn, loc.cit.) that the electrojet is due to abnormally high equatorial conductivity at a height close to 100 km. Here the relaxation time of the ionosphere is only a few minutes, and the conductivity must drop rapidly over a substantial section of the electrojet. In this case no bypassing is possible, and the electrojet should be wiped out over *all* the daylight hemisphere, whether inside or outside the region eclipsed. One would expect the field variation in Sq at Kubbu during the eclipse to drop to less than half its normal range.

Kubbo. Lat. 10°07'.3N Long. 26°37'.0E

1952	Time	Horizontal Component	Remarks
23-2	17^{h}22^{m}	34595γ	
	36	595	Quiet
	47	597	
24-2	6 42	477	
	54	490	
	7 08	506	
	19	508	
	11 01	634	
	12	616	Disturbed
	26	586	
	40	620	
	16 56	497	
	17 06	492	
	16	490	
	25	494	
25-2	6 38	527	
	46	530	
	54	534	
	7 02	537	
	9 38	604	
	46	606	
	57	605	
	10 08	600	Quiet except
	18	594	a bay from
	28	589	13^{h} to 15^{h}

1952	Time	Horizontal Component	Remarks
25-2	10^{h}37^{m}	34582γ	
	49	582	
	59	585	
	11 08	591	
	17	587	
	28	570	
	36	565	
	50	567	
	12 04	562	
	14	559	
	23	564	
	17 33	557	
	40	557	
	47	554	
	55	555	
26-2	6 30	561	
	39	565	
	47	566	
	56	573	
	10 58	669	Disturbed
	11 07	676	
	16	671	
	28	650	

Special Report on Instrumental Equipments for the Recording of Rapid Magnetic Variations

At the request of the Special Committee for the International Geophysical Year (CSAGI) and on behalf of the IATME Committee on Observational Technique Prof. *E. Thellier,* in his capacity as Chairman of the latter Committee has prepared a comprehensive report on instrumental equipments used for the recording of rapid magnetic variations. This report was presented at the IATME meeting (see p. 36) and is being printed in the "Annals of the International Geophysical Year", Vol. IV, Part V.

Special Reports on the International Geophysical Year

During the Rome Assembly several working groups were established by the IATME for the study of observational programmes to be carried out within different disciplines during the International Geophysical Year 1957—58. All of these working groups prepared special reports which were later submitted to the CSAGI and which, to a large extent, served as base for the recommendations made by that body during its meeting in Rome in September—October 1954. The working groups have already been mentioned in the minutes of the meeting of the Association and are listed here for reference:

1. *Working Group on Geomagnetism*
   Membership see p. 17. CSAGI recommendations see I.U.G.G. News Letter No 9, pp. 109—119.
2. *Working Group on Aurora*
   Membership see p. 25. CSAGI recommendations see I.U.G.G. News Letter No 9, pp. 120—133.
3. *Working Group on Airglow*
   Membership see p. 24. CSAGI recommendations see I.U.G.G. News Letter No 9, pp. 133—136.
4. *Working Group on Cosmic Rays*
   Membership see p. 40. CSAGI recommendations see I.U.G.G. News Letter No 9, pp. 156—163.
5. *Working Group on Rockets*
   Membership see p. 15. CSAGI recommendations see I.U.G.G. News Letter No 9, pp. 176—181.

Part V

Communications

In accordance with a policy adopted at the Brussels meeting 1951, the full text of technical communications will not be included in the Transactions. The presentation will be limited to references to periodicals where the complete texts may be found and where such information has become available to the Editor, or to brief author's abstracts in those cases where they have been supplied and citations are not available.

Observations of low-latitude aurorae in Greece

By W. N. Abbott

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It should be very interesting to secure as many observations of low-latitude aurorae as possible, and stations in Greece would be very useful. Although by no means frequent, low-latitude aurorae are not as rare as it is generally believed, and appropriate team work may yield interesting information as to their frequency, and, thereby, increase our knowledge of the mechanism of auroral phenomena in general. We shall mention that on the night of August 19, 1950, the author obtained a photograph of an aurora from the station on Spetsai Island, located at azimuth 260° (Journal of Atm. and Terr. Physics, vol. I, p. 343). A programme of work is, therefore, under study.

These observations in Greece will be made from two stations. One located on Spetsai Island in South Greece, the other in Macedonia in the region of Salonica. The length of this base-line is about 400 kilometres and its direction is almost due N—S. Observing will be primarily visual, preferably with Patton auroral filter (5577 Å) mounted on goggles and costing about £ 50— a piece. Detailed records will be kept in writing and in drawing of the aspect, orientation, intrinsic brightness, and shape of the streamers and the position and motion of the base or bases. Photographic recording will have to be left for the time being to the judgement and, especially, to the individual possibilities of the observers, and although of course welcome will not be compulsory. For the moment it is financially impossible to supply observers with cameras and appropriate equipment or train them to their use. Altitude and azimuth will be measured by means of simple and rugged contraptions giving satisfactory approximation, and continuous measurements of position when an aurora is in view are essential, considering the impossibility of establishing long-distance telephone contacts on very short notice and maintaining them through the night. With the present development of telephone communications in Greece on an entirely new principle it may be possible in the future to establish a permanent contact of the two stations at night, by telephone.

Routine patrol-observing would be ideal. Anyway, and even if this is rendered possible, the Astronomical and Meteorological Institutes of the Observatory of Athens will cooperate to alert observers of eventual solar disturbances.

The Salonica station will, further, be relayed to a Yugoslav station; if this is located in the environs of Belgrade the base line will be about 500 kilometres, which is excellent.

This is a very general outline of the project, the realisation of which will necessitate the collaboration of several departments.

Observations on the red line of oxygen

By P. St. Amand

U.S. Naval Ordnance Test Station, China Lake, California

The complete text is published under the title: "Some possible relations between the nightglow and the ionosphere" in Ann. Géophys. 11, pp. 450—460, 1955. (IAGA Bull. 15 b, pp. 250—260, 1956).

Instrumentation for nightglow research

By P. St. Amand

U.S. Naval Ordnance Test Station, China Lake, California

The complete text is published in Ann. Géophys. 11, pp. 435—449, 1955. (IAGA Bull. 15 b, pp. 235—249, 1956).

Variations with time of cosmic ray intensity

By F. Bachelet and A. M. Conforto

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Consiglio Nazionale delle Ricerche, Roma

An apparatus for the continuous registration of the total ionizing component of cosmic rays at sea level is described. This has been set up at Rome to study the correlation between cosmic ray intensity and atmospheric, geomagnetic and solar phenomena.

The apparatus consists of telescopes of Geiger-Müller counters in triple coincidence, directed vertically, and inclined at 30° to the vertical in the directions South and North respectively. The difference between the diurnal variations in the two inclined directions is considered free from atmospheric effects and is thus able to show an anisotropy of the primary radiation.

There are four independent telescopes in each direction, with a total of about 27000 coinc./hr. in North and South directions respectively, and about 48000 coinc./hr. in the vertical.

The counters are held thermostatically at $(30 \pm 1)\,°C$.

The methods used to reduce the instrumental differences and to obtain the maximum stability and continuity of working are described.

The preliminary results obtained in the first counting period, from January to March 1954, are presented.

Correlation of reverse remanent magnetism and negative anomalies with certain minerals

By J. R. Balsley and A. F. Buddington

U.S. Geological Survey, Washington, D.C. and Princeton, N.J.

The complete text is published in Journal of Geomagnetism and Geoelectricity, Vol. VI, No. 4, pp. 176—181, 1954.

Interpretation of the airglow spectrum

By D. Barbier

Institut d'Astrophysique, Paris

The complete text is published under the title: "Analyse du spectre du ciel nocturne" in Ann. Géophys. 11, pp. 181—208, 1955. (IAGA Bull. 15 b, pp. 67—94, 1956).

Theory of the auroral spectrum

By D. R. Bates

Department of Applied Mathematics, Queens University of Belfast

The complete text is published in Ann. Géophys. 11, pp. 253—278, 1955. (IAGA Bull. 15 b, pp. 135—160, 1956).

Map of the disturbances of the geomagnetic vertical intensity of Europe

By R. Bock

Berlin — Friedenau

In co-operation with the Amt für Bodenforschung of Hannover it is attempted to make a new map of Europe with the anomalies of the geomagnetic vertical intensity based on a uniformly derived normal field.

The first draft (scale 1:6 000 000) will be presented at the Rome Meeting.

It is suggested that the IATME recommend this work to be done on a Europe-wide basis, and the Geophysical Department of the Amt für Bodenforschung to be entrusted with the designing, until the next meeting, of a new sketch corresponding to the latest situation.

All the European geophysical institutions and companies are invited to support this task by delivering pertinent values.

Die Zeitdauer des Blitzes

von M. Bossolasco

Istituto Geofisico e Geodetico, Genova

The complete text has been published under the title: "La durata dei lampi" in Geofisica e Meteorologia, Vol. II, nr. 5—6, 1954.

Physical properties of the earth's core

By K. E. Bullen

University of Sydney

The complete text is published in Ann. Géophys. 11, pp. 53—64, 1955. (IAGA Bull. 15 a, 1955).

Etudes des p.s.c. enregistrées au moyen du variomètre électromagnétique. Comparaison avec les enregistrements classiques

Par J. L. Bureau

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de l'Université d'Alger

Les p.s.c. enregistrées à Tamanrasset sur un variomètre électromagnétique apparaissent sous différentes formes pulsationnelles. Leur répartition diurne présente un maximum entre 21^h et 1^h T. U., leur répartition annuelle un minimum en Juin—Juillet et un autre en Décembre. Quand elles correspondent à une baie sur un appareil classique, elles la précèdent ou se trouvent dans sa partie initiale. On trouvera une comparaison de débuts de p.s.c. enregistrées sur variomètre électromagnétique à Tamanrasset et M'Bour.

Variomètre électromagnétique Type B

Par J. Castet et G. Grenet

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de l'Université d'Alger

Dans ce travail on rappelle les caractéristiques principales du variomètre Type A qui permet d'enregistrer la dérivée des variations du champ magnétique terrestre par rapport au temps, la sensibilité restant constante pour les périodes supérieures à 8 secondes.

L'appareil Type B diffère du précédent par son bobinage qui combine un solénoïde court et des bobines compensatrices. Le résultat est que l'appareil tout en conservant les mêmes caractéristiques est pratiquement insensible à l'agitation microséismique.

The magnetic secular variation

By J. Coulomb
Université de Paris

The complete text has been published under the title: "Variation séculaire par convergence ou divergence à la surface du noyau" in Ann. Géophys. 11, pp. 80—82, 1955. (IAGA Bull. 15 a, 1955).

The direction of the earth's magnetic field in remote epochs

By K. M. Creer, E. Irving and S. K. Runcorn
Department of Geodesy and Geophysics, University of Cambridge

The complete text is published under the title: "The direction of the geomagnetic field in remote epochs in Great Britain" in Journal of Geomagnetism and Geoelectricity, Vol. VI, No. 4, pp. 163—168, 1954.

Contribution to the study of the violet and ultraviolet airglow spectrum

By M. Dufay and J. Dufay
Observatoires de Lyon et de Haute-Provence

The complete text is published under the title: "Contribution à l'étude du spectre du ciel nocturne dans le violet et le proche ultraviolet" in Ann. Géophys. 11, pp. 209—213, 1955. (IAGA Bull. 15 b, pp. 95—99, 1956).

The origin of magnetic storms and aurorae

By V. C. A. Ferraro
Queen Mary College, University of London

The complete text is published in Ann. Géophys. 11, pp. 284—304, 1955. (IAGA Bull. 15 b, pp. 166—186, 1956).

World-wide variations of cosmic-ray intensity and terrestrial magnetic activity

By S. E. Forbush
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Recent analysis of cosmic-ray data from Compton-Bennett meters at Godhavn (1939—1950), Cheltenham (1937—1952), Huancayo (1937—1952) and Christchurch (1938—1950) confirms that except for solar-flare effects,[1, 2] the variations at each station result from the superposition[3] of: (1) a seasonal wave (of zero amplitude at Huancayo), (2) irregular effects resulting from unsystematic variations in vertical air-mass distribution and consequent variations from meson decay (negligible at Huancayo), and (3) a world-wide component of about the same magnitude at all stations.

That the upper limit of effects, (2) above, at Huancayo is small is shown by the small standard deviation of daily means from monthly means which in 1944 (near sunspot minimum) was only about 0,2 percent. Comparison of results for Huancayo with those obtained by J. A. Simpson[4] with neutron counters and with those of H. V. Neher[5] from balloon-borne ionization chambers indicates that the daily mean world-wide component is provided by Huancayo with an uncertainty of about 0,2 percent.

The world-wide component comprises: (1) the quasi-periodic 27-day variations[6] opposite in phase to those in terrestrial magnetic activity, (2) an 11-year variation with range about 4 percent, negatively correlated with sunspot numbers, and (3) decreases during some magnetic storms.

The main purpose of this note is to indicate results of an attempt to determine whether terrestrial magnetic effects are different for storms with and without cosmic-ray effects. According to a theory of H. Alfvén[7], changes in cosmic-ray intensity during magnetic storms should result from the change in energy of cosmic-ray particles due to the difference in potential to which they are subjected when crossing a solar stream of particles carrying a magnetic field. Since the magnitude and direction of the magnetic field carried in the stream is expected to vary, from one storm to another, the electric field across the stream (as seen by an observer not moving with it) would consequently be different, and would possibly affect the direction of flow of the electric currents across the polar cap which form the return circuit for the auroral zone currents responsible for the S_0 magnetic variations.[8]

An interval of 24 hours was selected, near the maximum of the main phase, for each of a few magnetic storms dichotomized according to whether or not the associated cosmic-ray decreases were large. For each hour of each selected interval, the direction (relative to magnetic north) of the vector representing the departure of the total magnetic component in the horizontal plane, from its average for magnetically quiet days, was determined for Godhavn, and plotted as function of the time of day for each selected interval. Although the amplitudes of these vectors varied considerably within the selected 24-hour interval, their directions varied in a remarkably systematic manner, which was the same for both classes of storms and also consistent with the variations of the vectors for the average of disturbed days.[8] Thus results of this study revealed no difference for storms with and without cosmic-ray decreases.

Since this investigation was completed, W. F. G. Swann[9] has shown that if the velocity of the solar stream is taken as 2×10^8 cm sec^{-1}, then the change in energy of a cosmic-ray particle crossing the stream cannot exceed about one percent however large the magnetic field in the stream or its width. Nevertheless, it should be pointed out that the observed world-wide changes in cosmic-ray intensity may possibly result from scattering effects on cosmic-ray particles due to the magnetic field of the stream and that such effects would depend on the size of the stream and the magnitude and direction of the field in it.

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Rocket results on ultraviolet radiation and X-rays

By H. Friedman

U.S. Naval Research Laboratory, Washington

The complete text is published under the title: "The solar spectrum below 2000 ångströms" in Ann. Géophys. 11, pp. 174—180, 1955. (IAGA Bull. 15 b, pp. 60—66, 1956).

Pulsations in the terrestrial magnetic field at the time of bay disturbance

By G. Grenet, Y. Kato, J. Ossaka and M. Okuda

The complete text is published in the Science Reports of the Tôhoku University, Series 5, Geophysics, Vol. 6, No. 1, July 1954.

The remanent magnetism of varved clays from Sweden

By D. H. Griffiths

Department of Geology, University of Birmingham

The complete text is published in Journal of Geomagnetism and Geoelectricity, Vol. VI, No. 4, pp. 217—220, 1954.

The lunar air tide

By B. Haurwitz
New York University

The complete text is published (by B. Haurwitz and R. Sawada) in Ann. Géophys. 11, pp. 145—147, 1955. (IAGA Bull. 15 b, pp. 31—33, 1956).

Summary of studies on rock magnetism

By J. Hospers
University of Cambridge

The complete text is published in Journal of Geomagnetism and Geoelectricity, Vol. VI, No. 4, pp. 172—175, 1954.

Machine processing of magnetic data

By L. Hurwitz, P. L. O'Dea and J. H. Nelson
U.S. Coast and Geodetic Survey

The U.S. Coast & Geodetic Survey is now using punched-card techniques for computing the main hourly value tables in the MHV publication, and for the routine computation necessary for the construction of world isomagnetic charts, using machines of the International Business Machines Corporation. The computation of hourly values includes the application of variometer temperature coefficients, where necessary, and the use of a code for taking selected-day hourly sums. The final tables, ready for reproduction, are then processed by the machines. The machine work for the world charts includes secular change reductions, computation of other elements, and averaging operations. The use of the machines results in a considerable saving in manpower and money.

Theories of the ultraviolet emission from the sun

By C. de Jager
Sterrewacht Sonnenborgh, Utrecht

The complete text is published under the title: "The ultraviolet and X-ray spectrum of the sun" in Ann. Géophys. 11, pp. 330—352, 1955. (IAGA Bull. 15 b, pp. 212—234, 1956).

Mass spectrometric determination of atmospheric ions

By C. Y. Johnson and E. B. Meadows
Naval Research Laboratory, Washington 25, D.C.

The complete text is published under the title: "First investigation of the ambient positive ion composition to 219 Km by rocket borne spectrometer" in Ann. Géophys. 11, p. 173, 1955. (IAGA Bull. 15 b, p. 59, 1956).

Radioecho from aurorae

By T. R. Kaiser

Jodrell Bank Experimental Station of the University of Manchester

The complete text is published (by T. R. Kaiser and K. Bullough) in Ann. Géophys. 11, pp. 279—283, 1955. (IAGA Bull. 15 b, pp. 161—165, 1956).

Atmospheric data from meteors

By T. R. Kaiser

Jodrell Bank Experimental Station of the University of Manchester

The complete text is published (by T. R. Kaiser and S. Evans) under the title: "Upper atmospheric data from meteors" in Ann. Géophys. 11, pp. 148—152, 1955. (IAGA Bull. 15 b, pp. 34—38, 1956).

Investigation of terrestrial magnetism by means of a fluxmeter

By A. G. Kalashnikov

USSR Academy of Sciences

1. Investigations of the earth's magnetic field and the magnetic properties of rocks can in many cases be reduced to fluxmeter measurements of the changes in the magnetic flux in a certain circuit. These determinations can be brought to a high degree of precision.

2. Theoretical investigations of the author enabled him to elaborate a series of schemes of a fluxmeter for different use in the field of geomagnetics. In elucidating the physical laws underlying the performance of a fluxmeter, definite interrelations have been found to exist between some of its parameters, enabling the scientist to make allowance for the constant errors of the instrument inherent in its construction. It has been established by experiment that a fluxmeter will integrate the impulses of magnetic intensity and can register their variations in time with a definite degree of precision.

3. In the fluxmeters constructed at the Geophysical Institute of the USSR Academy of Sciences, the sensibility is about 60 maxwell units for 1 mm (on the recorder scale), which corresponds to an impulse integration of $6 \cdot 10^{-7}$volts per sec. By means of these fluxmeters a series of precise magnetic determinations can be carried out.

4. The following geomagnetic problems have been solved thereby:

A. *Investigations of very feeble variations in the magnetic field of the earth* due to different causes of geophysical nature. The instrument was connected with a big induction circuit in the shape of a cable ring 100—300 m. in diameter and with an autographic recorder. Experimental stations thus equipped, registering as slight variations in the magnetic field of the earth as about 0.005 γ, were set up in the vicinity of Moscow and in Central Asia.

I. *The magnetic effect of the meteors* during meteoric showers was investigated at these stations in the period 1948—1952. It has been found that the frequency of magnetic impulses during the Leonids and Perseids greatly exceeds the usual frequency of these impulses. Magnetic impulses of about 0.01 γ were registered at the fluxmetric stations, and this fully accords with the elementary meteoric magnetic effect theory, which forecasts the appearance of such impulses as a result of the meteor electronic tracks in the atmosphere.

II. *Registering of magnetic impulses from lightning currents* gives the intensity of these currents provided that the distance between the station and the lightning is known.

III. *Microvariations in the terrestrial magnetic field.* Systematic fluxmeter measurements of the earth's magnetic field have led to the discovery of new types of microvariations of an amplitude 0.1—0.01 γ; among them there are four different groups of periodic microvariations with the periods of 30—60 sec., 10—15 sec., and 1—1.5 sec.

IV. *Constant 24-hour variations of two types in the terrestrial magnetic field* have been discovered from the records of the fluxmeter stations: series-type in daytime and rather constant sinusoidal types at night.

B. *A magnetic gradientmeter with a fluxmeter* consists of two couples of rotating coils connected with a fluxmeter through a commutator specially designed for the purpose. This device serves for measuring the gradients of the geomagnetic field (the 2nd derivative of the magnetic potential) in a sphere 0,7 meters in diameter: in the test the sensibility was about 3 γ for 1 meter on the recorder scale. Evidently, this device can be equally used without the impulses being commuted to a fluxmeter, with coils rotating at constant speed.

C. *A combination of a magnetometer with fluxmeter* provides for swift and easy measurements of magnetic permeability and residual magnetization of rocks. It includes one magnetizing coil and two induction coils, one serving for the compensation of the e.m.f. in the measuring coil, while the other contains the sample. For a field reluctance of about 40 oersted 10^{-5} C.G.S. units correspond to 1 mm. scale of the recorder (for magnetic permeability — $\varkappa$). The minimum residual magnetization recorded is $5 \cdot 10^{-4}$ gauss, cm^3. The device can be used as an autographic recorder for hysteresis loops of slightly magnetic rocks.

Reverse natural remanent magnetism of dyke of basaltic andesite

By Y. Kato, A. Takagi and I. Kato
Tôhoku University

The complete text is published in Journal of Geomagnetism and Geoelectricity, Vol. VI, No. 4, pp. 206—207, 1954.

Instability of natural remanent magnetism of rocks

By N. Kawai
Geological Institute, Kyoto University

The complete text is published in Journal of Geomagnetism and Geoelectricity, Vol. VI, No. 4, pp. 208—209, 1954.

The Norwegian Hydrographic Office and the magnetic survey of Norway

By R. Kjær
Norges Sjökartverk, Oslo

The complete text is published in the International Hydrographic Review (May 1954).

The synthesis of external magnetic fields by means of radial internal dipoles

By David G. Knapp
U.S. Coast and Geodetic Survey

The complete text is published in Ann. Géophys 11, pp. 83—90, 1955. (IAGA Bull. 15 a, 1955).

Le gradient de potentiel en altitude (mesures obtenues par radiosondes)

Par L. Koenigsfeld
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Aprés avoir obtenu des résultats intéressants sur la variation du potentiel atmosphérique au sol et en altitude pendant l'éclipse solaire du 25 février 1952 à Libenge (Congo Belge), des mesures ont été poursuivies à l'Institut Météorologique d'Uccle (Belgique).

Les lancés très fréquents de radiosondes, tant de jours que de nuits, ont été effectués à Uccle permettant ainsi de mesurer les 4 éléments de pression, température, humidité et gradient du potentiel.

Le résultat de ces mesures a été discuté en le comparant avec les mesures de potentiel au sol, les différentes masses d'air, vents, humidité etc ...

Ces mesures ont montré en particulier que les variations du potentiel augmentaient progressivement jusqu'au niveau de la première couche nuageuse.

On observe presque toujours les variations maxima au niveau des nuages, même si la sonde passe dans une partie de l'atmosphère où il n'y a pas de nuages.

Une augmentation souvent très nette du potentiel est remarquée à moins 32° ainsi que vers moins 40° mais moins fréquemment.

A partir de la stratosphère les variations sont très faibles et comprises entre 0 et 10 volts.

Enregistrements des courants telluriques à l'occasion de l'éclipse de soleil du 25 février 1952

Par G. Kunetz

Compagnie Générale de Géophysique, Paris

La présente communication est consacrée à l'étude des enregistrements des courants telluriques auxquels on a procédé à l'occasion de l'éclipse de soleil du 25 février 1952.

Ces enregistrements ont eu lieu, du 24 février à 20 heures au 25 février à 20 heures (GMT), en France, en Italie, au Sahara, en Afrique Equatoriale, au Vénézuéla et aux U.S.A. Les deux composantes N—S et E—W ont été enregistrées en chacun des points de mesure à une vitesse de déroulement de 2 cm. à la minute et une sensibilité qui, suivant l'emplacement et l'intensité des variations, était comprise entre 20 mm. et 200 mm. pour une différence de potentiel de 1mV entre des électrodes généralement distantes de 1.000 m.

Après une rapide étude de la précision des signaux horaires que comportent ces enregistrements, et de la constance de leur vitesse de déroulement, on examine successivement:

1° — la corrélation détaillée des variations rapides au cours d'intervalles de temps particulièrement caractéristiques. — On en conclut à la simultanéité de certaines de ces variations, dans la limite de précision de quelques secondes que l'on peut atteindre.

2° — la corrélation du niveau moyen de l'agitation, les moyennes étant étendues à des intervalles de temps plus ou moins longs. — On constate que les moyennes relatives à des intervalles assez *courts* (30 minutes) présentent une excellente corrélation en heure GMT et une corrélation trés médiocre en heure locale, alors que les conclusions sont inverses quand on considère des intervalles de temps assez longs (3 à 4 heures).

3° — la comparaison des niveaux de cette agitation au cours de l'éclipse et en dehors de l'éclipse. — Aucun effet de l'éclipse sur le niveau de l'activité tellurique n'a pu être mis en évidence.

The geomagnetic secular variation and induction in the earth's core

By F. J. Lowes

Department of Geodesy and Geophysics, Cambridge University

The complete text is published under the title: "Secular variation and the non-dipole field" in Ann. Géophys. 11, pp. 91—94, 1955. (IAGA Bull. 15 a, 1955).

Diffusion processes in the thermosphere

By P. Mange

Ionosphere Research Laboratory, Pennsylvania State University, State College, Pa.

The complete text is published in Ann. Géophys. 11, pp. 153—168, 1955. (IAGA Bull. 15 b, pp. 39—54, 1956).

On the Es near the magnetic equator

By S. Matsushita

Geophysical Institute, Kyoto University

Characteristic variations of the Es near the magnetic equator are obtained from the studies of the world-wide fEs distribution, the relations between the Es and the sun-spot number, and the disturbance daily variation of the Es.

That may be due to the peculiar formation mechanism of the Es and intense electrical conductivity at the Es level near the magnetic equator.

Lunar tidal variations in the sporadic-E region

By S. Matsushita

Geophysical Institute, Kyoto University

The complete text is published in Report of Ionosphere Research in Japan, Vol. III, No. 2, pp. 45—52, 1953.

Investigations of the upper ionosphere by observations of the radio stars

By A. Maxwell

Jodrell Bank Experimental Station, University of Manchester

Drift movements in the F region.

The metre wavelength emission from the radio stars is subject to considerable fading when it is diffracted by irregularities in the electron density of the ionosphere; this diffracting screen is believed to be at a height of approximately 400 km. and is essentially a night time phenomenon. Fading records taken with three receiving equipments, triangularly sited, show systematic time displacements, and these are attributed to a steady translational movement of the diffracting screen. Measurements of the drift movements in the F region of the ionosphere made in this way at the Jodrell Bank Experimental Station from 1951 show that the motion is normally of the order of 50—300 m/sec., is generally transverse to the magnetic field and often remains constant over periods of many hours. During the first half of the night the prevailing direction is towards the West and then at approximately 00h there is often a reversal, normally effected within a period of 30 minutes, after which Easterly directions predominate; observations during the latter half of the night were, however, limited to winter months and require to be extended. (It is interesting to notice that the apparent reversal at 00h is in agreement with a tentative model of the circulation in the upper ionosphere proposed by Vestine for magnetically disturbed conditions.) The effective wavelength of the ionospheric irregularities remains appreciably constant over a velocity range of 20:1, so that the magnitude of the drift velocity may be estimated simply from a count of the fading rate. Investigation of the drift motions at points separated by 800 km. suggests that the drift speeds and directions are the same over wide areas, and some experiments made in cooperation with members of the Cavendish Laboratory, Cambridge, over a 200 km. base line support this. By observing the Cygnus radio star when it is low on the Northern horizon, it is possible to determine the F region drift velocities in the auroral zone; these are of the order of 400 m/sec., that is, twice as fast as the F region motions at temperate latitudes.

The origin of the diffracting screen which causes the radio star fading is still the subject of some doubt. Investigation of this problem from the aspect of turbulence theory suggests, however, that many of the sporadic irregularities in the upper ionosphere may result from non-laminar flow in these regions. The Reynolds number at the 400 km. level, for instance, is of the order of 300.

Correlation of F region drift speeds with geomagnetic disturbances.

The remarkable correlation between F region drift speed (and radio star fading rate) and the disturbance variations in the geomagnetic field pointed out by Little and Maxwell in 1952 has now been analysed in some detail. At the latitude of Great Britain velocities in the range 0—50 m/sec. correspond to magnetic disturbances in the K index range 0—1; with increasing K indices the velocities increase proportionately until at the highest K ranges of 8—9, during the most intense storms, drift velocities of the order of 1000 m/sec. are observed. Collation of geomagnetic and F region drift data covering both the auroral and temperate zones shows that at a given magnetic latitude the magnitude of the magnetic disturbances, when measured in gamma units of force, is directly proportional to the F region drift speeds overhead.

Electronic recording of the transient variations in the geomagnetic field

By A. Maxwell

Jodrell Bank Experimental Station, University of Manchester

Continuous records of the transient variations in the geomagnetic field (E—W component) have been made at Jodrell Bank since 1951 with a saturable core (fluxgate) magnetometer and amplifier. The output of this equipment is connected to a pen recorder which is damped with a time constant of two seconds, comparable with the inertial time-constant of a variometer magnet. The noise level of the equipment is approximately one gamma, and the pen recorder gives a full scale deflection of 115 mm at 300 gamma, the major part of the earth's field being backed off by a small d.c. voltage impressed across a coil wound coaxially with the fluxgate coil.

A K-scale has been drawn up for the records in accordance with the international system, and this gives figures which are in excellent agreement with the Kp values. The fine structure of the records also shows a high correlation with the variometer records of declination taken at Abinger, some 200 km. South of Jodrell Bank.

Advantages inherent in the electronic equipment are the increase in sensitivity which may readily be attained, and the ease with which time-constants can be reduced below the inertial constants of variometer magnets. Disturbances in the geomagnetic field are also immediately visible on the pen-recorder chart. This is of particular assistance in ionospheric wind experiments where it is often advantageous to make a direct comparison of sudden changes in wind velocity, or signal fading rate, with variations in the terrestrial magnetic field.

Analysis and interpretation of a transient geomagnetic anomaly in secular variation in "Peninsula Iberica" and North Atlantic

By A. A. Mendonça Dias

Observatório Afonso Chaves, Ponta Delgada, Azores

The geomagnetic secular variation can be considered as a source of information about mechanical movements in upper parts of the earth's fluid core.

The secular variation of the vertical intensity at S. Fernando, Tortosa, Coimbra and S. Miguel (Azores) is analysed for this purpose.

A remarkable anomaly, occurring with difference of time at these observatories, could be separated from the main secular variation which was considered as uniform, and only the anomaly has been studied.

From the arrival time of the postulated frontal line of this anomaly to each observatory, it was possible to obtain the direction (SE—NW) and the sign (S. Fernando—S. Miguel) of its drift; it seems that the drift velocity of this frontal line from S. Fernando to Coimbra (land) is lower than that from S. Fernando to S. Miguel (sea).

It must be remarked that the direction of this frontal line shows coincidence with the selected direction SW—NE in the terrestrial morphology of North Africa, Peninsula Iberica and North Atlantic.

These movements, occurring in the fluid core, reflected and detected in the transient geomagnetic anomalies must have important geophysical significance and possibly offer a good information about the thermal convective theory; their connection to the seismic phenomena must be investigated.

Variations at the E-layer

By D. H. Menzel and J. G. Wolbach

An analysis, on a statistical basis, of the world-wide observations of E-layer critical frequences, as a function of the zenith angle of the sun, latitude, and phase of the sunspot cycle.

On the deviations of the course of the atmospheric electrical elements above the continents from the world-wide course

By R. Mühleisen
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The atmospheric electrical elements, namely the potential gradient and the vertical conducting current, show on the oceans a single-periodical diurnal course with a minimum at appr. 4^h GMT and a maximum at appr. 18^h GMT. Most continental stations, however, record at good weather single- or double-periodical diurnal courses with minima at 4^h and possibly 12^h and maxima at appr. 8^h and 16—20^h *local time*. Up to the present time only the changes of conductivity in the lower troposphere were considered to be the cause for this. However, the increase of the vertical current which is mostly observed during the course of the forenoon, is contrary to this assumption. The author could prove that charges which are produced artificially on the ground, and which are mostly positive, are transported from towns, traffic centres and industrial regions to the atmosphere. Further sources are high voltage lines which — according to the meteorological conditions — can produce positive or negative charges. Further causes are being investigated more precisely. After mixing up of the atmosphere by air motions we have larger regions with mostly positive electrical space charge density. During their existence, which may last for hours, these space charges are transported far away by the wind. Even at a far distance from the source they change the potential gradient and vertical current considerably and in the same way.

Worth to be mentioned is the fact that at higher speed of the wind the nuclear density and space charge density decrease considerably. In such cases we recorded even within a large town diurnal courses which were nearly in agreement with the world-wide course.

It is therefore pointed out that the knowledge of local sources of disturbances and the utilization of recordings during wind are essential preliminary conditions for comparative recordings of atmospheric electricity over large regions. Only if these experiences are considered it is possible to investigate world-wide processes as well as the influence of air masses etc. with sufficient precision.

Ref.: Journ. Atm. Terr. Physics, Vol. 8, pp. 146—157 (1956).

Characteristics of polar magnetic storms

By T. Nagata and N. Fukushima
Geophysical Institute, Tokyo University

Even the sudden commencement part of magnetic storms takes an anomalously large value in high latitudes. The inverse preliminary kick of SC* is generally distributed within the afternoon hemisphere, becoming remarkably large towards the polar cap. The Ds-field (which has newly been defined by Chapman to be a world-wide instantaneous field, whose average with respect to time and longitude corresponds to the SD-field), begins to take place in high latitudes at the time of SC and grows up with storm time. These facts may suggest that some corpuscular stream begins to impinge on the auroral zone upper atmosphere from the time of commencement of a magnetic storm.

From analyses of magnetograms during the Second Polar Year, is was found out that instantaneous Ds-fields in the initial, main and recovery phases of storms are frequently composed of a number of elementary storms of short duration, which are generally a partial incomplete appearance of the SD-field pattern, the loçality of its active centre varying with time. The average of these elementary storms with respect to time forms the complete pattern of the SD-field. This fact may suggest that at the time of magnetic storms, the upper atmosphere is not always activated simultaneously throughout the whole auroral zone, but frequently locally by impinging corpuscular streams. This irregularity of polar storms has already been known since the time of Birkeland, but it must be emphasized that even an elementary storm which has only a short duration still has partially the character of Chapman's SD-field.

From a theoretical stand-point, the Ds-field can be well explained by the dynamo-theory by taking into account the high conductivity of the auroral zone ionosphere; when the whole part of the auroral zone ionosphere is highly ionized, the resulting ionospheric current produces the complete SD-field, while it causes a partial SD-field when only a part of the auroral zone is ionized. Further, a distortion of the real SD-field in comparison with Chapman's ideal SD-field can satisfactorily be attributable to the anisotropic character of the ionospheric conductivity.

Reverse magnetization of rocks and its connexion with the geomagnetic field

By T. Nagata, S. Akimoto, S. Uyeda, K. Momose and E. Asami

The complete text has been published in Journal of Geomagnetism and Geoelectricity, Vol. VI, No. 4, pp. 182—193, 1954.

Preliminary report on a differential magnetograph

By J. H. Nelson
U.S. Coast and Geodetic Survey

The observation of magnetic gradient fluctuations may contribute to the understanding of ionospheric electric current systems. An array of magnetometers so connected electrically as to permit continuous recording of the instantaneous differential would provide such observations. Such an installation is under development for use at College, Alaska, by the U.S. Coast and Geodetic Survey.

Rocket data on atmospheric pressure, temperature, density, and winds

By H. E. Newell Jr.
Naval Research Laboratory, Washington 25, D.C.

The complete text is published in Ann. Géophys. 11, pp. 115—144, 1955. (IAGA Bull. 15 b, pp. 1—30, 1956).

Magnetic field variations caused by lightning in vicinity

By H. Norinder
Institute of High Tension Research, Uppsala

An investigation has been carried out at the Institute of High Tension Research in order to analyse the rapid variations in the magnetc field as caused by lightning discharges. The frame aerial method introduced by the author was used in combination with specially constructed cathode ray oscillographs. By an integrating circuit in the units the variation curves H of the magnetic field were obtained. A little more than 2000 lightning strokes recorded during the thunderstorm season of 1953 within the vicinity region — up to 19 kilometres from the lightning paths — were analysed. The investigation resulted in values of H of 200—300×10^{-4} gauss.

From a calculation of simultaneous measurements of the magnetic field variations from lightning discharges with frame aerials placed both in vertical and horizontal planes followed that the amplitudes of the horizontal components of the magnetic field attained in average a mere 30 percent of the vertical components.

The interpretation of reversed magnetization in igneous rocks

By J. H. Parry
Department of Geodesy and Geophysics, Cambridge University

The complete text is published in Journal of Geomagnetism and Geoelectricity, Vol. VI, No. 4, pp. 210—214, 1954.

The fine structure of natural point discharge currents

By E. T. Pierce and M. Large
Department of Physics, University of Cambridge

It is shown that most of the phenomena observed in laboratory experiments on corona discharge also occur in natural point discharge. No attempt is made to claim that the point-to-plane apparatus available in the laboratory in any way simulates the natural configuration of earth and atmosphere. Since, however, the discharge from a point depends primarily upon the field distribution in its immediate vicinity, the relevant parts of many field distributions encountered in nature can be reproduced with comparative ease in the laboratory.

The continual variations in natural conditions make it necessary to make a considerable number of observations in order to derive a comprehensive pattern for the overall behaviour in all kind of weather, and work is being continued at Cambridge.

Diurnal magnetic variation in equatorial regions

By S. K. Pramanik and S. Yegnanarayanan
Meteorological Office, Poona

The complete text is published in the Indian Journal of Meteorology and Geophysics, Vol. 3, No. 3, July 1952.

Diurnal magnetic variations near the magnetic equator

By S. K. Pramanik and P. S. Hariharan
Meteorological Office, Poona

The complete text is published in the Indian Journal of Meteorology and Geophysics, Vol. 4, No. 4, pp. 353—358, Oct. 1953.

Causes of irregularities in the rotation of the earth

By R. Revelle and W. Munk
University of California

The complete text is published under the title: "Evidence from the rotation of the earth" in Ann. Géophys. 11, pp. 104—108, 1955. (IAGA Bull. 15 a, 1955).

Anomalous relations between H and Z components of transient geomagnetic variations

By T. Rikitake and I. Yokoyama
Earthquake Research Institute, Tokyo University

The complete text is published in Journal of Geomagnetism and Geoelectricity, Vol. V, No. 3, pp. 59—65. 1953.

Electrical conductivity of the core

By T. Rikitake
Tokyo University

The complete text is published under the title: "Electrical conductivity of the earth's core" in Ann. Géophys. 11, pp. 95—97, 1955. (IAGA Bull. 15 a, 1955).

Variations in the airglow spectrum

By F. E. Roach
National Bureau of Standards, Boulder, Colorado

The complete text is published under the title: "A review of observational results in airglow photometry" in Ann. Géophys. 11, pp. 214—231, 1955. (IAGA, Bull. 15 b, pp. 100—117, 1956).

Exposé sommaire des études relative à l'aimantation de matériaux volcaniques

Par A. Roche

Institut et Observatoire de Physique du Globe du Puy de Dôme, Université de Clermont

The complete text is published in Journal of Geomagnetism and Geoelectricity, Vol. VI, No. 4, pp. 169—171, 1954.

Sur les aimantations rémanente isotherme et thermorémanente du sesquioxyde de fer α et de la magnétite

Par J. Roquet

Institut de Physique du Globe, Université de Paris

The complete text is published in Journal of Geomagnetism and Geoelectricity, Vol. VI, No. 4, pp. 200—205, 1954.

Motions in the earth's core and geomagnetism

By S. K. Runcorn

Department of Geodesy and Geophysics, Cambridge University

The complete text is published under the title: "Core motions and reversals of the geomagnetic field" in Ann. Géophys. 11, pp. 73—79, 1955. (IAGA Bull. 15 a, 1955).

The electrical properties of olivine and related substances at high pressures and temperatures

By S. K. Runcorn and D. C. Tozer

Department of Geodesy and Geophysics, Cambridge University

The complete text is published under the title: "The electrical conductivity of olivine at high temperatures and pressures" in Ann. Géophys. 11, pp. 98—102, 1955. (IAGA Bull. 15 a, 1955).

Variations of temperature in the stratosphere up to 30 km over the British Isles

By F. J. Scrase

Great Britain

The complete text is published in the Scientific Proceedings of the International Association of Meteorology, Publication AIM No. 10 c, pp. 514—517, 1956.

Theory of the airglow spectrum

By M. J. Seaton

Institut d'Astrophysique, Paris

The complete text is published in Ann. Géophys. 11, pp. 232—248, 1955. (IAGA Bull. 15 b, pp. 118—134, 1956).

L'application des fusées à l'étude de l'ionosphère

Par J. C. Seddon et J. E. Jackson
Naval Research Laboratory, Washington 25, D.C.

The complete text is published in Ann. Géophys. 11, pp. 169—172, 1955. (IAGA Bull. 15 b, pp. 55—58, 1956).

The meteorological point of view on observational data in the mesosphere

By P. A. Sheppard
Great Britain

An extended summary is published in the Scientific Proceedings of the International Association of Meteorology, Publication AIM No. 10 c, pp. 509—513, 1956.

The cosmic radiation and solar-terrestrial relationships

By J. A. Simpson
Institute for Nuclear Studies, University of Chicago, Illinois

The complete text is published in Ann. Géophys. 11, pp. 305—329, 1955. (IAGA Bull. 15 b, pp. 187—211, 1956).

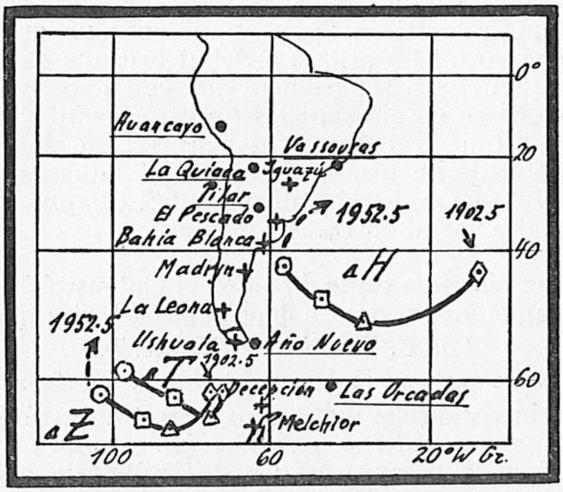
On the movement of geomagnetic intensities' isoporic foci near the South-American continent

By L. Slaucitajs
Observatorio Astronómico, Universidad Nacional, La Plata

The Department of Terrestrial Magnetism, Carnegie Institution of Washington, has given the isoporic world charts for 10-year intervals 1912.5—1942.5, on which basis the situation and movement of foci can be considered (Fisk, Fleming, Vestine). Two especially pronounced intensities' foci of Southern Hemisphere, one of H, the other of Z (also of T) are located near the South-American continent. Following the resolution 10 of the Brussels Meeting of ATME the author has made an attempt to extend in some way the knowledge of these two foci's movements: at first back from 1912.5 to 1902.5 (with the intermediate 1907.5), secondly from 1942.5 to 1952.5 (with the intermediate 1947.5). This would mean an extension of Carnegie's 30-year interval to one of 50 years.

There were not many stations from which to study the situation at the epoch 1902.5, but some valuable data of Año Nuevo Observatory and of old continental stations can be used. To see the situation for the epoch 1952.5, an exertion was made to find out former stations and establish new ones in the region from Argentine subtropics into the Antarctic continent, using naturally all existing observatory data in question. It is to stress also here the successful use of QHM and BMZ magnetometers. The mentioned work is done especially in the years 1950—1954, so the isoporic epoch 1952.5 falls just in the middle.

For the sake of uniformity the reduction methods used were



◇ = 1912.5, △ = 1922.5, ⊡ = 1932.5, ⊙ = 1942.5
after C.I.W.
● Observatories + Repeat-stations, now especially established or elected

the same as those previously used by the C.I.W. Nevertheless there may be some discussion concerning the use of them, f. i. on proposed geomagnetic departures with sunspot-cycle.

At this moment the author will not give a detailed local isoporic picture for these epochs 1902.5 and 1952.5, but wants to limit himself to present the results, showing only the *tendency* of intensities' isoporic foci movement at the mentioned additional epochs 1902.5 and 1952.5.

The tendency is indicated on the attached map by broken-line arrows, forming extensions of the full-line curves for 1912.5—1942.5.

Effect of electric current on the magnetic instruments at Alibag Observatory

By V. V. Sohoni, S. K. Pramanik, S. L. Malurkar and S. P. Venkiteshwaran

India Meteorological Department

The complete text is published in the Indian Journal of Meteorology and Geophysics, Vol. 4, No. 1, pp. 43—60, Jan. 1953.

Sur la variation D_{St} des orages à début brusque et des orages à début progressif

Par E. Thellier et O. Thellier
Observatoire Géophysique du Parc Saint-Maur

L'évolution moyenne D_{St} des orages magnétiques établie par Moos, puis par S. Chapman, est reprise, pour une seule station, pour la composante H seulement, mais pour un grand nombre d'orages en séparant les orages à début brusque et les orages à début progressif. Puis, séparément sur ces deux types d'orage, l'étude est poussée en classant les orages suivant l'heure locale de leur début (par tranches de 4 heures) ; on cherche ainsi à atteindre l'effet de l'heure locale sur le déroulement de la perturbation, effet que recherche autrement S. Chapman en établissant sa nouvelle variation D_S.

Nouveaux résultats sur la direction et l'intensité du champ magnétique terrestre dans le passé historique

Par E. Thellier et O. Thellier
Observatoire Géophysique du Parc Saint-Maur

Alors que la recherche du champ terrestre passé à partir des aimantations rémanentes des roches (volcaniques ou sédimentaires) continue à rencontrer des difficultés de principe considérables, cette recherche à partir de l'aimantation thermorémanente des terres cuites est remarquablement sûre et précise ; sa limitation est seulement dans la précision de date et de provenance des matériaux archéologiques utilisés. Depuis l'Assemblée de Bruxelles, nous avons pu ajouter à nos résultats antérieurs des résultats nouveaux sur la direction du champ aux époques carolingienne et romaine, en Allemagne, Angleterre et Belgique, et sur son intensité à l'époque punique à Carthage et à l'époque romaine en Suisse.

Energy sources in the core

By H. C. Urey
Institute for Nuclear Studies, University of Chicago, Illinois

The complete text is published under the title: "Distribution of elements in the meteorites and the earth and the origin of heat in the earth's core" in Ann. Géophys. 11, pp. 65—72, 1955. (IAGA Bull. 15 a, 1955).

The intensity distribution of the sodium D-line emission in the atmosphere

By L. Vegard
Physical Institute of the University of Oslo

The complete text is published in Geofysiske Publikasjoner, Vol. XIX, No. 3, 1955, under the title "Studies of the Twilight

Sodium Lines from Observations at Oslo and Tromsö, and Results of Auroral Spectrograms from Oslo" by L. Vegard, G. Kvifte, A. Omholt and S. Larsen, with an appendix by L. Vegard on "Cosmic-physical Consequences of the Results regarding the Sodium D-line in Twilight".

Intensity variations of auroral hydrogen lines and the influence of the solar proton radiation on the auroral luminescence

By L. Vegard
Physical Institute of the University of Oslo

The complete text is published in Geofysiske Publikasjoner, Vol. XIX, No. 4, 1955.

Geomagnetic and geoelectric pulsations

By J. Veldkamp
Koninklijk Nederlands Meteorologisch Instituut

Four selected cases of geomagnetic pulsations published in the Tables of p.s.c.'s (IATME Bulletins No. 12 e-h and three-monthly reports on character figures from the K+C-centre De Bilt), have been investigated. The pulsations were connected with the beginning of a very local disturbance near the auroral zone. Whereas the amplitude of the geomagnetic bay falls off very fast with increasing distance from the auroral zone, the amplitude of the accompanying pulsation diminishes more slowly, so that the pulsation is recorded over more than half of the earth's surface. An analysis of quick-run records shows that the vibrations occur practically at the same time over the whole world. This leads to the surmise that pulsations are caused by vibrations of the ionosphere set up by a disturbance of the normal ionisation. A similar idea was put forward by Holmberg (1953).

The geomagnetic pulsations are accompanied by geoelectric fluctuations, as measured between two electrodes in the ground. The north-south component H_y of the magnetic fluctuation corresponds to the east-west component E_x of the electric field. In spite of the fact that the wavelength of the pulsation is very much larger than the earth's radius, the formula for the ratio E_x/H_y calculated by Kato and Kikuchi (1950) and by Cagniard (1953) for a plane earth is valid; this is caused by the fact that the index of refraction in the earth has an extremely high value for all periods involved.

The amplitude ratio E_x/H_y and the phase-differences between corresponding maxima and minima of the magnetic and electric pulsations have been checked by measurements at the observatory Witteveen. The values obtained roughly agree with the distribution of the electric conductivity in the ground as known from geological side.

Magnetic storms as an atmospheric phenomenon

By E. H. Vestine

Department of Terrestrial Magnetism, Carnegie Institution of Washington

It was discovered that the initial phase of magnetic storms is usually abnormally augmented at the magnetic equator, as in the case of the solar daily variation, during sunlit hours. This surprising result was a by-product of an attempt to develop a dynamo theory of geomagnetic disturbance. At Huancayo, Peru, this augmentation is by a factor as great as 600 percent or more. The immediate sources of magnetic field at the ground are necessarily electric currents of undetermined origin, flowing within the atmosphere, and in induced form within the earth.

In an interesting speculative study, zonal and meridional wind-systems that might generate the magnetic fields of storms by dynamo action were tentatively derived, using previously deduced atmospheric current systems of simple form as the assumed immediate cause of a magnetic storm. An interesting consequence of the dynamo theory is that the zonal winds in ionized regions should produce toroidal magnetic fields in the ionosphere. The main electric current flow yielding these magnetic fields may be upward near the equator, thence polewards, and finally equatorwards at lowest levels. If the latter are near the E-region, westward flowing Hall currents may be expected, yielding the storm-time variation at ground level. The oppositely directed Hall currents in higher regions where the gyrofrequency exceeds the collisional frequency should be negligible, if the F-region is electrically neutral. Initially, if the wind-system is heat driven, the air circulation will be mainly meridional, producing the initial phase of storms by the dynamo action of electrically conducting air mowing equatorwards at lower levels of the ionosphere. It can be shown that the fate of such a meridional circulation, once initially established, will as the result of further acceleration become a mainly zonal circulation. In this case the counter-acceleration of the zonal winds will tend to reduce and extinguish the original meridional flow. A slow recovery to the initially undisturbed condition may then take place. It is believed that the dynamo theory of disturbance is at least partially responsible for magnetic storms. As our Japanese co-workers have shown, no real difficulty has been found other than that the upper air winds may not blow in the manner required.

References:
(1) Sugiura, M., J. Geophys. Res., vol. 58, 558—559 (1953); E. H. Vestine, J. Geophys. Res., vol. 58, 560—562 (1953).
(2) Vestine, E. H., J. Geophys. Res., vol. 58, 539—541 (1953); ibid. vol. 59, 93—128 (1954).

Relation between fluctuations in the earth's rotation, the variation of latitude, and geomagnetism

By. E. H. Vestine

Department of Terrestrial Magnetism, Carnegie Institution of Washington

The complete text is published in Ann. Géophys. 11, p. 103, 1955. (IAGA Bull. 15 a, 1955).

Travelling disturbances in the upper ionosphere

By H. W. Wells

Department of Terrestrial Magnetism, Carnegie Institution of Washington

The properties of travelling disturbances in the F-region of the ionosphere have been observed in the vicinity of Washington, D.C., U.S.A. A program conducted by the Carnegie Institution of Washington in liaison with nearby universities has contributed significantly to the meager information available on ionospheric "winds" or disturbances which appear to travel at rapid rates through our outer atmosphere.

Experiments have been conducted using networks or triangulations having station-separations as great as 150 miles, and as small as 15 miles. The observing instruments have been automatic multifrequency recorders in some cases, and fixed-frequency instruments in others. A small ionospheric disturbance is identified by an abrupt change in the record. The same feature is identified at different times at the other observing stations. Apparent velocity of travel and direction of motion are determined from the observed time-differences, and the configuration of the network. In some cases a fourth station was used as a "check point" to assess the accuracy and continuity of the information.

The results show a scatter in apparent velocities between 50 and 700 meters per second. Preferred velocities, however, are nearer to 100 and 200 meters per second. The predominant direction of apparent motion is into the east or southeast, although most apparent directions have been observed, except in the southwest quadrant.

Further analyses of the multifrequency records have revealed a *downward* component of velocity in addition to the horizontal movement. Estimates of the magnitude of the downward component are based on the determination of true heights in the ionosphere. Of the several cases analyzed at this time values close to 100 meters per second have been derived. In many cases, therefore, the disturbance appears to be inclined to the earth at angles of 35 to 45 degrees.

There has been much conjecture regarding the nature and size of such travelling disturbances, or clouds. We know that some are appreciably more than 100 miles in extent. A basic question, however, remains unanswered: Are these effects really winds indicating physical movement through our atmosphere or are they apparent effects caused by wave motions and possibly electric fields?

On the morphology of the cosmic ray storms

By the Working Association of Primary Cosmic Ray Research, Japan

After the well known discovery of the world-wide cosmic ray decrease (Δ I) associated with the magnetic storms, it was found that the amplitude increase (Δ a) and the phase advancement ($\Delta \varphi$) of the local time dependence of cosmic ray intensity were associated with Δ I. It has been difficult to find a simple quantitative relation between these cosmic ray variations and the magnetic storms. But the quantities Δ I, Δ a and $\Delta \varphi$ are nearly proportional to each other. Sometimes, a combined variation of these three quantities occur even if no magnetic storm is reported.

Therefore, the conception of cosmic ray storm was established. The world wide distribution of cosmic ray intensity at the time of a cosmic ray storm was found to be a superposition of D_{st}-variation (Δ I) and D_s-variation (Δ a and $\Delta \varphi$), where the symbols D_{st} and D_s have similar meanings as those used in the analysis of the magnetic storm or the ionospheric storm. The beginning of a cosmic ray storm is not associated with the solar flare but with a magnetic storm, if both of them are observed. The duration of a cosmic ray storm is longer than that of a magnetic storm. Cosmic ray storms occur almost always on magnetically disturbed days, but the 27day recurrence tendency is more persistent than that of magnetic storms.

From the preliminary studies, the cosmic ray storm is considered to be due to the acceleration (or deceleration) of general cosmic rays through some electric fields caused by the solar stream. Detailed and systematic studies on the latitude, altitude and component dependence of Δ I, Δ a and $\Delta \varphi$ will be useful to know the mechanism of the cosmic ray storm as well as the nature of the solar stream. In this case, the effect of the cosmic ray emission from the sun and also the apparent effect due to the difference in the type of equipment must be carefully taken into account. Therefore, it is desirable that the world-wide network of standardized equipment should be set up as soon as possible.

Part VI

Resolutions and Committees

Resolutions of the Association

The resolutions have previously been published in the I.U.G.G. News Letter No. 10, pp. 306—311, 1955. To avoid confusion they are given here in the standard form in which they were published by the Union. The French text of the resolutions is to be found on pp. 393—400.

RESOLUTION NO. 1

The International Association of Terrestrial Magnetism and Electricity,

(1) *Considering* the world-wide importance of the magnetic observatory of Hong Kong,

Urges that the observatory be rapidly rebuilt and re-equipped, in order to make it possible to provide full co-operation with the International Geophysical Year, 1957—1958.

(2) *Considering* the importance of the Observatory of Tatuoca for the International Geophysical Year, 1957—1958,

Urges that its construction be actively pursued, and that the Observatory be equipped and put into service as rapidly as possible.

(3) *Considering* the importance of magnetic observations in Greece,

Recommends that attempts be made to complete the instrumental equipment of the already established observatory of Athens.

RESOLUTION NO. 2

The International Association of Terrestrial Magnetism and Electricity,

Considering that deficiencies in the magnetic charts caused by the lack of magnetic observations over the oceans, particularly in the regions of rapid secular change, have now impaired the security of traffic by air and sea,

Recommends strongly that:

(a) Steps be taken to arrange for magnetic observations at oceanic islands, particularly those near regions of rapid secular change, and that the stations be occupied every tenth year;

(b) Sites of old Carnegie stations in the oceans be reoccupied using suitable instruments carried by ships or airplanes;

(c) Non-magnetic ships be equipped for observations over the oceans by great seafaring nations;

(d) National Committees of the different countries try to provide that measurements of magnetic declination be made on board naval and merchant ships.

The International Association of Terrestrial Magnetism and Electricity proposes that the results of such measurements be sent to that agency in these countries which is responsible for the preparation of geomagnetic charts. The Association authorizes the Committee No. 5 (Magnetic Charts) to contact the national authorities concerned for implementing the above recommendations.

RESOLUTION NO. 3

The International Association of Terrestrial Magnetism and Electricity,

Recommends that in the future, the epoch .0 be used for magnetic charts. The value to be assigned to the epoch .0 will be the mean of the values for the six months preceding and the six months following the adopted date of January 1.

RESOLUTION NO. 4

The International Association of Terrestrial Magnetism and Electricity,

(1) *Expresses* its thanks to Observatorio del Ebro for magnetic measurements made in Spanish Guinea.

(2) *Expresses* its thanks to Dr. *M. R. Madwar* and his staff for magnetic measurements at a chain of stations in the Sudan.

(3) *Expresses* its thanks to the Sudan Meteorological Service for magnetic measurements at the magnetic equator in connection with the solar eclipse of February 25, 1952.

(4) *Expresses* its thanks to the Observatorio Nacional, Rio de Janeiro, for magnetic measurements on the island of Fernando de Noronha.

(5) *Expresses* its thanks to the Geophysical Institute of Huancayo and to the Inter-American Geodetic Survey for magnetic measurements at a long chain of stations in South America.

(6) *Expresses* its thanks to Dr. *Pramanik* and to Mr. *Gulatee* for magnetic measurements in South India.

(7) *Expresses* its thanks to the Instituto Geográfico y Catastral of Madrid for magnetic measurements in Spanish Guinea in connection with the solar eclipse of February 25, 1952.

RESOLUTION NO. 5

The International Association of Terrestrial Magnetism and Electricity,

Recommends to Committee No. 9 (Characterization of Magnetic Activity):

(a) To continue current schemes of K, Kp, Ap and Ci;

(b) To provide for further correlation studies of K, Kp, to be used in conversion tables of K into Ks and for discussions on the geographical and time distribution of magnetic activity;

(c) To encourage the scaling of K-indices for years before 1937 by stations with long series of magnetograms.

RESOLUTION NO. 6

The International Association of Terrestrial Magnetism and Electricity,

Instructs Committee No. 10 (Rapid Variations and Earth Currents) to continue the work regarding ssc, psc, si and sfe, which has formerly been carried out by Committee No. 9 (Characterization of Magnetic Activity).

RESOLUTION NO. 7

The International Association of Terrestrial Magnetism and Electricity,

Sends, on the occasion of the Golden Jubilee of the foundation of the Alibag Observatory, its warmest greetings to all of its members and expresses the wish that this Observatory will continue for a long time its excellent work, which, with observations of the Colaba Observatory, gives us one of the longest series of magnetic data in the world.

RESOLUTION NO. 8

The International Association of Terrestrial Magnetism and Electricity,

Recommends, to secure maximum benefit from the extended geomagnetic observations of the International Geophysical Year:

(a) That new stations established in regions where the value of the horizontal force is lower than 10,000 γ should be equipped for recording X, Y and Z, X and Y being the components of the magnetic horizontal force along the astronomical North and East directions;

(b) That some magnetic observatories in the auroral regions should be supplemented by two satellite stations for the measurement of the horizontal space gradients of the magnetic elements; the auxiliary stations should be situated in directions from the main station that are approximately at right angles; their distances from the main station should be about 5 miles; the determination of the space gradients should be made in the manner most convenient to the main station, either by the method being developed by the U.S. Coast and Geodetic Survey or otherwise;

(c) That international comparisons of magnetic standards be intensified for the period of the International Geophysical Year as well as for the periods immediately preceding and following the International Geophysical Year;

(d) That quick-run recording of earth currents should be carried out at all stations having the possibility of doing so;

(e) That attention should be drawn to the German procedure for examining inhomogeneities of conductivity in the earth's crust in order to study the magnetic character of the district in which a magnetic observatory is situated;

(f) That all the International Geophysical Year stations, permanent as well as temporary, be utilized for the reduction of such aeromagnetic surveys as may be carried out during the International Geophysical Year, and that the Committee No. 5 (Magnetic Charts) of the International Association of Terrestrial Magnetism and Electricity be charged with the selection of such oceanic areas where an aeromagnetic survey would be of special importance.

RESOLUTION NO. 9

The International Association of Terrestrial Magnetism and Electricity,

Recognizing the world-wide importance of the Huancayo Observatory,

Urges that every effort be made in order to provide for its efficient participation in the programme of the International Geophysical Year, 1957—1958.

RESOLUTION NO. 10

The International Association of Terrestrial Magnetism and Electricity,

Recognizing the world-wide importance of the Djakarta Observatory,

Urges that every effort be made in order to have it in full operation in time for the International Geophysical Year, 1957—1958.

RESOLUTION NO. 11

The International Association of Terrestrial Magnetism and Electricity,

Invites the New Zealand Government to consider the possibility of establishing a temporary magnetic station near the southern magnetic axis pole. This should be of considerable importance during the International Geophysical Year, 1957—1958.

RESOLUTION NO. 12

The International Association of Terrestrial Magnetism and Electricity,

Following the proposal of the Joint Committee on Atmospheric Electricity of the International Association of Terrestrial Magnetism and Electricity and of the International Association of Meteorology,

Recommends:

(a) That systematic comparisons be made between meteorological disturbances and the variations of the electric field at the surface of the earth, observed at places unaffected by surface features;

(b) That systematic vertical soundings be made of the earth electric field at different stations without neglecting the tropical and subtropical regions.

RESOLUTION NO. 13

The International Association of Terrestrial Magnetism and Electricity,

Following the proposition of the Joint Committee on the Upper Atmosphere of the International Association of Terrestrial Magnetism and Electricity and of the International Association of Meteorology,

Noting that the crepuscular tables of J. Lugeon which have been of considerable value to specialists of the high atmosphere are now out of print, and further noting that there is a great demand for these tables, *Recommends* that the tables should be reprinted together with a translation into several languages of the directions for their use.

RESOLUTION NO. 14

The International Association of Terrestrial Magnetism and Electricity,

Recommends the publication by magnetic observatories through the media of year books or other publications, of the following, in order of significance:

(a) Primary importance:

(1) Hourly values of three elements, with notations regarding interpolated values. If mean values are scaled, they should be centred upon the half-hour.

(2) Yearly and monthly means, at earliest availability.

(3) K-indices, also C-figures if previously reported, and if useful description of magnetic activity.

(4) Account of normal equipment, and of records available and information bearing on the reliability of the values; this information refers, for example, to absolute observations or consequent base-line determinations, scale-value determinations, performance of absolute and variation instruments, orientation and interaction of magnets, temperature coefficients, and calibration of the instruments used for absolute observations.

(5) Reproduction of magnetograms for all days or, failing this, reproduction of selected magnetograms.

(6) Daily sums and means, and sums and means by hours for each whole month, and the corresponding means for the selected five quiet and five disturbed days thereof.

(7) The times of sudden commencements of magnetic disturbance, and as far as practicable, of crochets, pulsations, giant pulsations, and of similar changes and other remarkable phenomena, together with magnitude and sense in each magnetic element.

(b) Desirable additional data:

(1) Composite daily variation or hour-by-hour departures of the general and selected-day means by months, Lloyd's seasons, and years, including also non-cyclic changes as appropriate.

(2) Individual daily maxima and minima and ranges.

(3) Account of special equipment and statements of intervals for which special records were obtained, such as rapid-run magnetograms, rate-of-change records, etc.

RESOLUTION NO. 15

The International Association of Terrestrial Magnetism and Electricity,

Considering the interest in the continuous recording of pulsations in the Earth's magnetic field, and the necessity for making results taken over the entire Globe comparable with each other,

Recommends that magnetic observatories be equipped for this purpose at least during the International Geophysical Year.

Committee No. 8 (Magnetic Instruments) should undertake to study the possibilities of making these measurements by means of electromagnetic sondes.

If such measurements turn out to be impracticable for most observatories, thereby making it necessary to employ the older methods, then the minimum equipment is the following:

(1) Rapid recording of the variations of three components by means of magnet variometers for X and Y (or H and D) and by means of a coil with fluxmeter for the Z component. The scale-value for non-polar regions should be 1 γ/mm for X and Y (or H and D) and $1/_{10}$ γ/mm for Z. The free period of the magnets of the variometers should not be more than 3 seconds, and the damping coefficient should be about 0,5. The paper speed of the records should be standardized to 6 mm/minute. In these measurements an accuracy of 1 second is necessary for the time marks. The sensibility of the instruments should be experimentally determined over the entire range of measurement.

(2) Rapid recording of the variations of the time derivatives for two horizontal rectangular components. If only one component can be measured, the selection of dH/dt is recommended. The scale-value for non-polar regions should be about 0.05 γ/sec/mm. The preceding recommendations concerning the speed of recording, the time marks, and the calibration of the instruments apply also to these records.

Résolutions de l'Association

Les résolutions ont été publiées déjà dans le Bulletin d'Information de l'U.G.G.I. No 10, pp. 333—339, 1955. Pour éviter de la confusion elles sont données ici dans la rédaction standard adoptée par l'Union. Le texte anglais des résolutions se trouve aux pp. 387—393.

RÉSOLUTION NO. 1

L'Association Internationale de Magnétisme et Électricité Terrestres,

(1) *Considérant* l'importance mondiale de l'Observatoire Magnétique de Hong Kong,

Souhaite instamment que l'observatoire soit rapidement reconstruit et rééquipé afin de lui permettre de participer pleinement aux travaux de l'Année Géophysique Internationale 1957—1958.

(2) *Considérant* l'importance de l'Observatoire de Tatuoca pour l'Année Géophysique Internationale 1957—1958,

Souhaite instamment que sa construction soit activement poursuivie et qu'il soit équipé et mis en service le plus rapidement possible.

(3) *Considérant* l'importance des observations magnétiques en Grèce,

Recommande que l'on essaye de compléter l'équipement de l'Observatoire d'Athènes.

RÉSOLUTION NO. 2

L'Association Internationale de Magnétisme et Électricité Terrestres,

Considérant les imprécisions des cartes magnétiques provenant du manque de mesures sur les océans, tout particulièrement dans les régions à variation séculaire rapide, réduisant la sécurité des trafics maritime et aérien,

Recommande instamment :

(a) Que des dispositions soient prises pour organiser des mesures magnétiques sur les îles océaniques, tout particulièrement sur celles situées dans des régions à variation séculaire rapide, et pour répéter ces mesures tous les dix ans ;

(b) Que les anciennes stations du navire "Carnegie" soient réoccupées au moyen d'instruments portés par des navires ou des avions ;

(c) Que des navires non-magnétiques soient équipés par les nations maritimes pour des observations sur les océans;

(d) Que les Comités Nationaux s'efforcent d'obtenir, que des mesures de la déclinaison magnétique soient effectuées à bord des navires de guerre ou marchands.

L'Association Internationale de Magnétisme et Électricité Terrestres propose que les résultats de ces mesures soient adressés aux services responsables de la préparation des cartes magnétiques dans leur pays. Elle autorise le Comité No. 5 (Cartes Magnétiques) à prendre contact avec les organismes responsables pour l'exécution de ces recommandations.

RÉSOLUTION NO. 3

L'Association Internationale de Magnétisme et Électricité Terrestres,

Recommande que désormais l'époque .0 soit adoptée pour les cartes magnétiques. On prendra pour valeur d'un élément à l'époque .0 la moyenne des valeurs observées pendant les six mois précédant et les six mois suivant le 1er Janvier correspondant.

RÉSOLUTION NO. 4

L'Association Internationale de Magnétisme et Électricité Terrestres,

(1) *Exprime* ses remerciements à l'Observatoire de l'Èbre pour les mesures magnétiques effectuées en Guinée Espagnole.

(2) *Exprime* ses remerciements au Dr. *M. R. Madwar* et à ses collaborateurs pour les mesures magnétiques effectuées sur une chaîne de stations au Soudan.

(3) *Exprime* ses remerciements au Service Météorologique du Soudan pour les mesures magnétiques sur l'équateur magnétique à l'occasion de l'éclipse solaire du 25 Février 1952.

(4) *Exprime* ses remerciements à l'Observatoire National de Rio de Janeiro pour les mesures magnétiques effectuées dans l'île de Fernando de Noronha.

(5) *Exprime* ses remerciements à l'Institut Géophysique de Huancayo et à l'Inter-American Geodetic Survey pour les mesures magnétiques effectuées sur une longue chaîne de stations en Amérique du Sud.

(6) *Exprime* ses remerciements au Dr. *Pramanik* et à M. *Gulatee* pour les mesures magnétiques effectuées dans le Sud de l'Inde.

(7) *Exprime* ses remerciements à l'Institut Géographique et Cadastral de Madrid pour les mesures magnétiques effectuées en Guinée Espagnole à l'occasion de l'éclipse solaire du 25 Février 1952.

RÉSOLUTION NO. 5

L'Association Internationale de Magnétisme et Électricité Terrestres,

Recommande au Comité No. 9 (Caractérisation de l'Activité Magnétique)

(a) De continuer son travail sur les indices K, Kp, Ap et Ci,

(b) De poursuivre les comparaisons entre K et Kp et d'utiliser les résultats pour obtenir des indices Ks et pour étudier les variations systématiques dans le temps et dans l'espace de l'activité magnétique,

(c) D'encourager les observatoires possédant de longues séries d'enregistrements à déterminer les indices K pour les années antérieures à 1937.

RÉSOLUTION NO. 6

L'Association Internationale de Magnétisme et Électricité Terrestres,

Charge le Comité No. 10 (Variations Rapides et Courants Telluriques) de poursuivre sur les ssc, psc, si et sfe le travail effectué jusqu'ici par le Comité No. 9 (Caractérisation de l'Activité Magnétique).

RESOLUTION NO. 7

L'Association Internationale de Magnétisme et Électricité Terrestres,

Au moment où l'Observatoire d'Alibag célèbre le cinquantième anniversaire de sa fondation,

Adresse à tous ses membres ses félicitations les plus chaleureuses et exprime le voeu que leur observatoire puisse longtemps encore poursuivre ses excellentes mesures qui, faisant suite à celles de l'observatoire de Colaba, constituent l'une des séries d'observations magnétiques les plus longues du monde.

RÉSOLUTION NO. 8

L'Association Internationale de Magnétisme et Électricité Terrestres,

Recommande, pour assurer le plus grand profit des observations géomagnétiques étendues de l'Année Géophysique Internationale :

(a) Que les stations nouvelles établies dans des régions où la valeur de la composante horizontale du champ magnétique terrestre est inférieure à 10.000 γ soient équipées pour enregistrer les variations des composantes X, Y, Z, les composantes X et Y correspondant au N et à l'E géographique ;

(b) Que quelques observatoires magnétiques dans les régions aurorales soient complétés par deux stations satellites pour la mesure des gradients horizontaux des éléments magnétiques. Par rapport à la station principale les stations auxilaires doivent être situées dans des directions approximativement rectangulaires, leur distance de la station principale doit être de 10 km env. La détermination des gradients doit être effectuée par la méthode qui s'adapte le mieux à la station principale, soit par la méthode à l'étude au U.S. Coast and Geodetic Survey, soit par une méthode différente ;

(c) Que les comparaisons d'étalons magnétiques soient intensifiées pendant un temps couvrant largement la durée de l'Année Géophysique Internationale ;

(d) Que des enregistrements rapides de courants telluriques soient effectués à toutes les stations en ayant la possibilité ;

(e) Que l'on considère l'intérêt du procédé allemand pour examiner les hétérogénéités de la conductivité du sous-sol dans le but d'étudier le caractère magnétique de la région où est situé un observatoire magnétique ;

(f) Que toutes les stations de l'Année Géophysique Internationale, permanentes ou temporaires, soient utilisées pour la réduction des réseaux magnétiques aériens qui pourront être effectués pendant cette période, et que le Comité No. 5 (Cartes Magnétiques) soit chargé de suggérer les régions océaniques où de tels réseaux aériens seraient particulièrement utiles.

RÉSOLUTION NO. 9

L'Association Internationale de Magnétisme et Électricité Terrestres,

Reconnaissant l'importance mondiale de l'Observatoire de Huancayo,

Recommande que tout soit tenté pour qu'il puisse participer pleinement au programme de l'Année Géophysique Internationale 1957—1958.

RÉSOLUTION NO. 10

L'Association Internationale de Magnétisme et Électricité Terrestres,

Reconnaissant l'importance mondiale de l'Observatoire de Djakarta,

Recommande que tout soit tenté pour qu'il se trouve en fonctionnement régulier durant l'Année Géophysique Internationale 1957—1958.

RÉSOLUTION NO. 11

L'Association Internationale de Magnétisme et Électricité Terrestres,

Invite le Gouvernement de la Nouvelle-Zélande à considérer la possibilité d'établir une station magnétique temporaire près du pôle géomagnétique Sud (pôle de Gauss). Un tel observatoire serait particulièrement utile pendant l'Année Géophysique Internationale 1957—1958.

RÉSOLUTION NO. 12

L'Association Internationale de Magnétisme et Électricité Terrestres,

Suivant la proposition du Comité Mixte de l'Électricité Atmosphérique des Associations Internationales de Magnétisme et Électricité Terrestres et de Météorologie,

Recommande :

(a) Que des comparaisons systématiques soient entreprises entre les perturbations météorologiques et les variations du champ électrique terrestre au sol en des lieux exempts d'effet de relief ;

(b) Que des sondages systématiques du champ électrique terrestre en altitude soient entrepris en différentes stations, sans négliger les régions tropicales et subtropicales.

RÉSOLUTION NO. 13

L'Association Internationale de Magnétisme et Électricité Terrestres,

Suivant la proposition du Comité Mixte de la Haute Atmosphère des Associations Internationales de Magnétisme et Électricité Terrestres et de Météorologie,

Observant que les tables crépusculaires de J. Lugeon, qui ont rendu des services considérables aux spécialistes de la haute atmosphère, sont maintenant épuisées, alors qu'elles sont de plus en plus demandées,

Recommande leur réimpression avec la traduction en plusieurs langues de leur mode d'emploi.

RÉSOLUTION NO. 14

L'Association Internationale de Magnétisme et Électricité Terrestres,

Recommande aux observatoires magnétiques la publication dans les annuaires ou par d'autres moyens des données suivantes par ordre d'importance :

(a) Données de première importance

(1) Valeurs horaires des trois éléments avec indication des valeurs interpolées. Lorsque les valeurs moyennes sont utilisées, elles doivent être centrées sur les demi-heures.

(2) Moyennes mensuelles et annuelles, dès que possible.

(3) Indices K (et aussi indices C s'ils ont été donnés antérieurement) et si on le juge utile description de l'activité magnétique.

(4) Renseignements sur l'équipement normal, sur les enregistrements exécutés, et sur la précision des mesures (observations absolues, détermination des lignes de base, valeurs d'échelle, fonctionnement des appareils absolus et des variomètres, orientation et interaction des aimants, coefficients de température et étalonnage des appareils absolus).

(5) Reproduction des magnétogrammes de chaque jour ou au moins reproduction de magnétogrammes choisis.

(6) Sommes et moyennes journalières et sommes et moyennes horaires mensuelles et valeurs moyennes correspondantes pour les cinq jours calmes et les cinq jours perturbés sélectionnés pour le mois en question.

(7) Heures des débuts brusques des perturbations magnétiques et autant que possible des crochets, pulsations, pulsations géantes et changements semblables et autres phénomènes remarquables, avec indication de l'amplitude et du sens pour chaque élément.

(b) Données supplémentaires

(1) Variations diurnes ou écarts heure par heure pour tous les jours et pour les jours sélectionnés en moyenne sur les mois, les saisons de Lloyd et les années ; indication éventuelle de la variation non cyclique.

(2) Pour chaque jour les valeurs maxima et minima et les différences de ces valeurs extrêmes.

(3) Descriptions des installations spéciales et indications sur les périodes de fonctionnement de ces installations (magnétographes à marche rapide, enregistrements de vitesse de variation, etc.).

RÉSOLUTION NO. 15

L'Association Internationale de Magnétisme et Électricité Terrestres,

Considérant l'intérêt de l'enregistrement continu des pulsations du champ magnétique terrestre et la nécessité de rendre comparables les résultats obtenus sur tout le Globe.

Recommande que les observatoires magnétiques s'équipent pour enregistrer ces pulsations au moins pendant la durée de l'Année Géophysique Internationale.

Le Comité No. 8 (Instruments Magnétiques) est chargé d'étudiér la possibilité d'effectuer ces mesures au moyen de sondes électromagnétiques,

Recommande, au cas où de telles mesures s'avéreraient difficilement réalisables par la plupart des observatoires, ce qui conduirait à recourir aux procédés utilisés jusqu'ici, l'équipement minimum suivant :

(1) Enregistrement rapide des variations des trois composantes au moyen de variomètres à aimant pour X et Y ou H et D et au moyen d'un cadre avec fluxmètre pour la composante Z. Les valeurs d'échelle devraient être amenées, pour les régions non-polaires, aux valeurs de 1 γ/mm pour X et Y ou H et D et $1/10$ γ/mm pour Z. Les périodes propres des aimants des variomètres ne devraient pas dépasser 3 sec. et le degré d'amortissement devraient être amené à 0,5 environ. Les vitesses de déroulement des enregistreurs devraient être standardisées à 6 mm/min. Pour ces mesures la précision de la seconde est indispensable dans les marques de temps. La sensibilité des appareils devrait être déterminée expérimentalement dans toute l'étendue de l'échelle de mesures.

(2) Enregistrement rapide des variations des dérivées par rapport au temps pour deux éléments suivant des directions horizontales et rectangulaires; si on ne peut mesurer qu'un élément l'adoption de dH/dt est recommandée. La valeur d'échelle pour les régions non-polaires devrait être de l'ordre de 0,05 γ/sec/mm. Les recommandations précédentes sont valables en ce qui concerne les vitesses de déroulement, les marques de temps et l'étalonnage.

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*) See footnote on p. 16.

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*) See footnote on p. 16.

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