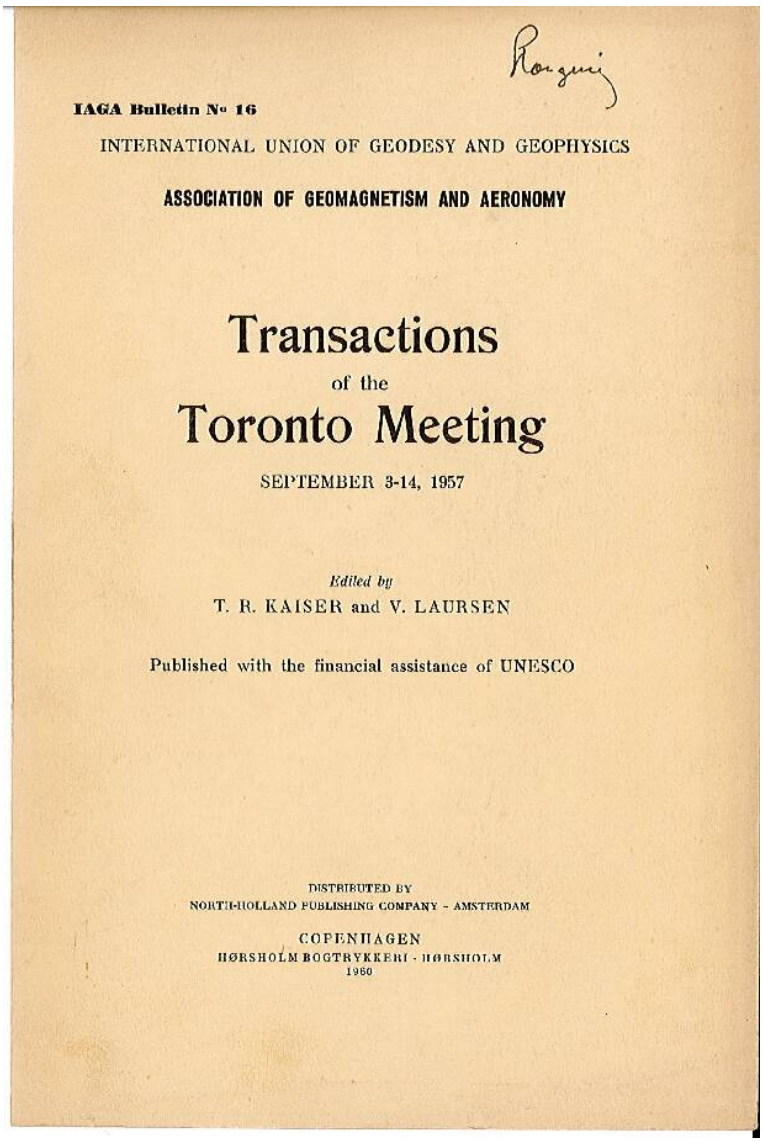

IAGA Bulletin Nº 16

INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS

ASSOCIATION OF GEOMAGNETISM AND AERONOMY

Transactions

of the

Toronto Meeting

SEPTEMBER 3-14, 1957

Edited by

T. R. KAISER and V. LAURSEN

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CORRIGENDA

p. 6, l. 2 f. a.: *A. G. Kalashnikov, M. A. Grabovsky, G. B. Petrova*
read: *A. G. Kalashnikov, M. A. Grabovsky & G. N. Petrova*

p. 55, l. 19 f. b.: côté
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Introduction

Statement summarizing the proceedings of the Toronto meeting

by J. BARTELS

(Presented at the final plenary session of the International Union of Geodesy and Geophysics, September 14, 1957)

The geomagnetic field is only partly due to permanent magnetism af rocks near the surface. The greater part is caused by electric currents near the Earth's core, slowly changing in the course of the years; and there is also a small, but highly variable part due to electric currents flowing high in the atmosphere. These fields are not only of interest in themselves, but they also provide information on many other geophysical and even solar phenomena, and they were all covered by papers presented at our regular meetings as well as in two symposia held during the Assembly. One af these, arranged by Sir Edward Bullard, was on palaeomagnetism and secular variation: When volcanic rocks are formed the lava cools down in the Earth's magnetic field and the rocks acquire a magnetization which can be preserved through hundreds of millions of years; sediments may also have such fossil magnetization which is now intensely studied as bearing on polar wandering and continental drift. Another symposium, arranged by Dr. Kaplan, discussed aeronomy, a name proposed by Sydney Chapman, our former Union President for the science of those regions of the upper atmosphere where dissociation and ionisation are important. This is a lively and fast advancing subject: aurora, air-glow, meteors, ionosphere, chemical composition, were discussed. Ever since 100 years ago, Sabine, from magnetic observations made here at

Toronto, discovered the influence of the sunspot-cycle on magnetic disturbances, new aeronomical results on solar influences have been found, with new highlights added by research with rockets. More can be expected from the IGY and the satellites.

A visit to the Toronto magnetic station, now at Agincourt, gave an impression of the leading part which our Canadian colleagues of the Dominion Observatory are playing in such instrumental developments as the Airborne Magnetometer and the Nuclear Proton-Precession Magnetometer.

A Committee has been formed to organize a new World Magnetic Survey.

The Geomagnetician has one foot 2000 miles deep in the Earth, and his aeronomic foot 80 miles high up in the ionosphere. This may seem an uncomfortable position, but our Association has again proved to be as healthy and productive as one might wish.

The Officers of the Association elected for the next period are:

President:	Prof. *J. Kaplan* (USA)
Vice-Presidents:	Dr. *A. G. Kalashnikov* (USSR)
	Mr. *V. Laursen* (Denmark)
Secretary and Director of the Central Bureau:	Rev. *J. O. Cardús* (Spain)
Members:	Prof. *J. Bartels* (Germany)
	Prof. *T. Nagata* (Japan)
	Prof. *M. Nicolet* (Belgium)
	Dr. *J. M. Rayner* (Australia)
	Dr. *O. Schneider* (Argentina)
	Prof. *E. Thellier* (France)

Part I

Agenda and Minutes

Final agenda for the meeting

The following agenda is based on the provisional programme issued August 1, 1957, but will include all later modifications and amendments. The agenda given under the heading A will comprise

Plenary sessions of the Association
Group meetings devoted mainly to geomagnetism
Joint meetings with the Association of Meteorology*)

whereas separate agendas will be given under the headings B and C for the two symposia arranged in connection with the General Assembly, namely:

B A Symposium on Secular Variation and Palaeomagnetism, arranged by Sir *Edward Bullard* on behalf of the IAGA Committee on Secular Variation and Palaeomagnetism.

C A Symposium on Aeronomy, arranged by Professor *J. Kaplan* in his capacity of Chairman of the IAGA Committee on the High Atmosphere.

A

Tuesday, 3rd September

14^h30: IAGA, opening session (Minutes see p. 13).

1. Introductory remarks by the President, Prof. *J. Bartels*.
2. Secretary's report.
3. Nomination of Temporary Committees for the Toronto meeting.
4. Special Committees for the next three-year period.
5. Symposia to be arranged under the auspices of the IAGA.
6. National reports.

*) Now the Association of Meteorology and Atmospheric Physics.

Wednesday, 4th September

9h00: IAGA, plenary session (Minutes see p. 15).
1. National reports (cont.).

14h00: IAGA, plenary session (Minutes see p. 17).
1. Report of Committee No 6 (Lunar Variations).
2. Communications on lunar variations.
3. Communications on recent cosmic ray studies and their relationship to the geomagnetic field.
4. World magnetic survey.

Friday, 6th September

9h00: Joint meeting with the Association of Meteorology (Minutes see p. 20).
Atmospheric Electricity.

Saturday, 7th September

9h00: IAGA, plenary session (Minutes see p. 21).
1. Election of Executive Committee for the next three-year period.
2. Nomination of Chairmen of Special Committees.
3. Establishment of a Special Committee on the History of Geomagnetism and Aeronomy.

Monday, 9th September

9h00: IAGA, group meeting, geomagnetism (Minutes see p. 23).
1. Report of Committee No 8 (Magnetic Instruments).
2. Communications on magnetic instruments.

14h00: IAGA, group meeting, geomagnetism (Minutes see p. 24).
1. Report of Committee No 5 (Magnetic Charts).
2. Communications on magnetic charts.

Tuesday, 10th September

9h00: Joint meeting with the Association of Meteorology (Minutes see p. 25).
Atmospheric Ozone and Problems of the Upper Atmosphere.

9h00: IAGA, group meeting, geomagnetism (Minutes see p. 26).
1. Report of Committee No 9 (Characterization).
2. Communications on magnetic storms.

14h00: IAGA, group meeting, geomagnetism (Minutes see p. 27).
1. Report of Committee No 1 (Observatories).
2. Report of Committee No 7 (Comparisons).
3. World magnetic survey (cont.).
4. Communications on magnetic storms (cont.).

Wednesday, 11th September

9h00: IAGA, group meeting, geomagnetism (Minutes see p. 28).
1. Communications on special geomagnetic problems.
2. Report of Committee No 10 (Rapid Variations and Earth Currents).
3. Communications on rapid variations and earth currents.

Thursday, 12th September

14h00: IAGA, plenary session (Minutes see p. 29).
1. Nomination of members of Special Committees.
2. Report of the Committee on Finances.
3. Budget.
4. Communications on special geomagnetic problems (cont.).

Friday, 13th September

14h00: IAGA, plenary session (Minutes see p. 31).
1. Resolutions.
2. Closure of Assembly.

B

Symposium on Secular Variation and Palaeomagnetism

Arranged by Sir *Edward Bullard* on behalf of the IAGA Committee on Secular Variation and Palaeomagnetism.

Thursday, 5th September

9h00:
1. *E. C. Bullard:* Introductory remarks.
2. *T. Nagata:* Report on secular variation and palaeomagnetism (presented by the Chairman).
3. *Y. D. Kalinin:* Method of forecasting secular geomagnetic variations.
4. *E. Thellier* and *O. Thellier:* Researches on the intensity of the earth's magnetic field in the past.
5. *A. Chargoy:* A physical interpretation of the central quadrupole.
6. *A. de Mendonça Dias:* A convective system in the mantle between the NW of Africa and the Azores (presented by the Chairman).
7. *R. F. King:* The difficulties in using quaternary varved sediments for palaeomagnetic studies of the secular variation.
8. *K. M. Creer:* The procedure of magnetic cleaning.

Friday, 6th September

9h00: 1. *A. G. Kalashnikov, M. A. Grabovsky, G. B. Petrova:* Some results of investigating magnetic properties of rocks and geological bodies.
2. *M. G. Rutten:* Palaeomagnetic research at the State University of Utrecht.
3. *J. A. Clegg:* Some recent palaeomagnetic results from Europe and from India.
4. *E. Irving* and *R. Green:* Movement of the pole relative to Australia since the Proterozoic.
5. *S. K. Runcorn, K. M. Creer, E. Irving, R. Green & A. E. M. Nairn:* Palaeomagnetic results from five continents.
6. *P. M. DuBois:* Palaeomagnetism and geological correlation.
7. *W. S. Jardetzky:* Polar wandering, shifting of the earth's axis and dipole variations.
8. *F. Frölich:* Zum Problem der inversen Gesteinsmagnetisierung.
9. *E. R. Deutsch, P. W. Sahasrabudhe & C. Radakrishnamurty:* Palaeomagnetism of the Deccan Traps.
10. *B. M. Yanovsky:* Palaeomagnetism of some sedimentary rocks in the USSR.
11. *B. M. Yanovsky:* Some peculiar magnetic properties of titanomagnetites on negative anomalies.

14h00: 1. *D. W. Allen* and *E. C. Bullard:* Origin of the secular variation.
2. *F. J. Lowes:* The eddy model of the secular variation.
3. *A. Herzenberg:* Geomagnetic dynamos (presented by Dr. Lowes).
4. *P. H. Roberts:* Propagation of induced fields through the core.
5. *S. K. Runcorn:* Theory of the secular variation.
6. *G. Barta:* Ideas concerning the causes of the secular variation of the geomagnetic field.

C

Symposium on Aeronomy

Arranged by Prof. *J. Kaplan* in his capacity of Chairman of the IAGA Committee on the High Atmosphere.

Monday, 9th September

9h00: 1. *J. Kaplan:* Introduction.
2. Chemical composition of the upper atmosphere.
(a) *M. Nicolet* and *P. Mange:* Distribution of chemical elements, atomic and molecular.

(b) *J. W. Townsend, Jr.* and *E. B. Meadows:* Atmospheric composition.
(c) *M. Zelikoff:* Artificial modification of the high atmosphere.

3. Physical properties of the upper atmosphere.
3.1 Temperature.
(a) *F. S. Johnson:* Temperatures in the high atmosphere.

3.2 Density.
(a) *T. A. Chubb:* Determination of atmospheric densities from absorption of solar radiation.
(b) *H. E. LaGow:* The arctic upper atmosphere.

14h00: 1. Physical properties of the upper atmosphere (cont.).
1.1 Electron and ion densities.
(a) *C. Y. Johnson:* Results obtained with rocket-borne ion spectrometers.
(b) *J. Carl Seddon:* The ionosphere.
(c) *H. K. Kallmann:* A new model of the atmosphere and ionosphere.
(d) *M. Nicolet:* Ultraviolet radiation and X-rays from the sun in relation to the ionospheric layers.
(e) *V. M. Driatsky:* Ionosphere in the region near the pole.

1.2 The exosphere.
(a) *H. K. Paetzold:* On the qualities of the exosphere.
(b) *L. R. O. Storey:* Protons outside the earth's atmosphere.
(c) *K. Maeda:* Some theoretical investigations on the study of the high and outer atmosphere.

20h00: 1. Solar-terrestrial relationships.
(a) *W. O. Roberts:* Transient solar phenomena as observed by solar observatories.
(b) *John W. Evans:* Solar activity.
(c) *A. H. Shapley* and *R. W. Knecht:* Ionospheric effects associated with the February 23, 1956 solar-cosmic ray event.
(d) *A. Ehmert:* The solar-cosmic ray event of February 23, 1956 and its ionospheric influence.

2. Satellites.
(a) *H. E. Newell, Jr.:* Preparations for the scientific research with the IGY artificial satellites.

Tuesday, 10th September

14h00: 1. Phenomena of the upper atmosphere.

1.1 Meteors.

(a) *G. S. Hawkins, F. Cook* and *R. E. McCroskey:* Meteors and the upper atmosphere.

(b) *P. M. Millman:* Meteors as observed by radar.

1.2 Aurora.

(a) *C. T. Elvey:* The vertical distribution of the hydrogen lines in the auroral spectrum.

(b) *D. M. Hunten:* Recent work at the University of Saskatchewan on auroral and night sky spectra.

(c) *T. R. Kaiser:* Relationships between auroral ionization and magnetic disturbance.

(d) *S. Matsushita:* Some studies of the high atmosphere in auroral latitudes.

(e) *N. J. Oliver:* Noctilucent clouds and zodiacal light.

(f) *V. I. Krassovsky:* Results of investigations of airglow and aurorae in the USSR.

(g) *A. E. Veller:* Hydrogen emission in the auroral spectrum.

(h) *A. I. Lebedinsky:* Instrumental equipment for auroral research during the IGY.

(i) *C. W. Gartlein:* The shapes of certain auroral forms.

(j) *F. D. McDonald:* Direct detection of low energy radiation in the auroral zone.

Tuesday, 10th September

20h00: 1. Satellites (cont.).

(a) *J. Allen Hynek* and *F. L. Whipple:* The IGY satellite tracking program as a source of upper atmospheric data.

2. Physical properties of the upper atmosphere (cont.).

2.1 Winds.

(a) *N. C. Gerson:* The general circulation of the high atmosphere.

(b) *J. F. Bedinger:* Sodium twilight experiments and wind measurements.

(c) *D. F. Martyn:* Winds and turbulence.

Wednesday, 11th September

9h00: 1. Phenomena of the upper atmosphere (cont.).

1.1 Airglow.

(a) *M. Huruhata:* Airglow observations.

(b) *F. Roach:* Excitation patterns in the airglow.

(c) *J. E. Blamont:* Twilight sodium effects.
(d) *A. V. Jones:* Oxygen and calcium in twilight,
(e) *V. I. Krassovsky:* Nature of emissions of the upper atmosphere.
(f) *R. Tousey:* Night airglow from rockets.
(g) *E.R.Manring:* Sodium night sky experiments.
(h) *J. W. Chamberlain:* Interpretation of the twilight airglow.
(i) *H. K. Paetzold:* Two new spectrophotometers for airglow observations.
(j) *J. E. Kupperian, Jr.:* Extreme ultraviolet radiation in the night sky.
(k) *H. B. Pettit:* Night airglow at 5577 Å.
(l) *I. S. Shklovsky:* Elementary processes in the upper atmosphere and their activity in emissions.

Wednesday, 11th September

14h00: 1. Laboratory and theoretical studies relating to the upper atmosphere.
(a) *O. Oldenberg:* General.
(b) *W. H. Bennett:* Störmertron.
(c) *R. W. Nicholls:* Transition probabilities.
(d) *S. J. Smith, D. S. Burch* and *L. M. Branscomb:* Experimental photodetachment cross section and ionospheric detachment rate for O_2^-.
(e) *S. Chapman:* Extended solar corona and heating of the upper atmosphere.
(f) *A. Dalgarno:* Diffusion coefficient in the F-layer.
(g) *T. Obayashi:* Geomagnetic pulsations and the earth's outer atmosphere.

Thursday, 12th September

9h00: 1. Solar-terrestrial relationships (cont.).
(a) *H. Friedman:* X-ray emission from the active sun.
(b) *V. A. Petukhov:* On neutron eruptions in the sun as sources of geomagnetic disturbances and aurorae.
(c) *B. W. Currie:* Auroral characteristics as revealed by magnetic, ionosonde and radar observations.
(d) *W. Dieminger:* Drifting sporadic-E clouds.

List of Delegates attending the Toronto meeting

The following list gives the names of Delegates who attended the Toronto meeting of the Association of Geomagnetism and Aeronomy.

Name	Country	Name	Country
Adkins, C. J.	Great Britain	Coulomb, J.	France
Afshar, H. K.	Iran	Cox, Allan	USA
Agarwal, R.	India	Creer, K. M.	Great Britain
Allen, D. W.	Canada	Cumming, C.	Canada
Aono, Y.	Japan	Currie, B. W.	Canada
Arsic, L.	Yugoslavia	Dalgarno, A.	USA
Balavadze, B.	USSR	Dawson, E.	Canada
Balsley, J. R.	USA	Deirmendjian, D.	USA
Bancroft, A. M.	Canada	Dence, M.	Canada
Bartels, J.	Germany	Denson, M. E.	USA
Barth, C. A.	USA	Derus, R. A.	USA
Bartman, F. L.	USA	Deutsch, E. R.	Canada
Beck, A. E.	Great Britain	Dickinson, T. M.	USA
Bedinger, J. F.	USA	Dieminger, W.	Germany
Belmont, A. D.	USA	Dinger, J. E.	USA
Bennett, W.	USA	Doell, R. R.	USA
Benson, W. E.	USA	Doporto, M.	Ireland
Berkner, L. V.	USA	Drouilhet, P. R.	USA
Bernard, E. A.	Canada	Drummond, A. J.	Great Britain
Blake, F. G.	USA	DuBois, P. M.	Canada
Blamont, J. E.	France	Ehmert, A.	Germany
Bobrovnikoff, N. T.	USA	Elvey, C. T.	USA
Broggi, J. A.	Peru	Engle, E. G.	USA
Brooks, Charles F.	USA	Evans, John W.	USA
Brooks, Edward M.	USA	Ewing, W. M.	USA
Bucher, Walter H.	USA	Fedinski, V.	USSR
Bukhnikashvili, A. V.	USSR	Ferguson, H. B.	USA
Bullard, Sir Edward	Great Britain	Finch, H. F.	Great Britain
Bullerwell, W.	Great Britain	Fitzgerald, D. R.	USA
Burke-Gaffney, M. W.	Canada	Forsyth, P. A.	Canada
Bushey, A. H.	USA	Frenkiel, F. N.	USA
Byers, H. R.	USA	Friedman, H.	USA
Byrnes, B. C.	USA	Gaizauskas, V.	Canada
Cagniard, L. P. E.	France	Gallet, Roger M.	USA
Cardús, J. O.	Spain	Gamsberg, H. E.	USA
Chamberlain, J. W.	USA	Gartlein, C. W.	USA
Chapman, S.	Great Britain	Georgii, H. W.	Germany
Chargoy, A.	Mexico	Gerson, N. C.	USA
Chernosky, E. J.	USA	Ghosh, S. N.	India
Christie, R. L.	Canada	Giorgi, M.	Italy
Chubb, T. A.	USA	Gjellestad, Guro	Norway
Clark, J. F.	USA	Goguel, J.	France
Clegg, J. A.	Great Britain	Graf, Anton	Germany
Collett, L. S.	Canada	Graham, John W.	USA
Constantinescu, L.	Roumania	Greenberg, M.	USA
Cook, F.	USA	Grenet, G.	France

Name	Country	Name	Country
Griffiths, R.	USA	Leith, T. H.	USA
Grossling, B. F.	USA	Lowes, F. J.	Great Britain
Groth, W.	Germany	McLeod, K. C.	Canada
Hannaford, W. L.	Canada	McNamara, A. G.	Canada
Hansen, W. H.	USA	McNish, A. G.	USA
Harang, L.	Norway	Madill, R. Glenn	Canada
Hartz, T. R.	Canada	Maeda, K.	Japan
Hasegawa, M.	Japan	Mange, P.	USA
Haurwitz, B.	USA	Manring, E. R.	USA
Heezen, B. C.	USA	Maple, E.	USA
Hernandez, R.	Argentina	Martyn, D. F.	Australia
Hess, H. H.	USA	Massip, S.	Cuba
Hines, C. O.	Canada	Matsushita, S.	Japan
Holl, M. M.	USA	Mayaud, P. N.	France
Hood, P. J.	Great Britain	Meek, J. H.	Canada
Houghton, Henry G.	USA	Miatech, G. J.	USA
Houghton, J. T.	Great Britain	Millman, Peter M.	Canada
Howe, H. H.	USA	Miyake, Y.	Japan
Howell, L. G.	USA	Morelli, Carlo	Italy
Hoylman, C. W.	USA	Morris, Fred	USA
Hughson, J. T.	Canada	Mousuf, A. K.	Canada
Hunten, D. M.	Canada	Möller, F.	Germany
Hutchison, R. D.	Canada	Naugle, J. E.	USA
Jacobs, J. A.	Canada	Neiburger, M.	USA
Jacobs, W. C.	USA	Nelson, J. H.	USA
Jaeger, J. C.	Australia	Newell, H. E.	USA
Jakabashi, J.	USA	Nicholls, R. W.	Canada
Jardetzky, W. S.	USA	Nicolet, M.	Belgium
Jarman, C. A.	Great Britain	Nikolsky, A.	USSR
Johnson, C. Y.	Canada	Nordberg, W.	USA
Johnson, F. S.	USA	Obayashi, T.	Japan
Jones, A. V.	USA	O'Brien, P. N. S.	Great Britain
Joyce, J. W.	USA	Odishaw, Hugh	USA
Kaiser, T. R.	Great Britain	Olczak, T.	Poland
Kalinin, Y. D.	USSR	Oldenberg, O.	USA
Kallman, H. K.	USA	Oldham, C. H. G.	USA
Kane, R. W.	USA	Oliver, N. J.	USA
Kaplan, J.	USA	Onhauser, A. A.	Canada
Karoli, A. R.	USA	Onhauser, Helen	Canada
Kato, Y.	Japan	Ozima, M.	Japan
Katz, S.	USA	Paetzold, H. K.	Germany
Kellogg, W. W.	USA	Patton, B. J.	USA
King, R. F.	Great Britain	Pearse, C. A.	USA
Knapp, D. G.	USA	Peoples, J. A.	USA
Koenigsfeld, L.	Belgium	Peters, A. J.	USA
Kollar, F.	Canada	Petrie, W. L.	USA
Koncek, M.	Czechoslovakia	Pettit, H. B.	USA
Kraakevik, J. H.	USA	Pratap, R.	Canada
Krassovsky, V. I.	USSR	Queney, P.	France
Kunetz, G.	France	Ramanathan, K. R.	India
Kupperian, J. E.	USA	Ramos Dominguez, A.	Spain
LaGow, H. E.	USA	Rasool, S. I.	Pakistan
Larochelle, A.	Canada	Rayner, J. M.	Australia
Laursen, V.	Denmark	Reid, G. C.	Canada
Lebedinsky, A. I.	USSR	Ringwood, A. E.	USA

Name	Country	Name	Country
Roach, F.	USA	Smith-Rose, R. L.	Great Britain
Roberts, E. B.	USA	Stam, I. C.	Canada
Roberts, P. H.	Great Britain	Storey, L. R. O.	Canada
Roberts, W. O.	USA	Straten, F. W. van	USA
Rochester, M. G.	USA	Stroud, W. G.	USA
Rodriguez-Navarro y Fuentes, J.	Spain	Tatom, John	USA
Romañá, A.	Spain	Thellier, E.	France
Rose, D. C.	Canada	Thellier, O.	France
Ross, J. E. R.	Canada	Thompson, S. O.	USA
Ross, W. E.	Canada	Thorpe, J. R.	Great Britain
Roy, J.	Canada	Touart, C. N.	USA
Runcorn, S. K.	Great Britain	Tousey, R.	USA
Ruska, W. E. A.	USA	Tozer, D. C.	Great Britain
Rutten, M. G.	Holland	Troitskaya, V. A.	USSR
Ruttenberg, S.	USA	Tskhakaya, A.	USSR
St. Amand, P.	USA	Uffen, R. J.	Canada
Schonstedt, E. O.	USA	Ursin-Smith, R.	USA
Schwendinger, W.	USA	Vajk, R.	USA
Seddon, J. Carl	USA	Veldkamp, J.	Holland
Selzer, E.	France	Vestine, E. H.	USA
Serson, P. H.	Canada	Voogt, A. H. de	Holland
Sestoft, Ingolf	Denmark	Walton, G. F.	Great Britain
Shapley, A. H.	USA	Warga, Mary	USA
Shen, C. C.	China	Weelden, A. van	Holland
Sheppard, P. A.	Great Britain	Whipple, F. L.	USA
Sherburne, R. K.	USA	Whitham, K.	Canada
Shimazu, Y.	Japan	Wormell, T. W.	Great Britain
Shneiderov, A. J.	USA	Woodbridge, Dav. D.	USA
Singer, S. F.	USA	Worden, S. P.	USA
Slichter, L. B.	USA	Wright, Sir Charles	Canada
Slutz, R. J.	USA	Yanovsky, B. M.	USSR
Smellie, D. W.	Canada	Yudine, M.	USSR
Smith, Stephen J.	USA	Zelikoff, M.	USA
Smith, Waldo E.	USA	Zorilla, C. M.	Mexico

Minutes of the meeting

Minutes of the Meeting on Tuesday, Sept. 3

Opening Session

The meeting was opened at 14h30 by the President, Prof. *J. Bartels,* in the Cody Hall of the School of Nursing, University of Toronto.

In his introductory remarks the President greeted the Delegates to the Toronto Assembly, where for the first time the Association met under the new name, International Association of Geomagnetism and Aeronomy. Prof. *Bartels* quoted the definition, which Prof. *Chapman* has recently given to the new word aeronomy, and noted with satisfaction that it had been possible to arrange an extensive symposium on Aeronomy in connection with the Toronto meeting.

The President mentioned some of the scientists who had been active in the geophysical disciplines with which the Association is concerned, and who have passed away since the Rome meeting 1954. Among them was Dr. *J. A. Fleming,* who has contributed in an outstanding way to the development of the science of geomagnetism.

The Secretary presented his report on the activities of the Association in general and on those of the Central Bureau in particular. He regretted to have to report an undue delay in the publication of the Rome transactions. After a few explanatory remarks by the President the report was approved by the meeting (see Appendix 1, p. 32).

The following Temporary Committees were appointed for the Toronto meeting:

Committee on Nomination:

Prof. *Chapman,* Convenor
Prof. *Veldkamp*
Dr. *Joyce*
Dr. *Maeda*
Dr. *Currie*
Father *Cardús*
Dr. *Lebedinsky*

Committee on Resolutions:

Prof. *Thellier,* Convenor
Dr. *Nelson*
Mrs. *Troitskaya*

Committee on Finances:

Dr. *Koenigsfeld,* Convenor
Capt. *Roberts*
Dr. *Kato*

The meeting then went on to discuss the continuation or discontinuation of the Special Committees of the Association. The following decisions were made:

Committee No 1 (Observatories) to be continued.

Committee No 2 (Aurora and Airglow) to be continued.

Committee No 3 (High Atmosphere) to be continued under the name: Committee on Aeronomy.

Committee No 4 (Secular Variation and Palaeomagnetism) to be continued.

Committee No 5 (Magnetic Charts) to be continued under the name: Committee on World Magnetic Survey and Magnetic Charts.

Committee No 6 (Lunar Variations) to be continued.

Following a proposal by Prof. *Chapman* and the President it was decided that the Association of Meteorology should be asked whether they would like to have the Committee retransferred into a Joint Committee of the two Associations.

Committee No 7 (Comparisons) to be continued.

Committee No 8 (Instruments) to be continued.

Committee No 9 (Characterization) to be continued.

Committee No 10 (Rapid Variations and Earth Currents) to be continued.

A proposal by Prof. *Pushkov* that there be established a Special Committee on the history of the science of geomagnetism will be discussed later during the Assembly.

The two IAGA/IGY Committees, the one on Geomagnetism and the one on Aurora, shall be continued.

It was decided that pending the approval of the Association of Meteorology the two Joint Committees on the Upper Atmosphere and on Atmospheric Electricity respectively shall be continued.

The following were appointed IAGA representatives in the Joint Commissions on Ionosphere and on Solar and Terrestrial Relationships:

Ionosphere:

Prof. *Chapman*
Dr. *Maeda*
Prof. *Bates*
Prof. *Nicolet*

Solar and Terrestrial Relationships:
Prof. *Bartels*
Dr. *Denisse*
Dr. *Vestine*

A recommendation by the British National Committee concerning a speedy publication of the Transactions of General Assemblies was fully supported by the meeting.

With reference to a Union report on the study of radioactivity within the frame of the IUGG, it was decided that the attention of the Union should be drawn to the interest of the IAGA in this subject.

The Assembly approved a suggestion by the IAGA Executive Committee that the following symposia be planned for the coming years:

(1) A symposium on pulsations and rapid variations in geomagnetism and earth currents (1959)
(this symposium has already been fixed).
(2) A symposium on polar wandering (1960).
(3) A symposium on the regular variation and distribution of the geomagnetic field and cosmic rays (with IUPAP) (1960).
(4) A symposium on earth storms in geomagnetism, aurora, ionosphere and cosmic rays (with URSI, IUPAP and IAU) (1961).

A question by Dr. *Selzer* as to what magnetic data should be given in Ursigrams was referred to the Committees 9 and 10.

Dr. *Knapp* wondered why *new* observatories were requested to provide C-characters for the period of the IGY.

Prof. *Bartels* presented the National Report of Germany with special regard to the direct recording of the variation vector and to comparative records made at a fairly dense net of magnetic stations.

Minutes of the Meeting on Wednesday Morning, Sept. 4

Plenary Session

The meeting was opened at 9^h00 by the President. National reports were called for and presented as follows:

Canada by Dr. *Madill* (geomagnetism)
Dr. *Forsyth* (aeronomy)
Dr. *Jones* (spectroscopic auroral and airglow research).

In connection with his report Dr. *Madill* extended an invitation to Delegates who might wish to pay a visit to the Agincourt observatory sometime during the Assembly.

U.S.A. by Capt. *Roberts* (geomagnetism)
Dr. *Newell* (upper air research by means of rockets).

Dr. *McNish* gave a few details of a new technique by which the magnetic field in a coil can be measured with an accuracy of about 10^{-6}. The method will be further discussed in the meeting devoted to magnetic instruments.

U.S.S.R. by Mrs. *Troitskaya.*
Referring to a question by Dr. *Newell,* Prof. *Nikolsky* estimated the second auroral zone for which he has found evidence to be at about 78° geomagnetic latitude. About 25 standard magnetic observatories are now in operation in the U.S.S.R.

France by Prof. *Thellier.*
In his report Prof. *Thellier* drew attention to a considerable number af dissertations on geophysical topics, which had been published in France during recent years, but of which only a limited number af copies had been printed. Those specially interested might, however, be able to obtain copies upon request.

In connection with the French report the President made some general remarks concerning the use af direct current for electric railways. He suggested that the Association might pass a resolution urging upon railway companies and others not to use direct current for the operation of electric railways.
In reply to a question by Dr. *Newell,* Prof. *Thellier* confirmed that a limited rocket programme will be carried out by France during the IGY.

Japan by Prof. *Hasegawa.*

Belgium by Dr. *Koenigsfeld.*

Spain by Dr. *Rodriguez-Navarro.*

Great Britain by Dr. *Finch.*

Denmark by Dr. *Laursen.*

Australia by Dr. *Rayner.*

Although the number of Australian operated magnetic observatories shows a most remarkable increase during recent years, Dr. *Rayner* regretted that it had not been possible to maintain the observatory on Heard Island.

India by Prof. *Ramanathan.*
Discussing the distribution of magnetic observatories in India the importance of the re-establishment of the Dehra Dun observatory was emphasized. The Resolutions Committee was

charged with the preparation of an appropriate resolution in the matter (see Part VI, Resolution No 3).

Ireland by Dr. *Doporto.*

Iran by Dr. *Afshar.*

The President drew attention to the Peruvian report which had just been received and stressed in particular the importance of the computing of hourly values for Huancayo, which computing has now been completed also for the years from 1948 onwards.

Minutes of the Meeting on Wednesday Afternoon, Sept. 4

Plenary Session

The meeting was opened at 14h15 by the President, who at once called on Prof. *Chapman,* Chairman of Committee No 6 (Lunar Variations) to give the report of his Committee.

The report was discussed by Dr. *McNish* and Capt. *Roberts* and by the President who made some general remarks on the attraction of lunar studies.

Dr. *S. Matsushita* then presented his communication "Lunar effects on the equatorial Es", which communication was discussed by Dr. *McNish* and the President.

Prof. *Runcorn* presented his communication on "Recent cosmic ray studies and their relationship to the geomagnetic field". This communication was to illustrate a proposal by the British National Committee, asking the Association to note the discrepancy between geomagnetic data resulting from recent cosmic ray studies and that based on surface measurements, and to organize a new magnetic survey to investigate this discrepancy.

The speaker first introduced Dr. *D. C. Rose* who gave a statement concerning the observed position of the equatorial minimum of cosmic ray intensity. There is a considerable longitudinal difference between what might be called the cosmic ray equator and the geomagnetic equator.

Prof. *Runcorn* continued by saying that cosmic ray evidence seems to indicate that the external part of the magnetic field is considerably greater than should be expected from available surface observations. A new magnetic survey would be needed to investigate this problem.

The paper was first discussed by Capt. *Roberts,* Prof. *Chapman* and the President who drew attention to the decision which had been made the day before and by which the IAGA Committee on Magnetic Charts had been transformed into a Committee on World Magnetic Survey and Magnetic Charts.

Dr. *McNish* doubted that a magnetic survey would be of real use for the solution of the problem under discussion; he would

prefer an intensification of the cosmic ray studies. Dr. *Knapp* made the following statement:

"We should all welcome any means of improving the accuracy of our knowledge of the field distribution. Two relevant points are these: The Koror observatory, intended to fall approximately on the magnetic equator, was successfully located very exactly on it. Secondly, a new world survey, to be a substantial improvement on the present knowledge, must greatly expand the coverage of arctic and antarctic regions, since the polar gaps are the chief source of uncertainty in the existing world surveys and harmonic analyses."

Father *Mayaud:* "On a trouvé que, pour ordonner et rendre compte des résultats d'activité magnétique, il était nécessaire de substituer au champ géomagnétique — qui ne représente que le champ à l'infini — un champ intermédiaire entre ce champ et le champ au sol.

Le champ choisi, à savoir le champ à 5000 km d'altitude tel qu'il peut être déduit de l'analyse de *Vestine,* n'a aucune signification en lui-même ; son seul intérêt est de jouer ce rôle intermédiaire entre deux champs dont l'un, purement théorique, ne peut représenter adéquatement les phénomènes, et l'autre — champ au sol — ne peut certainement pas commander ces phénomènes puisque les corpuscules n'en subissent à aucun moment l'influence.

Il est possible que ce champ intermédiaire permette d'ordonner lui-même les phénomènes relatifs aux rayons cosmiques comme il ordonne mieux les phénomènes d'activité magnétiques."

Dr. *T. R. Kaiser:* "It is possible that some information concerning both the magnetic field and the electron density at great distances from the earth may be available from studies of radio echoes from the moon. One observes a rotation of the plane of polarization of the wave which is proportional to the line integral of $H_L n$ along the propagation path. H_L is the longitudinal component of the field and n is the electron density. The major part of this rotation occurs in the ionosphere, however it would be worth investigating whether a suitably arranged experiment would make possible the separation of the small extra ionospheric component."

Dr. *K. Whitham:* "I agree with the suggestion that a new World magnetic survey, particularly covering ocean areas is desirable. However I do not think that, with at least one vector airborne magnetometer capable of doing such work, the real difficulties are widely understood. These arise primarily from errors in geographical position which associated with the local magnetic gradients constitute the largest source of error of airborne observations as plotted on charts; the errors arising from magnetic disturbance are generally less important and in any case approximate corrections for such disturbance can readily be made. This

means that with continuous magnetic profiles in those elements the selection of appropriate values at suitable points for a spherical harmonic analysis becomes difficult. In other words expansions to a finite degree (n=6 say) with world-wide coverage may still leave a great deal of "so-called" non-potential terms, and the presence af these will in turn affect the accuracy of separation of lower degree terms into interior and exterior parts. It might be better if the latter is one of the main purposes of such a survey, to consider the selection of data only from areas where the local gradients are small. This in turn would increase the computational difficulties.

The limited experience the Dominion Observatory Group has over ocean areas suggests that this difficulty is still the greatest practical one, but of course local gradients do not in the average cause such a large uncertainty as over continental areas."

In answer to Dr. *Runcorn:* "The sources of error in measuring three components of the earth's field from a moving aircraft are common to all airborne magnetometers known to us. Equipment does exist which can measure the field components inside a moving aircraft under suitable conditions of flight to the accuracy you mention (ten to twenty gammas). Because of the magnetic field of the aircraft and its changes, and because of errors due to magnetic disturbance and errors in geographical position, in the case of the Dominion Observatory three component magnetometer the probable error of an instantaneous airborne observation as plotted on a chart is presently about 100 gammas."

Dr. *Knapp* drew attention to the chapter on magnetic airborne survey in the U.S.A. National Report.

Prof. *Runcorn* would estimate at 100 gammas the accuracy that would be needed for the suggested magnetic survey.

Following a suggestion by the President it was decided to appoint at once the members or some of the members of the IAGA Committee No 5 (World Magnetic Survey and Magnetic Charts). The delegations from the countries most directly interested were requested to suggest candidates for membership and the following were finally appointed:

Prof. *Pushkov*	U.S.S.R.
Dr. *Ivanov*	U.S.S.R.
Dr. *Byrnes*	U.S.A.
Dr. *Nelson*	U.S.A.
Dr. *Maple*	U.S.A.
Dr. *Serson*	Canada
Dr. *Rose*	Canada
Dr. *Rayner*	Australia
Dr. *Finch*	Great Britain
Prof. *Runcorn*	Great Britain

Dr. *Selzer*	France
Dr. *Meyer*	Germany
Dr. *Maeda*	Japan
Dr. *Koenigsfeld*	Belgium

Minutes of the Meeting on Friday Morning, Sept. 6

Joint meeting with the Association of Meteorology)*

(Arranged by the Joint Committee on Atmospheric Electricity, IAGA and IAM)

Atmospheric Electricity

The meeting was presided over by Dr. *L. Koenigsfeld,* the Chairman of the Joint Committee, who opened the discussion by a few introductory remarks, emphasizing the importance of the continuance of the Committee as a coordinating body for the furtherance of studies in atmospheric electricity. A coordination of efforts within this domain would be of particular significance during the International Geophysical Year.

In continuation of the Chairman's remarks a resolution concerning atmospheric electric research during the IGY was submitted and approved by the meeting. The resolution was later endorsed by a plenary session of the IAGA (see Part VI, Resolution No 17).

Communications were then presented as follows:

H. Norinder: Results obtained recently regarding the mechanism of lightning discharges.

Ross Gunn: The non-equilibrium electrification of rain-drops by the association of charged cloud droplets (presented by title).

A. Kimpara and *H. Ishikawa:* Lightning mechanisms and radiation of atmospherics (presented by the Chairman).

D. R. Fitzgerald and *H. R. Byers:* Aircraft observations of convective cloud electrification.

T. W. Wormell: Splashing of rain and atmospheric electricity observations in disturbed weather.

N. Kitagawa: Field-changes due to lightning discharges and their discharge mechanisms (presented by the Chairman).

The following papers were presented by title:

R. H. Woessner, W. E. Cobb and *Ross Gunn:* Simultaneous measurements of the positive and negative light ion conductivities to 20 kilometers.

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*) Now the Association of Meteorology and Atmospheric Physics.

L. de Miguel Gonzales Miranda: Appareil compteur automatique d'ions.

L. de Miguel Gonzales Miranda: Ionisation — Année 1954.

R. Mühleisen: Electric fields below thunderclouds.

A. Grigoriu: Méthode pour éliminer l'influence non-contrôlable due à l'inertie de l'égalisateur de potentiel dans les mesures du champ électrique terrestre.

A. Grigoriu, G. Giurgea et *H. Ivanovici:* Deux phases dans l'évaporation ionique des gouttes d'eau.

A. Grigoriu: L'origine de la composante universelle (Mauchly) du champ électrique terrestre par ciel clair.

A. Grigoriu: L'origine de l'électrification négative permanente de la surface du globe.

P. N. Tverskoy: L'état électrique de l'atmosphère par rapport au mélange turbulent.

Minutes of the Meeting on Saturday Morning, Sept. 7

Plenary Session

The meeting was opened at 9h10 by the President, who called upon Prof. *S. Chapman,* Chairman of the Nominations Committee to present the Committee's list of candidates for the posts as Officers of the Association and Members of the Executive Committee. The candidates were unanimously elected as suggested, and the Executive Committee for the period 1957-1960 will be constituted as follows:

President:	Prof. *J. Kaplan*
Vice-Presidents:	Prof. *A. G. Kalashnikov*
	Mr. *V. Laursen*
Secretary and Director of the Central Bureau:	Father *J. O. Cardús*
Members:	Prof. *J. Bartels*
	Prof. *T. Nagata*
	Prof. *M. Nicolet*
	Dr. *J. M. Rayner*
	Dr. *O. Schneider*
	Prof. *E. Thellier*

Acting upon a suggestion by the Executive Committee that there should be appointed an Assistant Editor for the Transactions of the General Assemblies, the Nominations Committee suggested Dr. *T. R. Kaiser* as Assistant Editor for the Toronto Transactions. This suggestion was unanimously accepted by the meeting.

Prof. *Chapman* went on to present the list of candidates for the posts as Chairmen of the Special Committees of the Association. The list was accepted by the meeting without modifications and the following Chairmen appointed:

Committee No 1	(Observatories):	Capt. *E. B. Roberts*
- - 2	(Aurora and Airglow):	Prof. *C. T. Elvey*
- - 3	(Aeronomy):	Prof. *M. Nicolet*
- - 4	(Sec. Var. and Palaeomagn.):	Prof. *T. Nagata*
- - 5	(World Magn. Survey and Magn. Charts):	Dr. *E. H. Vestine*
- - 6	(Lunar Variations):	Prof. *S. Chapman*
- - 7	(Comparisons):	Mr. *V. Laursen*
- - 8	(Instruments):	Dr. *J. H. Nelson*
- - 9	(Characterization):	Prof. *J. Bartels*
- - 10	(Rapid Var. and Earth Currents):	Father *A. Romañá*

Prof. *J. Keränen* was reappointed as Honorary Chairman of Committee No 5.

In accordance with an agreement with the Association of Meteorology the Association of Geomagnetism and Aeronomy is to name a candidate for the chairmanship of the Joint Committee on Atmospheric Electricity. Following a suggestion by the Nomination Committee Dr. *L. Koenigsfeld* was unanimously appointed.

It was further suggested that Prof. *H. Norinder* be appointed Honorary Chairman of the Joint Committee on Atmospheric Electricity. This suggestion will be submitted to the Association of Meteorology for approval.

The meeting went on to a discussion of the proposal made by Prof. *Pushkov,* that there should be established a Special Committee on the history of the science of geomagnetism. The opinions of the speakers were rather divided but the final vote gave to hand that there was a great majority in favour of the proposal, and it was therefore decided to establish Committee No 11, Committee on the History of Geomagnetism and Aeronomy. To serve on the Committee the following were appointed:

Prof. *N. Pushkov,* Chairman
Capt. *E. B. Roberts*
Prof. *L. Cagniard*
Dr. *L. Koenigsfeld*
Dr. *S. Matsushita*
Mrs. *Rose*

Prof. *Pushkov*'s proposal concerning the institution of an Association medal was deferred to the next General Assembly.

Minutes of the Meeting on Monday Morning, Sept. 9

Geomagnetism Group

The meeting was called to order at 9h00 by the Vice-President Dr. *J. M. Rayner.*

Dr. *Nelson,* Chairman of Committee No. 8 (Magnetic Instruments) presented the report of the Committee which report gave rise to an extensive discussion on instrumental problems.

Mrs. *Troitskaya* stated that a nuclear precession magnetometer was installed in the non-magnetic ship "Zarya". She further drew attention to the installation of a differential magnetograph on the Kola Peninsula.

In reply to a question by Prof. *Thellier* Mr. *Kane* from the "Varian" Company stated that different types of precession magnetometers were now available. An observatory equipment, giving an accuracy of about 0,05 gamma, could probably be obtained for abt. $17500. The different types were all designed for measurement of the total intensity.

After additional remarks by Dr. *Maple,* Dr. *Selzer,* Prof. *Bartels* and Dr. *Serson,* Dr. *Nelson* gave a few details concerning a newly designed cathode tube magnetometer. The accuracy of the instrument has so far been influenced by a considerable drift.

Mrs. *Troitskaya* and Dr. *Maeda* gave additional information on recent magnetic installations in USSR and in Japan, and Dr. *Whitham* continued by giving a description of the air-borne magnetometer developed at the Dominion Observatory, Canada. He mentioned that a description of the instrument had been prepared, of which copies might be obtained upon application to himself or to Dr. *Serson.*

Details of the equipment and its use were discussed by Dr. *Selzer,* Dr. *Nelson* and Dr. *Whitham.*

The paper by *H. Schmidt:* "Eine Anlage zur Registrierung örtlicher geomagnetischer Feldstärkedifferenzen" was presented by title with reference to the distributed summary, and then Prof. *G. Grenet* was called upon to present his note "Sur les enregistrements des variations rapides à Tamanrasset". The note was commented upon by Dr. *Whitham.*

Dr. *Serson* presented a note by himself and by Dr. *Hannaford* on "A proton nuclear precessional magnetometer" which note was followed by Dr. *Nelson*'s "Proposal for using the nuclear precession magnetometer for measuring the components H and Z".

Commenting upon Dr. *Nelson*'s proposal Prof. *Yanovsky* stated that methods for measurements of the three components of the magnetic field and of the gyromagnetic ratio γ have been worked out at the Leningrad University and at the Leningrad Institute of Metrology. The method for measurement of Z and H is based on a compensation of the components by means of Helmholtz

coils. The determination of the gyromagnetic ratio is carried out by means of paramagnetic resonance field measurements in several Helmholtz coils. The parameters of these coils are determined from their geometrical dimensions.

Further comments were made by Capt. *Roberts,* Dr. *Whitham* and Dr. *Knapp.*

Dr. *McNish* gave an account of the work of the National Bureau of Standards on redetermining the precession rate of the proton. The procedure described was discussed by Dr. *Selzer,* Dr. *Chernosky* and Dr. *Whitham.*

There followed a report by Dr. *Nelson* on the first records from the differential magnetograph at College, Alaska. The equipment is measuring the difference between simultaneous variations at the central station and at a satellite station; during a storm of intensity 800—900 γ the variations may differ as much as 40 γ.

Dr. *Chernosky* gave a few details of the so-called "Variable-Area Magnetograph" and stated in reply to a question by Capt. *Roberts* that for the time being only a recording of the time variation is aimed at without paying regard to the absolute value of the magnetic field.

Minutes of the Meeting on Monday Afternoon, Sept. 9

Geomagnetism Group

The meeting was opened at 14^h00 by the acting Chairman, Dr. *E. H. Vestine,* who called on Dr. *R. G. Madill,* Chairman of the Committee on Magnetic Charts, to present the report of his Committee.

The report gave rise to some discussion, in which Dr. *Vestine,* Capt. *Roberts,* Dr. *Finch,* Prof. *Cagniard* and Prof. *Bartels* took part. Dr. *Madill* pointed out that magnetic maps should be constructed by people who know the country, and that in Canada a purely graphical method was used for the drawing of isomagnetic lines on maps. Dr. *Howe* stated that the basic purpose of an ordinary magnetic chart is to estimate values at points at which no observations have been made. Usually, sharp curvatures to show anomalies would only mislead in interpolations, so that it is better to smooth the lines considerably. Anomalies can then be shown (1) by special maps, (2) by plotting anomalous values on the maps which show the smoothed lines.

The next item on the agenda was a general discussion on the World Magnetic Survey, but this discussion was postponed until Dr. *Kalinin* who had not yet arrived in Toronto would be able to participate. Also the presentation of the report by Dr. *M. M. Ivanov* on the "Sea magnetic survey on board the non-magnetic ship "Zarya"" was postponed until Dr. *Kalinin*'s arrival.

A communication by Prof. *Slaucitajs* on "Some problems in antarctic geomagnetism" was presented by title, and so was a note by Dr. *Constantinescu:* "Distribution normale du champ géomagnétique en Roumanie pour l'époque 1955.0".

A note by *E. Lahaye, L. Koenigsfeld, Devuyst* and *E. Hoge* on "La nouvelle carte magnétique de Belgique" was presented by Dr. *Koenigsfeld.* The chart is based on about 700 stations in Belgium.

Prof. *Bartels* presented the text of a resolution concerning the detrimental effect caused in the recording of magnetic variations by the use of direct current for electric railways. He requested that this resolution, which in a general way recommends the use of alternating current for the operation of electric railways, should be passed by the Association and later submitted to the Union for adoption.

Prof. *Thellier* and Prof. *Cagniard* were not in favour of such a resolution, which they considered rather ineffective. It might even weaken the effect of other more concrete recommendations made by the Association.

The principle of adopting a resolution as the one suggested was put to a vote. 22 voted for, 2 against, and the proposal was referred to the Resolutions Committee (see Part VI, Resolution No 1).

Minutes of the Meeting on Tuesday Morning, Sept. 10

Joint meeting with the Association of Meteorology)*

(Arranged by the Joint Committee on the Upper Atmosphere, IAGA and IAM)

Atmospheric Ozone and Problems of the Upper Atmosphere

The meeting was presided by Prof. *K. R. Ramanathan,* who in his opening remarks reviewed recent progress in ozone research work and stressed the importance of systematic ozone observations during the International Geophysical Year.

The following communications were presented:

F. N. Frenkiel: On vertical ozone profiles in the troposphere.

H. K. Paetzold: Atmospheric circulation and variation of the vertical ozone distribution.

G. F. Walton: Secondary scattering.

R. N. Kulkarni and *K. R. Ramanathan:* A report on some recent measurements of atmospheric ozone in Kashmir (Lat. 34°N) (presented by the Chairman).

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*) Now the Association of Meteorology and Atmospheric Physics.

H. U. Dütsch: Routine measurements of the vertical distribution of atmospheric ozone by the Umkehr method and their evaluation with the help of a high speed electronic computer.

H. K. Paetzold and *H. Zschörner:* Measurements of the total ozone amount and its analysis.

A. W. Brewer: Ozone and water vapour in the upper atmosphere.

A. Halim: Variations in atmospheric ozone with meteorological conditions at Quetta (presented by *S. I. Rasool*).

A. J. Schneiderov: Thermonuclear explosions and the ozonosphere.

Minutes of the Meeting on Tuesday Morning, Sept. 10

Geomagnetism Group

The meeting was opened at 9h00, with Prof. *J. Veldkamp* in the chair.

Prof. *J. Bartels* in his capacity of Chairman of the Committee on Characterization presented the report of the Committee. In connection with the report he suggested two resolutions, one bearing on the provision of Q-indices during the IGY, and on the derivation of a current measure of the intensity of the equatorial ring current, the other requesting the provision by USSR obsertories of K-indices for years prior to 1955.

The report gave rise to some discussion during which Dr. *Knapp* asked why the derivation of C-figures could not be discontinued. Prof. *Coulomb* was not in favour of a discontinuation of C, and Dr. *Selzer* suggested that equatorial stations might be asked to supply C and *not* K. Prof. *Bartels* expressed the opinion that the Committee might be willing to drop the C-figure, but for the time being he would not suggest a change of the current scheme.

The two resolutions were adopted provisionally and referred to the Resolutions Committee (see Part VI, Resolutions No 4 and 5).

Prof. *S. F. Singer* then presented his communication on magnetic storms, which communication was followed by a lively discussion.

In reply to a question by Dr. *Selzer,* Prof. *Singer* mentioned that a bay preceding an sc may be due to faster particles which reach the earth before the sc starts.

Dr. *McNish* pointed out that in Watheroo sc's were generally not preceded by a bay, and Dr. *Finch* drew attention to the fact that some sc's were not followed by a storm.

Prof. *Bartels* underlined that there might be great storms which were not really world-wide. He would think it preferable to distinguish between *nascent* storms and *mature* storms. It

might be of interest to study not only storms with a sudden commencement, but also storms with a sudden end.

Also Prof. *Thellier* and Prof. *Grenet* took part in the discussion.

The presentation of a paper by Dr. *N. P. Benkova* on "Current systems of magnetic storms" was deferred to a later meeting, and there now followed a discussion on Prof. *Nikolsky's* communication: "Geographical distribution of magnetic disturbances in the arctic region near the pole", which communication was presented by Prof. *Bartels.*

The paper was commented upon by Prof. *Singer,* Prof. *Thellier,* Father *Mayaud,* Father *Cardús,* Dr. *McNish,* who felt that Prof. *Nikolsky's* ideas might very well be consistent with other conceptions of the same subject, and Dr. *Vestine,* who drew attention to Dr. *Stagg's* paper on magnetic disturbance in relation to geomagnetic latitude.

Dr. *Kato* then presented the paper by himself and by Dr. *Watanabe:* "Studies on geomagnetic and cosmic ray storms in relation to geomagnetic pulsations".

Owing to shortage of time the presentation of the remaining papers on the agenda:

T. Obayashi and *J. A. Jacobs:* "Sudden commencements of magnetic storms and atmosperic dynamo-action",

R. Pratap: "The effect of solar flares on the geomagnetic field", were deferred to the afternoon meeting.

Minutes of the Meeting on Tuesday Afternoon, Sept. 10

Geomagnetism Group

The meeting was called to order at 14h00 by the President with Father *J. O. Cardús* acting as Secretary.

In the absence of Prof. *Lahaye,* Chairman of the Committee on Observatories, Prof. *Bartels* presented the report of the Committee. He emphasized in particular the importance of the two volumes: "Description des Observatoires Géomagnétiques", which have been prepared by the Committee and published with the support of the Royal Meteorological Institute of Belgium.

The meeting was in favour of a proposal made by the Committee, that these descriptions should be printed in an appropriate form, and that if possible the Secretariat of the Association should arrange for regular publication of amendments which should keep the descriptions up to date. The President regretted that Prof. *Lahaye* had decided to resign from the chairmanship of the Committee, and expressed on behalf of the Association his deep appreciation of the most valuable work which the Committee had performed under his leadership.

Then the report of Committee No. 7, Committee on Comparisons, was presented by the Chairman, Mr. *V. Laursen.* It is re-

gretted in the report that during the period under review the programme of international comparisons has been somewhat hampered by other urgent activities in connection with the preparations for the International Geophysical Year, but the Committee is now prepared to intensify the work, and all observatories which might wish to participate in the programme are requested to notify the Committee.

Prof. *Thellier* raised the question whether it might not already now be possible to base international comparisons on the proton precession instruments. The President drew attention to some uncertainties that still remained in the corrections to be applied to measurements made with these instruments. He hoped, however, that the Instrument Committee would follow attentively the development of the new equipment and keep the Association informed of progress made.

In reply to a question by Father *Cardús* Mr. *Laursen* stated that the Danish BMZ-magnetometer could not be considered an adequate instrument for international comparisons of standard values of the vertical force.

The meeting went on to discuss a resolution concerning the implementation of a world magnetic survey including in particular intensified magnetic observations over the oceans. The suggested text was referred to the Resolutions Committee, and it was decided that the final resolution should be submitted to the Union for adoption (see Part VI, Resolution No 2).

Dr. *Obayashi* presented the communication by *Obayashi* and *Jacobs:* "Sudden commencements of magnetic storms and atmospheric dynamo-action".

Finally Dr. *R. Pratap* presented his paper on "The effect of solar flares on the geomagnetic field".

Minutes of the Meeting on Wednesday Morning, Sept. 11

Geomagnetism Group

The meeting was opened at 9h00 by the President. Father *J. O. Cardús* acted as Secretary.

Communications on special geomagnetic problems were presented as follows:

G. Fanselau: "Potentialberechnungen und geomagnetisches Normalfeld", presented by title.

Juan Sancho de San Roman: "Comparaison entre les variations moyennes diurnes et annuelles du champ magnétique terrestre, enregistrées dans les divers observatoires ibériques", presented by Dr. *Rodriguez-Navarro.*

L. Koenigsfeld: "Sur la variation séculaire de la déclinaison en Belgique pendant une période de 50 ans", presented by the

author and discussed by Prof. *Bartels,* Prof. *Cagniard* and Dr. *Howe.*

J. J. Boonzaaier and *L. Slaucitajs:* "Proposal concerning the establishment of a magnetic station on Tristan da Cunha". The proposal was referred to the Resolutions Committee (see Part VI, Resolution No 8).

H. F. Finch: "The Hartland magnetic observatory", presented by the author and discussed by Prof. *Bartels,* Prof. *Grenet* and Capt. *Roberts.*

The following papers were presented by title:

W. Krzeminski: "Establishment of the net of secular variation stations in Poland".

S. Pawlowski: "Variations de la composante horizontale en Pologne".

S. Pawlowski: "Variations des éléments magnétiques à Swider".

O. N. Sipahioglu: "La plus ancienne détermination de déclinaison magnétique faite par les Turcs".

Father *Romañá,* Chairman of Committee No 10 (on Rapid Variations and Earth Currents) presented the report of his Committee. The report was commented upon by Dr. *Knapp,* Prof. *Grenet* and Prof. *Bartels.*

In connection with the report Father *J. O. Cardús* presented his note: "Quelques résultats statistiques des données envoyées mensuellement au Comité No 10."

Then Mrs. *V. Troitskaya* presented her communication on "Short period pulsations of the earth's electromagnetic field" which communication was discussed by Dr. *Knapp,* Prof. *Grenet,* Dr. *Schwendinger,* Dr. *Kato* and Dr. *Selzer.*

Dr. *A. V. Bukhnikashvili* presented the paper by himself and by *V. V. Kebuladze:* "Investigations of the nature of earth regional currents and their relation to geology from observations in Georgia." Comments by Dr. *Vestine* and Dr. *Lowes.*

The following papers by *Louis de Miguel Gonzales Miranda* were presented by Dr. *Rodriguez-Navarro:*

"Courants telluriques. Année 1950 et suivantes".

"Sauts brusques dans les courants telluriques et leur relation avec les impulsions brusques du champ magnétique terrestre".

"Orages dans les courants telluriques."

Minutes of the Meeting on Thursday Afternoon, Sept. 12

Plenary Session

The meeting was opened at 14h00 by the President and proceeded at once to the first point on the agenda, the nomination of members of Special Committees. Tentative lists of member-

ship had been prepared for the different Committees, mainly based on suggestions made by the Chairmen already appointed The lists proposed were adopted by the meeting with some few amendments.

On behalf of the Committee on Finances Dr. *Koenigsfeld* presented the report of the Committee, expressing approval of the accounts for the financial period January 1, 1954 to December 31, 1956, as prepared by the Secretary (see p. 37).

A tentative budget for the period Jan. 1, 1957 to Dec. 31, 1959, was submitted in the form in which it had been prepared by the Executive Committee (se p. 38). The President regretted that in consequence of the general economy which had been practised in the administration of the Association, and which had resulted in a fairly large balance at the end of the expired financial period, the Finance Committee of the Union had found it appropriate to reduce drastically the annual contribution from Union funds for the next three-year period.

Communications were then presented as follows:

Dr. *M. M. Ivanov:* "Sea magnetic survey on board the non-magnetic ship "Zarya"." The communication was presented by Mrs. *V. Troitskaya* and the President expressed the congratulation of the Association on the construction and the putting in operation of this non-magnetic vessel, by which the USSR authorities had given a most important contribution to the planned magnetic survey of the oceans (see Part VI, Resolution No 7).

Dr. *N. P. Benkova:* "Current systems of magnetic storms". This communication also was presented by Mrs. *Troitskaya.* Dr. *Matsushita* took part in the discussion.

Dr. *H. Wiese*'s paper: "Erdmagnetische Erforschung von Zonen erhöhter elektrischer Leitfähigkeit im Untergrund (Tiefentellurik)" was presented by title.

Prof. *G. Grenet* presented a paper by *G. Grenet* and *R. Will:* "Remarques sur les amplitudes de certaines perturbations magnétiques pulsatoires". Dr. *Constantinescu,* Dr. *Hannaford* and Dr. *Selzer* discussed details of the communication.

A paper by Dr. *O. N. Sipahioglu:* "Sur l'intervalle de temps entre l'activité solaire et les perturbations géomagnétiques" was presented by title.

Dr. *C. S. Wright* reported on "Rapid registration of small magnetic variations at subaudio frequences." Discussion by Dr. *Chernosky* and *Dr. Selzer.*

In continuation of the communications Dr. *Knapp* showed magnetograms from the US magnetic station in Koror which station is situated practically on the magnetic equator.

Minutes af the Meeting on Friday Afternoon, Sept. 13

Plenary Session

The meeting was opened at 14h00 by the President.

The resolutions which during the General Assembly had been adopted in principle were submitted for final approval in the form recommended by the Resolutions Committee. All the resolutions were passed in the suggested form or with only slight modifications. The resolution regarding the derivation of Q-indices during the International Geophysical Year gave rise to some discussion in which Dr. *McNish,* Dr. *Rayner,* Capt. *Roberts,* Dr. *Howe* and the President took part. It was the general opinion of the meeting that the provision of Q-indices as recommended in the resolution was highly desirable for the purposes of the IGY, and the hope was expressed, that all the observatories concerned would provide such indices, although under no formal obligation to do so.

Before closing the meeting the President expressed the thanks of the Association to those who had contributed to the success of the Toronto Assembly: to the Canadian authorities who had provided the most excellent frame for the meeting by placing the facilities of the School of Nursing at the disposal of the Association, to Prof. *Kaplan* and Sir *Edward Bullard* who had arranged the successful symposia on Aeronomy and Palaeomagnetism respectively, and to those delegates who had served on the Temporary Committees on Finances, Nomination and Resolutions and who had all accomplished a most arduous and important task.

The retiring Secretary expressed a few words of personal thanks to all the colleagues with whom he had been in contact during his six years of service in the Association, and with whom he had always met the most sincere and encouraging willingness to friendly cooperation.

The President then declared the General Assembly closed.

Appendices to the minutes

APPENDIX 1

Report of the Secretary and Director of the Central Bureau for the period 1954—1957

General

Within the domain of our Association the three years between the Rome Assembly 1954 and the present Assembly were characterized by the rapidly increasing activities in connection with the preparations for the International Geophysical Year and by the final opening, a couple of months ago, of this unique international undertaking.

Since the liquidation of the International Polar Year 1932—33 a small stock of magnetic instruments (variometers and recorders of the la Cour type) have been at the disposal of the Association. Part of these instruments have been lent out to Norway, Sweden, Nigeria and Chile, where they will be in operation during the IGY.

At a meeting in Paris, April 1956, of the Executive Committee and the Council of the Union, and later in the same year when the CSAGI met in Barcelona, it was emphasized that the Unions and Associations directly involved in the IGY operations should be prepared to take over a part of the responsibility for the best and most efficient utilization of the immense amount of observational data that would result from the IGY. In order to meet this requirement the Executive Committee of the IAGA decided to establish two special IGY Committees, namely:

an IAGA/IGY Committee on Geomagnetism,
under the chairmanship of Prof. *J. Coulomb*, and

an IAGA/IGY Committee on Aurora
under the chairmanship of Prof. *C. T. Elvey*.

At the Barcelona meeting of the CSAGI it was also recommended that the IAGA Committee No 10 (on Rapid Variations and Earth Currents) should be convened early in 1957 in order to establish before the IGY a uniform scheme for the classification of rapid variations in geomagnetism and earth currents. The Executive Committee approved, that part of the money which had been earmarked in the budget for IGY-purposes could be used to defray the expenses in connection with such a meeting, and thanks to a special effort on the part of the General Secretary of the Union a UNESCO-grant was obtained for the same purpose, so that not only the members of the Committee, but also

a few additional experts could be invited to participate in the meeting, which took place in Copenhagen in April 1957.

Also the activity of other IAGA Committees has been influenced by the approaching Geophysical Year, as will be seen from the reports of the individual Committees. It can be mentioned here that in pursuance of a resolution adopted by the CSAGI at its Brussels meeting 1955, the Committee on Observatories has implemented a world-wide inquiry in order to establish a catalogue of all IGY magnetic stations with detailed information as to instrumental equipment and availability of data. The outcome of this inquiry has been published by the Committee.

Publications

The undue delay in the publication of the final Transactions of the Rome meeting has rightly been criticized. The responsibility for this delay rests entirely with the Secretary, who from the beginning of the practical preparations for the International Geophysical Year has seriously underestimated the amount of official duties which was to be imposed upon him in this connection. A desperate effort was made to have the Transactions ready for distribution before the opening of the Toronto meeting, and although it ultimately proved impossible to realize this intention, the printing has been advanced so far that the issue of the volume is now a question of a few weeks.

In the meantime the Rome resolutions and the lists of members of the Special Committees have been published in the IUGG News Letter No 10, 1955, while the scientific communications presented at the two Symposia of the Rome meeting have been published in the "Annales de Géophysique" and distributed in the form of reprints as

IAGA Bulletin 15 a,
Communications on the Earth's Core,

IAGA Bulletin 15 b,
Communications on Problems in the Physics of the High Atmosphere.

In the series of IAGA Bulletins 12, Geomagnetic Indices, the following volumes have been published during the period under review:

Bull. 12 h, Geomagnetic Indices K and C, 1953
Bull. 12 i, Geomagnetic Indices K and C, 1954
Bull. 12 j, Geomagnetic Indices K and C, 1955

These Bulletins have been prepared for printing by Prof. *J. Bartels,* Father *A. Romañá* and *Prof. J. Veldkamp* and printed in Holland under the supervision of Prof. *Veldkamp.*

Thanks to the efforts of Prof. *E. Lahaye,* Chairman of the IAGA Committee on Observatories, and with the generous support of the Royal Meteorological Institute of Belgium, the Observatory Committee has been able to publish two valuable volumes containing descriptions of magnetic observatories with detailed information as to their equipment and activities.

The report of the Copenhagen meeting on rapid variations has been prepared by Father *A. Romañá* as Chairman of Committee No 10, and has been published in No 4 of the IUGG Chronicle (July 1957).

Finances.

At the Rome meeting the Association approved the following budget for the period January 1, 1954, through December 31, 1956:

ESTIMATED RECEIPTS	$
Cash on hand 1/1 1954	16,130
From Union for period 1/1 1954 to 31/12 1956 (£ 900 a year)	7,560
Total	23,690
Estimated payments	21,200
Estimated balance 31/12 1956	2,490

ESTIMATED PAYMENTS	$
Management expenses	1,200
Brussels Transactions (expenses 1/1 1954 to Assembly)	1,200
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
Total	21,200

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 Finance Committee appointed for the Toronto Assembly.

As will be seen from the statement the UNESCO-subventions received during the period has made it possible to maintain the two Permanent Services of the Association, that of Geomagnetic Indices and that on Intercomparisons, practically without direct

financial support from Association funds. It should be borne in mind, however, that the national Institutions concerned with these Services, namely the Meteorological Institute at De Bilt and the Geophysical Institute at Göttingen, both for Geomagnetic Indices, and the Meteorological Institute at Charlottenlund for Intercomparisons, have borne a considerable part of the actual costs by placing scientific and technical personnel as well as bureau and observatory facilities at the disposal of the Services in question.

Further remarks to the accounts are as follows:

1. When the sum received from the Union is smaller than had been anticipated in the budget, in spite of the fact that it has become possible to raise the annual contribution considerably over the foreseen minimum of £ 900, it is due to the fact that the Union contribution for 1956 could not be transferred to the Association until after the 31st December 1956.
2. Owing to the delay in the printing of the Rome Transactions it was not possible to have the printing costs included in the statement as here presented. Nor could the costs involved in the publication of IAGA Bulletin 15 b (Symposium on the High Atmosphere) be defrayed until after the 1st January 1957.
3. Only half of the sum set aside in the budget for lunar studies could be used up before the end of the financial period.
4. Against the balance per December 31, 1956, should be entered as a firm commitment the sum allocated by the Executive Committee of the Association for the arrangement of a meeting early in 1957 of the IAGA Committee on Rapid Variations and Earth Currents. Thanks to a UNESCO-Subvention of $ 2,400 the original allocation to this Symposium, $ 4,000, could be reduced to $ 1,600.

The facts referred to in the above remarks 1—4 will be reflected, of course, in the budget for the next financial period.

APPENDIX 2

Statement of accounts and Budget

International Association of Geomagnetism and Aeronomy

Summary statement of accounts from 1st January 1954 through 31st December 1956

RECEIPTS	$	$
Balance 31st December 1953		
Dan. acc. (D. cr. 55120,68)	7988.50	
U.S. acc.	8132.09	
		16120.59
Allocation from the Union		
Dan. acc. (D. cr. 43310,27)		6276.84
Grants-in-aid from UNESCO		
For Rome Assembly, Dan. acc. (D. cr. 2371.66)	343.72	
For Perm. Services, Dan. acc. (D. cr. 31026.68)	4496.62	
		4840.34
Interests:		
Dan. savings acc. (D. cr. 5483.46)	794.70	
U.S. savings acc.	707.88	
		1502.58
Sale of publications:		
Dan. acc. (D. cr. 1226.32)	177.73	
U.S. acc.	68.15	
		245.88
From IATME Committee No 11 (Equatorial Observations)		
Balance of 1951—1953 subvention		
Dan. acc. (D. cr. 105.90)		15.35
Adjustment		.02
Total receipts		29001.60

The above statement is summarizing the two sub-accounts of the Association: the Danish sub-account prepared by the Secretary of the Association and the U.S. sub-account prepared by Dr. J. W. Joyce. The two sub-accounts have been audited by B. Hoff-Jessen, Chief Accountant of the Danish Meteorological Institute. In the summary all receipts and payments in Danish crowns have been converted to U.S. dollars, using as rate of exchange 1 U.S. dollar to 6,90 Danish crowns. (Please note that in the corresponding summary for the financial period 1st January 1951 to 31st December 1953 — Transactions of the Rome Meeting, p. 61 — the rate of exchange 1 U.S. dollar to 6.8886 Danish crowns has been used, so that the Danish balance on December 31, 1953, 55120.68 Danish crowns, has been entered as dollars 8001.71 as against dollars 7988.50 in the present statement.

Charlottenlund, 6th April, 1957

V. LAURSEN
Secretary, IAGA

PAYMENTS	$	$
Subvention from Association funds to		
Permanent Services, Dan. acc. (D. cr. 357.95) ...	51.88	
Lunar studies, Dan. acc. (D. cr. 6936.30)	1005.26	
		1057.14
Publications:		
Brussels Transactions, U.S. acc.	1112.00	
Symposia, Dan. acc. (D. cr. 2805.33)	406.57	
Bulletin No 12 g, U.S. acc.	84.00	
		1602.57
Management expenses:		
Dan. acc. (Dan. cr. 5000.97)	724.78	
U.S. acc.	314.35	
		1039.13
Instrumental programme:		
Dan. acc. (D. cr. 4114.32)		596.28
Rome Assembly 1954:		
Dan. Acc. (D. cr. 7087.70)		1027.20
Preparations for Toronto Assembly 1957:		
Dan. acc. (D. cr. 254.00)		36.81
UNESCO grants-in-aid for Permanent Services:		
Dan. acc. (D. cr. 31026.68)		4496.62
Miscellaneous:		
Dan. acc. (D. cr. 26.00)		3.77
Total payments		9859.52
Balance 31st December 1956		
Dan. acc. (D. cr. 81035.72)	11744.31	
U.S. acc.	7397.77	
		19142.08
Total		29001.60

Report of Finance Committee

The Finance Committee has examined the financial report of the Association of Geomagnetism and Aeronomy, presented by Dr. *V. Laursen*. The Finance Committee approves this report without reservation, and compliments Dr. *Laursen* for his excellent services as Secretary of the Association. It is proposed to the Assembly that this report be accepted with thanks.

Toronto, 12th September, 1957.

L. Koenigsfeld *E. B. Roberts* *Y. Kato*

Approved budget for the International Association of Geomagnetism and Aeronomy for the period 1st January 1957 to 31st December 1959

ESTIMATED RECEIPTS		$	ESTIMATED PAYMENTS	$
Balance 1/1 1957		19,000	Management expenses	1,200
From Union for the period 1/1 1956 to 31/12 1959:			Rome Transactions incl. Bull 15 b	5,500
1/1 1956—31/12 1956	$ 3,000		Toronto Assembly	500
1/1 1957—31/12 1959 (£ 500 a year)	$ 4,000	7,000	Toronto Transactions	7,000
			Copenhagen Symposium .	1,600
			Magnetic indices	2,000
			Comparisons	1,000
			Lunar Studies	2,000
Total		26,000	Rapid variations (Committee 10)	1,000
Estimated payment		24,300	1959 Symposium	2,500
Estimated balance 31/12 1959		1,700	Total	24,300

APPENDIX 3

Proposals

I

Proposals by the British National Committee

The Subcommittee on Geomagnetism of the British National Committee proposes:

(1) that the attention of the International Association should be drawn to the delay in publication of the report of the proceedings of the Rome General Assembly, and that it be a recommendation that proceedings should be published within one year of the General Assembly to which they refer and should contain reports on the main administrative decisions taken, national reports, accounts of discussions and scientific meetings, and a list of delegates.

(2) that the Association should be asked to note the discrepancy between geomagnetic data resulting from recent cosmic ray studies and that based on surface measurements, and to organise a new magnetic survey to investigate this discrepancy.

II

Proposals by Prof. *N. Pushkov,* Director, Institute of Terrestrial Magnetism, Moscow:

(1) *On a world magnetic survey*

It seems to me that it would be useful if the Association applied to all maritime nations and first and foremost to

USA and Great Britain, inviting them to follow the example of the USSR and to build just one more non-magnetic ship for the carrying out of magnetic surveys over the oceans.

(2) *On the institution of an Association medal*

It seems to me that it would be useful to institute an Association medal which should be bestowed upon an individual scientist or a group of scientists for outstanding work in the domain of geomagnetism and aeronomy.

The assignment of the medal could take place every three years through a special committee appointed by the Association. The presentation of the medal could take place at the General Assemblies of the Association.

In Toronto a committee might be appointed which should be charged with the preparation of the regulations for the Association medal and rules for its assignment.

(3) *On the study of the history of the geomagnetic science*

We do not pay sufficient attention to the study of the history of the geomagnetic science. I do not know one paper in which the development of the geomagnetic science during the last century, after the appearance of Gauss's papers, has been treated. The Association should in every way encourage an effort to the effect that a history of the geomagnetic science be prepared.

I think it would be useful to appoint a special committee on the history of the geomagnetic science, which committee should be charged with the preparation of a historical outline of the development of the geomagnetic science during the 19th and 20th centuries. In the preparation of such an outline the cooperation of the National Committees of the Association in as many countries as possible should be invited.

(4) *On the collection of data concerning negative magnetic anomalies*

Negative magnetic anomalies (anomalies with reverse polarity) present an outstanding interest. However, the geographical distribution of the negative anomalies over the globe still remains unexplored.

It seems to me that it would be useful if the Association passed a resolution to the effect that all the National Committees of the Association should provide Committee No 4 (on Secular Variation and Palaeomagnetism) with data concerning negative anomalies in their respective countries, in order that the Committee might prepare a chart showing the distribution over the world of the negative anomalies.

APPENDIX 4

Meetings of the Executive Committee

First meeting

The Executive Committee of the Association met on the 2nd September at 10^h00 to discuss the items of the following agenda:

(1) Suggestions concerning membership of Temporary Committees for the Toronto meeting.
(2) Suggestions concerning the continuation or discontinuation of Special Committees of the IAGA.
(3) Suggestions concerning the continuation or discontinuation of Joint Committees with the Association of Meteorology.
(4) Suggestions concerning the IAGA representation in the
  (a) Joint Commission on the Ionosphere.
  (b) Joint Commission on Solar and Terrestrial Relationships.
(5) Symposia
(6) Publication
(7) Radioactivity
(8) IGY
(9) Aeronomy
(10) Association medal

The following members of the Executive Committee were present: Prof. *Bartels*, Prof. *Chapman*, Prof. *Coulomb* and Mr. *Laursen*.

(1) It was decided to submit to the General Assembly the following suggestions concerning membership of the three Temporary Committees to be appointed for the Toronto meeting.

(a) Committee on Nomination:
Prof. *Chapman*
Prof. *Veldkamp*
Dr. *Joyce*
Dr. *Maeda*
Dr. *Currie*
Rev. *Cardús*
Dr. *Lebedinsky*

(b) Committee on Resolutions:
Prof. *Thellier*
Dr. *Nelson*
Mrs. *Troitskaya*

(c) Committee on Finances:
Dr. *Koenigsfeld*
Capt. *Roberts*
Dr. *Kato*

(2) The Executive Committee will suggest to the General Assembly that the twelve existing Committees of the IAGA be continued with the following modification of names:

(a) that the name of Committee No 3, Committee on High Atmosphere, be changed into "Committee on Aeronomy".

(b) that the name of Committee No 5, Committee on Magnetic Charts, be changed into "Committee on World Magnetic Survey and Magnetic Charts".

The Executive Committee has studied a proposal which has recently been received from Prof. *Pushkov,* and which advocates the creation of a Special Committee on the history of the science of geomagnetism. Although recognizing the great interest of the subject the Executive Committee feels uncertain as to whether an appropriate working program for such a Committee could be drawn up without further consideration of the matter. The proposal will be submitted to the General Assembly for final decision.

(3) The Executive Committee will suggest to the General Assembly that pending the consent of the Association of Meteorology, the two Joint Committees with that Association be re-established. In case it is decided by both Associations that the two Committees shall be continued the Chairmen of the Committees may be appointed in accordance with the procedure adopted at the Rome meeting 1954.

(4) The following names will be suggested to the General Assembly:

(a) as IAGA representatives in the Joint Commission on Ionosphere:
Prof. *Chapman*
Dr. *Maeda*
Prof. *Bates*
Prof. *Nicolet*

(b) as IAGA representatives in the Joint Commission on Solar and Terrestrial Relationships:
Prof. *Bartels*
Dr. *Denisse*
Dr. *Vestine*

(5) The following Symposia were tentatively suggested for the next four years:

(1) A symposium on pulsations (1959)
(already fixed)

(2) A symposium on polar wandering (1960)

(3) A symposium on the regular variation and distribution of the geomagnetic field and cosmic rays (1960) (with IUPAP)

(4) A symposium on earth storms in geomagnetism, aurorae, ionosphere and cosmic rays (1961) (with URSI, IUPAP and IAU)

(6) Prof. *Coulomb* stated that Sir *Edward Bullard* and Prof. *Kaplan* were both in favour of a proposal that the scientific communications presented to the Symposium on Secular Variation and Palaeomagnetism and the Symposium on Aeronomy be published in the "Annales de Géophysique". It was decided that within the financial possibilities of the Association reprints of these publications should be distributed as IAGA Bulletins.

(7) With reference to the report on radioactivity which was presented to the first meeting (on August 31) of the Executive Committee of the Union, it was decided to notify the General Secretary that in addition to the Associations specified in the report also the IAGA is interested in the subject.

(8) The report on the IGY, which was also submitted to the Executive Committee of the Union, will be referred to the two IAGA/IGY Committees which will meet on Saturday the 7th September.

(9) Prof. *Chapman* will represent the IAGA at an informal meeting convened by the President of the Union to discuss questions relating to the use of the word aeronomy in the title of the IAGA.

(10) The Executive Committee has studied with great interest Prof. *Pushkov*'s proposal concerning the institution of an Association medal that should be awarded to scientists or to groups of scientists for outstanding work within the domain of the Association. It is felt, however, that with the present structure of the IAGA it would be difficult to include the assignment of such an award among the normal activities of the Association.

Second meeting

The second meeting was held on the 12th September at 11h30, and was attended also by most members of the new Executive Committee. Present were Prof. *Bartels,* Dr. *Rayner,* Prof. *Chapman,* Prof. *Coulomb,* Prof. *Hasegawa,* Prof. *Nicolet,* Capt. *Roberts,* Father *Cardús,* Prof. *Thellier* and Mr. *Laursen.*

The main item on the agenda was the preparation of a draft budget for the financial period 1/1 1957 to 31/12 1959. In this budget allowance had to be made for a drastic reduction of the annual contribution from the Union, which reduction had been

proposed by the Finance Committee of the Union in view of the rather large unspent balance in the Association account for the preceding period. The draft budget was submitted to the plenary session in the afternoon of the 12th September and was approved without amendments. Details of the budget are given on p. 38.

The Executive Committee then discussed the IAGA representation in the two Joint Committees with the Association of Meteorology and Atmospheric Physics, namely:

the Joint Committee on Upper Atmosphere
and the Joint Committee on Atmospheric Electricity

It was considered whether the Association should arrange for a Russian translation of the Toronto resolutions, but in view of the fact that the General Secretary of the Union was planning an early publication of all Association resolutions in English, French and Russian, a separate translation by the Association was not deemed necessary.

Third meeting

After the final plenary session of the Association the Executive Committee met on the 13th September at 16^h00. Present were Prof. *Bartels,* Dr. *Rayner,* Prof. *Nicolet,* Capt. *Roberts,* Father *Cardús,* Prof. *Thellier* and Mr. *Laursen.*

The resolutions just adopted by the Association were reviewed in order to decide what further action would have to be taken by the Association or by its Central Bureau in order to carry out the decisions and recommendations made.

The place for the coming IAGA symposia was preliminarily discussed. The hope was expressed that the 1959 symposium on rapid variations could be held in the Netherlands.

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 following: (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

I

Report on geomagnetic work carried out by the National Meteorological Service (Institute of Geophysics) during the period April 1954 to April 1957

1. The three Argentine geomagnetic observatories (La Quiaca, Pilar and Orcadas) continued in operation, each one with a continuous normal recording and five double sets of absolute observations per month.
2. In January 1957 the variometer equipment at Orcadas was replaced by a set of Ruska recorders.
3. In May 1954 comparisons were made at Pilar and La Quiaca with magnetometers Q.H.M. Nos 32, 33 and 34 belonging to the International Comparison Committee.
4. In January 1956 new geomagnetic charts for the whole country were published. These charts were adjusted to the dates established by the IAGA:

   Isogonic chart for the epoch 1955.0
   Isoclinic chart for the epoch 1955.0
   Isodynamic chart of H and Z for 1955.0

   In advance of the final reduction to the above reference date the observed instantaneous values have been reduced to a fixed reference level, based mainly on the night hour values of the element in question.
5. As a first step towards the preparation of an isogonic chart for 1960.0 an astronomic and geomagnetic survey was made of the three components D, H and I at 20 stations in the north eastern zone of the country; 15 of these were repeat stations and 5 were new.

6. Ideal reference curves are being calculated in order to determine three-hourly K indices for La Quiaca. It is estimated that after October 1957 this observatory will be able to report K, s.c. and s.f.e.

7. With regard to the Pilar Observatory, it is expected that the total rebuilding will be finished at the end of 1957. The equipment will include:
   One magnetic theodolite of the A. Schmidt type.
   One earth inductor with astatic galvanometer Askania.
   One set of Askania variometers with photographic and photoelectric recording, for normal velocity.
   One set of quick-run la Cour variometers.
   One set of low-sensitivity la Cour variometers.

II

Report on geomagnetic investigations carried out by the Observatorio Astronómico, Universidad Nacional de la Plata, during the period April 1954 to April 1957

Director of the Observatory:
Until Sept. 1955: Commander (R) G. O. Wallbrecher.
From Nov. 1955: Prof. Dr. Bernhard H. Dawson.

Chief of the Department of Terrestrial Magnetism and Atmospheric Electricity:
Prof. Dr. Leonidas Slaucitajs.

1. In the second part of the year 1954 measurements of the 3 magnetic elements were made at 8 secular stations in the Provinces of Pampa, Río Negro and Chubut. For the two repeat-stations: El Pascado and Bahia Blanca in the Province of Buenos Aires, special attention was paid to the maintenance of continuity in the annual series of observations.

2. In February and March 1955 an observer measured the 3 elements at 2 stations and 1 auxiliary point on the West Coast of the Antarctic Peninsula.

3. In January and February of 1956 special attention was again paid to Antarctica, where 15 stations of 3 elements and 3 auxiliary points were measured in the region of Weddell Sea and Antarctic Peninsula. Many old stations of former Antarctic expeditions were visited and remeasured, e.g. those of Charcot, Nordenskjöld and Finn Ronne.

4. In July 1956 5 secular stations were occupied in the Provinces of Corrientes and Misiones.

5. From October 1956 to February 1957 comparison observations were made with QHM at the observatories Hermanus, South Africa, Toolangi, Australia, and Fredericksburg, USA.

6. Preparations are being made to install a magnetic observatory in Patagonia and a registration station near La Plata for the International Geophysical Year.

7. List of published papers:

L. Slaucitajs: Aktivität Argentiniens in Antarktisforschung. Geofísica pura e applicata, Vol. XXIX, Milán 1954.

— Sobre el uso de los magnetómetros QHM y BMZ en la campaña y en el observatorio magnético. Meteoros, V, Buenos Aires 1955.

— Discussion of S. K. Runcorn's "The Earth's core". Trans. Amer. Geophys. Union, Vol. 36, No 3, Washington 1955.

— Mediciones geomagnéticas en la región de la Península Antártica, Islas adyacentes y Mar de Weddell en 1951-1956. Geofísica pura e applicata (In press).

— El conocimiento geomagnético de la región de la Península Antártica, Islas adyacentes y Mar de Weddell. Publicaciones del Instituto Antártico Argentino, Buenos Aires, No 3 (In press).

BELGIUM

Rapport National de la Belgique

Par L. Koenigsfeld

Enregistrements du champ magnétique terrestre.

Pendant la période de 1954 à 1957 les enregistrements de D, H, Z (variomètres la Cour à marche lente et marche rapide) ont été poursuivis au Centre de Physique du Globe à Dourbes.

Pour l'Année Géophysique des enregistreurs à marche rapide et à grande sensibilité seront mis en fonction (1 γ/mm). Des enregistreurs à grande vitesse (180 cm/h) seront également mis en service au moyen de deux bobines d'induction (de 25 m de côté) et de galvanomètres, l'une pour la force totale et l'autre pour Z.

Les enregistrements D, H, Z ont été également poursuivis à l'observatoire de Manhay (Université de Liège).

Des variomètres magnétiques la Cour à grande sensibilité (1 γ/mm) fonctionnent depuis le mois de juin 1957.

Des variomètres à barre fluxmètre, système Selzer, sont également employés pour les pulsations rapides.

Carte magnétique.

Les cartes magnétiques de la Belgique sont actuellement terminées pour D, H et Z. Environ 700 stations ont été occupées pour H et Z et 200 pour D.

Centre de Physique du Globe de Dourbes.

La réalisation du Centre créé par l'Institut Royal Météorologique est pratiquement terminée.

Fonctionnent d'une façon continue, le magnétisme, l'ionosphère, la séismologie, les courants telluriques, le radiogoniographe, la mesure du champ électromagnétique, l'électricité atmosphèrique et la mesure continue de la radioactivité.

Courants telluriques.

L'installation comprend deux lignes approximativement NS et deux lignes EW. La distance des électrodes EW est d'environ 2300 m et 1300 m entre les électrodes NS.

Les électrodes sont constituées par de grandes plaques de plomb enterrées à 3 m de profondeur. Elles sont reliées par des câbles isolés au polythène. Les lignes sont reliées à un potentiomètre électronique pour l'enregistrement normal (25 mm/h).

Les deux autres lignes sont branchées sur des galvanomètres qui permettent d'enregistrer photographiquement à grande vitesse (30 mm/minute).

Les sensibilités sont les suivantes :

Brown: 1 millivolt = 25 cm ou 100 millivolts = 25 cm
Galvanomètre: 100 millivolts = 1 cm

Une deuxième ligne courte, 100 m NS, 100 m EW, a été également réalisée, les électrodes étant constituées par des toles en cuivre plongées dans du charbon de bois et enterrées à 3 m de profondeur.

Des détails plus étendus seront donnés dans la publication : "Description des observatoires géomagnétiques", publiée par le Comité des Observatoires de l'A.I.G.A.

Expédition Antarctique.

Une expédition belge pour l'Antarctique est actuellement organisée. Elle quittera la Belgique en novembre 1957 et restera dans l'Antarctique jusqu'à fin 1958.

Les recherches porteront sur le magnétisme terrestre (enregistrement normal et rapide la Cour), la météorologie-aérologie (des radiosondages seront effectués régulièrement), l'électricité atmosphérique (au sol et en altitude par radiosondages), la radioactivité de l'air, la géologie, la glaciologie et l'océanographie (particulièrement pour la radioactivité de l'eau).

Des recherches ont été effectuées dans le domaine de l'aéronomie. Publications :

M. Nicolet: L'hélium dans l'atmosphère terrestre, Bull. Acad. Sc. Belgique 42, 956, 1956.

— Sur l'origine de l'argon atmosphérique, Bull. Acad. Sc. Belgique 42, 482, 1956.

— Meteor Ionization and the Night-time E Layer, Meteors, Pergamon Press, London 1955.

— The aeronomic problem of the nitrogen oxides, Journal of Atm. and Terr. Phys. 7, 152, 1955.

— Nitrogen oxides and the airglow, Journal of Atm. and Terr. Phys. 7, 297, 1955.

— The aeronomic problem of oxygen dissociation, Journal of Atm. and Terr. Phys. 5, 132, 1954.

CANADA

National Report on Geomagnetism and Aeronomy

Introduction.

Considerable progress has been made in all branches of the science of Geomagnetism and Aeronomy during the past three-year period. Studies in palaeomagnetism were accelerated by the construction of an astatic magnetometer at the Dominion Observatory and the redesigning of instrumental equipment at the Geological Survey of Canada and the University of Toronto. A base station for the study of telluric currents was established at Meanook Magnetic Observatory while the University of Alberta carried out telluric current surveys in Western Canada employing mobile equipment. Magnetic surveys were continued on the ground by the Dominion Observatory and in the air by the Geological Survey of Canada using a total intensity magnetometer and by the Dominion Observatory employing the three-component airborne magnetometer. A complete set of isomagnetic charts for Canada was published by the Dominion Observatory, and an imposing number of aeromagnetic total intensity map sheets was issued by the Geological Survey of Canada. Four magnetic observatories were in continuous operation throughout the period and three others were constructed on account of the International Geophysical Year. Phenomena relating to the upper atmosphere were studied intensively by several groups including the University of Saskatchewan, the University of Toronto, the Defence Research Board, the National Research Council, and the Dominion Observatory. In addition, a vast amount of practical and theoretical research was accomplished by commercial operators engaged in geophysical prospecting for oil and ore bodies.

Palaeomagnetism.

The Geological Survey of Canada carried out extensive measurements of the magnetic properties of rocks in relation to their petrography and geological setting in order to provide more information to assist in the interpretation of aeromagnetic maps. The Survey's ultimate aim is to see whether palaeomagnetism can be used for determining relative ages of rocks and for detecting overturning of folded beds. At the University of Toronto, a remanent magnetometer of the "rock generator" type was constructed for use primarily in magnetic stability studies. An astatic magnetometer was constructed at the Dominion Observatory but no regular program of measurements was undertaken owing to the prolonged construction of a new building designed for rock magnetism research. The Observatory magnetometer

will be used to find evidence to account for an apparent secular-change differential rate between the precambrian and palaeozoic formation in Eastern Canada and to measure the magnetic properties of drill cores from geological features of suspected meteoric origin.

Telluric Currents.

The Dominion Observatory installed earth-current apparatus at Meanook Magnetic Observatory during the latter part of 1955 and commenced recording in 1956. Lead electrodes were employed and spaced one mile (1.6 km) apart in two orthogonal directions, NS—EW, and recording was effected by fast pen-recorders having a paper speed of 6 inches (152.4 mm) per hour. The University of Alberta began an investigation of the regional variations in the current pattern over the Western Plains using mobile equipment.The first series of measurements from Western Alberta to the edge of the precambrian shield near Winnipeg, Manitoba, showed that the pattern in general reflects little influence of the depth of the basement. Measurements at Meanook and at field stations indicate that earth currents flowed in northwesterly and southeasterly directions. It is of great interest to note that the Canadian Society of Exploration Geophysicist has been instrumental in making available an abandoned dry oil well near Edmonton, Alberta, for the study of vertical earth currents during the International Geophysical Year.

Magnetic Surveys.

Magnetic surveys were continued on the ground and in the air by the Dominion Observatory. Ground survey parties made measurements for declination, inclination, and total intensity at 139 locations comprising 44 repeat and 95 new stations extending throughout Canada. Vertical intensity measurements were made at 381 points in an area radiating from Meanook Magnetic Observatory and 150 points were occupied in the environs of the Yellowknife Geophysical Year station.

The three-component airborne magnetometer of the Dominion Observatory was flown for a total of 440 flying hours representing approximately 85,000 miles (136,800 km) with the result that Canada has been covered by systematic survey flights up to latitude 60 degrees with the exception of the Province of British Columbia and the Western approaches.

The total intensity airborne magnetometer of the Geological Survey of Canada was flown in several areas for a total of approximately 133,000 miles (214,000 km).

While the National Committee is not unmindful of the extensive ground and airborne magnetic surveys carried out by commercial geophysical prospecting and exploration operators, it is unable to include statistical data in this report.

Magnetic Charts.

The Dominion Observatory published magnetic charts of Canada for the epoch 1955.0 showing isomagnetic lines and their corresponding isopors for declination, inclination, horizontal intensity, vertical intensity, and total intensity. In addition, detailed isogonic charts of the Provinces of Manitoba, Saskatchewan, and Alberta were completed and issued. Two charts of Canada depicting lines of the north and east components were constructed for theoretical purposes but not published. Magnetic data applying to topographic map sheets and marine and air navigation charts were supplied for a total of 4,380 items.

The Geological Survey of Canada published 192 aeromagnetic one-mile (1.6 km) map sheets depicting total intensity contours during the years 1955 and 1956.

Magnetic Observatories.

The four Canadian magnetic observatories at Agincourt, Meanook, Baker Lake, and Resolute have been in continuous operation, and have been supplemented for the duration of the International Geophysical Year by fully equipped stations at Churchill, Manitoba; Yellowknife, Northwest Territories; and Victoria, British Columbia. At the first two of these additional stations, Ruska photographic variometers have been installed and at the last an Askania three-component variograph. At Baker Lake the la Cour variometers have been supplemented by the addition of Ruska variometers recording X, Y, and Z at ordinary sensitivities. Absolute control of base lines is obtained at all stations except Agincourt by the use af QHM's and Dominion Observatory fluxgate electronic magnetometers.

All the observatories have been equipped with three-component fluxgate recording magnetometers designed at the Dominion Observatory. In addition, these instruments will be operated at ten other locations as part of the synoptic upper atmosphere program. The details of these locations and the auroral equipment now in operation at some magnetic observatories are given in the latest published report on the Canadian program of the Canadian National Committee for the I.G.Y.

A nuclear precession magnetometer, which provides absolute measurements of the total intensity of the earth's magnetic field in terms of an accurately known atomic constant, was designed and completed at the Geomagnetic Laboratory of the Dominion Observatory. Plans call for the construction of several of these magnetometers for use at magnetic observatories.

Photostats of observatory magnetograms were made available to all major geophysical exploration agencies operating in Ca-

nada as well as to scientific organizations and all magnetic results were made available for detailed analyses on request.

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 Europe, the United States of America, and Canada.

Research.

The magnitude and scope of Canadian research in the general field of geomagnetism during the past three-year period is indicated in the list of publications which follows.

Publications, 1954—1957

Defence Research Board.

Hope, E. R.: Spiral Patterning of Solar Corpuscular Precipitation. 1956. Nature 177:571.

— Linear Secular Oscillation of the Northern Magnetic Pole. 1957. J. Geophys. Res. 62:19.

— Rotation, Pulse-Disturbance and Drift in the Geomagnetic Secular Variation. 1957. J. Geophys. Res. 62:29.

— Westward Drift and Cyclic Secular Variation. 1957. J. Geophys. Res. 62:241.

— The Lowes-Runcorn Dipoles of Geomagnetic Secular Variation. 1957. In Press.

Wait, J. R.: On the Relation between Telluric Currents and the Earth's Magnetic Field. 1954. Geophys. 19, 2:281.

Jackson, W. E. W.: Record of Observations at the Magnetic Observatories, Agincourt and Meanook, 1934-1935. 1956. Pub. Dom. Obs. 17, No. 1.

Madill, R. G. and Cook, A. B.: Observations of Micropulsations in Meanook Magnetograms. (Presented Paper).

— and Dawson, E.: Magnetic Charts of Canada, epoch 1955.0, showing isomagnetic lines and corresponding isopors for D, I, H, Z, and F. Scale 1:6,336,000.

— — Isogonic Charts of Alberta, Saskatchewan, and Manitoba, epoch 1955.0, Scale 1:1,267,200.

Pratap, R.: The Effect of Solar Flares on the Geomagnetic Field. 1956. In Press.

Serson, P. H. and Hannaford, W. L. W.: A Portable Electrical Magnetometer. 1956. Can. Jour. of Tech. 34:232.

— — A Statistical Analysis of Magnetic Profiles. 1957. J. Geophys. Res. 62:1.

— Mack, S. Z. and Whitham, K.: A Three Component Airborne Magnetometer. 1957. Pub. Dom. Obs. 19, No. 2.

Small, G. R.: A Preliminary Study of Earth Currents in the Northern Hemisphere on Quiet and Very Quiet Days. (Presented Paper).

Whitham, K. and Loomer, E. I.: The Diurnal and Annual Motions of the North Magnetic Dip Pole. 1956. J. Atmosph. Terr. Phys. 8:349.

— — A Comparison of Magnetic Disturbance at Resolute Bay and Baker Lake, Canada. 1956. Tellus 8:276.

— — Characteristics of Magnetic Disturbance at the Canadian Arctic Observatories. 1957. Pub. Dom. Obs. 18, No. 12.

Whitham, K. and Loomer, E. I.: Irregular Magnetic Activity in Northern Canada with Special Reference to Aeromagnetic Survey Problems. 1957. Geophys. 22:646.

— — An Investigation of Magnetic Pulsations at the Canadian Magnetic Observatories. 1957. In Press.

University of Saskatchewan.

Meek, J. H. and McNamara, A. G.: Magnetic Disturbances, Sporadic-E and Radio Echoes Associated with Aurora. 1954. Can. Jour. Physics 32:326.

— Correlation of Magnetic, Auroral, and Ionospheric Variations at Saskatoon. 1954, J. Geophys. Res. 59:87.

— and Hector, F. S.: A Recording Magnetic Variometer. 1955. Can. Jour. Phys. 33:364.

— The Location and Shape of the Auroral Zone. 1955. J. Atmosph. Terr. Phys. 6:313.

University of Toronto.

Griffith, B. A., Jacobs, J. A. and Sachs, B.: Frequency studies of the Hourly Mean Values of the Magnitude F of the Earth's Field at Agincourt during the Period 1946-1951. 1955.

Jacobs, J. A. and Sachs, B.: The Effect of Altitude on the Position of the Magnetic Pole. 1956.

— and Obayashi, T.: The Diurnal Behaviour of SC of Magnetic Storms at Agincourt. 1956. Can. Jour. of Phys. 34:876.

— — The Average Electric Current System for the SC of Magnetic Storms. 1956. Geof. Pura e Appl. 34:21.

Upper Atmosphere Research.

The upper atmosphere has been studied intensively in Canada by several groups. Since radio is one of the most important tools in this research, much of the work is normally reported through URSI even though it is closely related to the work of UGGI. An attempt has been made in the following summary to cover the work on the physics of the upper atmosphere which is primarily of geophysical interest.

National Research Council.

In 1954 there was established in the Division of Radio and Electrical Engineering an Upper Atmosphere Research Section. It is intended that this group will study the fundamental aspects of upper atmosphere phenomena. Up to the present time a large part of their effort has been directed toward preparations for the International Geophysical Year; although some studies have been carried out in the fields of meteors and aurora.

Radar recording of meteor echoes during the active periods of the major annual showers has been continued on a frequency of 32 mc/s. This work has been carried out in cooperation with visual and photographic recording and has been part of a combined Dominion Observatory — N.R.C. study of meteors. Special meteor radar equipment in the same frequency range, designed to give a constant level of performance, is being prepared for continuous operation during the I.G.Y.

In addition to the radio observations which are planned during the I.G.Y., preparations have been made for visual and photographic observations of aurora. An all-sky camera has been designed and 9 units have been constructed. This camera differs from others which are currently in use, in that it uses 35 mm film in order to improve definition. Alternate exposures have durations of 40 sec and 4 sec in order to accomodate the wide range of auroral intensity and motion.

Detailed accounts of the studies undertaken by the N.R.C. group may be found in the following references.

McKinley, D. W. R.: The Meteoric Head Echo, Meteors. 1955. J. Atmosph. Terr. Phys. Spec. Sup. 2:65.

— Radio Determination of the Orbit of the Eta Aquarid Meteors. 1955. Astrophys. J. 122:513.

— Radar Echo Duration and Height of a Perseid Meteor. 1956. J. Atmosph. Terr. Phys. 8:76.

— Some Factors Affecting the Radio Determination of Meteoric Velocities. 1956. Naturwissenschaften 43:221.

— and McNamara, A. G.: Meteoric Echoes Observed Simultaneously by Back Scatter and Forward Scatter. 1956. Can. Journ. Phys. 34:625.

McNamara, A. G.: Radar Echoes from the Aurora and the Use of Doppler Techniques. 1956. Eng. J. 39:31.

Millman, Peter M. and McKinley, D. W. R.: Meteor Echo Durations and Visual Magnitudes. 1956. Can. Journ. Phys. 34:50.

— The Physics of Meteors. 1956. Phys. in Can. 12:7.

— and Burland, M. S.: The Magnitude Distribution of Visual Meteors. 1957. Sky and Telescope 16:222.

Defence Research Board, Radio Physics Laboratory.

For many years it has been recognized that the technique of ionospheric sounding by means of vertically directed radio waves does not provide enough information to describe completely the physical distribution of ionization in the ionosphere. Several studies are now being used to supplement the vertical incidence recordings.

A method has been developed which permits the examination of the ionosphere by means of radio waves which are incident obliquely on the ionospheric layers. The equipment is similar to the normal sweep-frequency pulse sounder except that the transmitter and receiver are separated by a distance of several thousand kilometers, the necessary timing being provided by accurate clocks. This technique has been used over a number of paths in Canada.

Studies have been made of the ionization existing in the lower ionosphere, of motions of inhomogeneities in the ionosphere as observed by vertical incidence recorders, of the ionization produced in the upper atmosphere by meteors using radio methods, of the relative amplitudes of signals reflected at 4 frequencies from auroral ionization over a forward-scatter path 1,000 km in

length, of the radiation from a radio star in Cassiopeia which has been recorded continuously for a period of three and one-half years, and of very low frequency radio waves which arise from thunder-storms and are propagated along paths which reach to the far outer regions of the Earth's atmosphere. Complete details of the studies may be found in the following references.

Chapman, J. H., Davies, K. and Littlewood, C. A.: Radio Observations of the Ionosphere at Oblique Incidence. 1955. Can. J. Phys. 33:713.

Cox, J. W. and Davies, K.: Statistical Studies of Polar Radio Blackouts. 1954. Can. J. Phys. 32:743.

— — Oblique-Incidence Pulse Transmission. 1955. Wireless Engineer 32:35.

Davies, K. and Hagg, E. L.: Ionospheric Absorption Measurement at Prince Rupert. 1955. J. Atmosph. Terr. Phys. 6:18.

Forsyth, P. A., Hines, C. O. and Vogan, E. L.: Diurnal Variations in the number of Shower Meteors Detected by the Forward-Scattering of Radio Waves. Part II. Experiment. 1955. Can. J. Phys. 33:600.

— and Vogan, E. L.: Forward-Scattering of Radio Waves by Meteor Trails. 1955. Can. J. Phys. 33:176.

— — The Duration of Forward-Scattered Signals from Meteor Trails. 1956. Can. J. Phys. 34:535.

— — The Frequency Dependence of Radio Reflections from Aurora. 1957. J. Atmosph. Terr. Phys. In Press.

Hagg, E. L. and Hanson, G. H.: Motion of Clouds of Abnormal Ionization in Auroral and Polar Regions. 1954. Can. J. Phys. 32:790.

Hartz, T. R.: Radio Star Scintillations and the Ionosphere. Can. J. Phys. 33:476.

— A Solar Noise Outburst of January 15, 1955. Nature 175:908.

— Reid, G. C. and Vogan, E. L.: V.H.F. Auroral Noise. 1956. Can. J. Phys. 34:728.

Hines, C. O.: Hydromagnetic Resonance in Ionospheric Waves. 1955. J. Atmosph. Terr. Phys. 7:14-30.

— Diurnal Variations in the Number of Shower Meteors Detected by the Forward-Scattering of Radio Waves, Part I, Theory. 1955. Can. J. Phys. 33:493.

— Electron Resonance in Ionospheric Waves. 1956. J. Atmosph. Terr. Phys. 9:56.

— Diurnal Variations in Forward-Scattered Meteor Signals. 1956. J. Atmosph. Terr. Phys. 9:229.

— Forsyth, P. A., Vogan, E. L. and Pugh, R. E.: The Dependence of Meteoric Forward-Scattering on Antenna Patterns and Orientations. 1955. Can. J. Phys. 33:609.

— and O'Grady, M.: Height-Gain in the Forward-Scattering of Radio Waves by Meteor Trails. 1957. Can. J. Phys. 35:125.

— and Vogan, E. L.: Variations in the Intrinsic Strength of the 1956 Quadrantid Meteor Shower. 1957. Can. J. Phys. In Press.

— and Pugh, R. E.: The Spatial Distribution of Signal Sources in Meteoric Forward-Scattering. 1956. Can. J. Phys. 34:1005.

Littlewood, C. A. and Chapman, J. H.: A Measurement at Ottawa of the Change in Height with Lunar Time of the E Region of the Ionosphere. 1955. Can. J. Phys. 33:11.

McKerrow, C. A.: Sudden Decrease in Low Frequency Atmospheric Noise during the Cosmic Radiation Storm of February 23. 1956. Nature 177: 1223.

Pugh, R. E.: The Number Density of Meteor Trails Observable by the Forward-Scattering of Radio Waves. 1956. Can. J. Phys. 34:997.

Storey, L. R. O.: A Method to Detect the Presence of Ionized Hydrogen in the Outer Atmosphere. 1956. Can. J. Phys. 34:1153.

Vogan, E. L. and Campbell, L. L.: Meteor Signal Rates Observed in Forward-Scatter. 1957. Can. J. Phys. In Press.

University of Saskatchewan, Saskatoon.

The investigations at Saskatoon (52.1°N; 106.6°W) include spectrographic studies of the emissions from the polar aurora and from the twilight and night airglows; correlations between auroral phenomena and magnetic and ionospheric disturbances; experimental studies of the inhomogeneities in the ionosphere (particularly during auroral displays), by reflecting radio waves from aurora, and by continuous observations on the scattering of radio waves and of the scintillations of the 50-Mc waves from the radio star in Cassiopeia; and the morphology of auroral displays over West-Central Canada. The observational program has been expanded in the past two years to include the operation of all-sky auroral cameras at Flin Flon (54.7°N; 102.0°W), Meanook (54.6°N; 113.3°W), and Uranium City (59.6°N; 108.8°W); and electronic fluxgate type magnetometers at Flin Flon and Swift Current (50.3°N; 107.7°W). The spectrographic program at Saskatoon is also being integrated with a somewhat similar one established at Churchill (58.8°N; 94.2°W) by the Radio Physics Laboratory of the Defence Research Board. It is anticipated that the integrated program will lead to reliable comparisons of the relative frequencies and intensities of various auroral and airglow emissions for a range of latitudes extending from inside to outside the auroral zone of maximum occurrence.

Spectrographic Studies.

The equipment consists primarily of five units — a spectrograph with at 5-inch, 600 line/mm, plane grating and a f/0.8, flat-field, Schmidt camera; a spectrograph with an 8-inch, 600 line/mm, plane grating and interchangeable f/2.5 and f/0.8, flat-field, Schmidt cameras, an infrared scanning spectrometer for the wave-length region between 6,000 and 20,000 A; a rapid scanning spectrometer capable of recording an auroral spectrum from 3,000 to 6,000 A with 10 A revolution in 10 seconds; and a patrol spectrograph with a 52×52 mm, 600 line/mm, transmission grating, and equipped with a spherical mirror and an objective lens so that a meridional strip of the sky from the north to the south horizons is focussed along the length of the slit. Various devices for changing films and plates automatically after a sufficient exposure for satisfactory measurements of the

spectral intensities and for absolute calibrations of the spectrographs and spectrometers are in regular use.

Details of the particular studies undertaken may be found in the following list of references.

Gush, H. P. and Jones, A. V.: 1955. J. Atmosph. Terr. Phys. 7:285.
Harrison, A. W. and Jones, A. V.: 1956. The Airglow and the Aurora. Pergamon Press, London (p. 95).
Hunten, D. M.: 1953. Can. J. Phys. 31:681.
— 1954. J. Atmosph. Terr. Phys. 5:44.
— 1955. J. Atmosph. Terr. Phys. 7:141.
— 1956. The Airglow and the Aurora. Pergamon Press, London (p. 114).
— 1956. The Airglow and the Aurora. Pergamon Press, London (p. 183).
— and Shepherd, G. G.: 1954. J. Atmosph. Terr. Phys. 5:57.
— — 1955. J. Atmosph. Terr. Phys. 6:64.
Jones, A. V.: 1955. Report AR-20, Geophys. Res. Dir. Air Force Cambridge Research Center.
— 1955. Nature. 175:950.
— 1956. Nature. 178:276.
— and Gush, H. P.: 1954. Rev. Sci. Inst. 25:928.
— and Harrison, A. W.: 1955. J. Atmosph. Terr. Phys. 6:336.
Montalbetti, R. and Jones, A. V.: 1957. Can. J. Phys. (In Press).
Petrie, W. and Small, R.: 1952. J. Geophys. Res. 57:51.
— — 1952. Astrophys. J. 116:433.
Scrimger, J. A. and Hunten, D. M.: 1955. Can. J. Phys. 33:780.
— — 1956. Nature. 178:753.
Shepherd, G. G. and Hunten, D. M.: 1955. J. Atmosph. Terr. Phys. 6:328.

Auroral Phenomena and Magnetic and Ionospheric Disturbances.

The equipment consists primarily of all-sky cameras which take a picture of the sky every minute on 16 mm film; three-component electronic fluxgate type magnetometers which are usually operated to give one inch (25.4 mm) of record per hour; an auroral intensity recorder which scans a meridional strip of the sky from the northern to southern horizons at Saskatoon; and a standard automatic ionosonde unit which has been operating on selected occasions at Saskatoon. Visual auroral data (hourly) have been available from Resolute and Baker Lake, Northwest Territories, and Churchill, Manitoba. Recently, all-sky camera records of aurora and one-component magnetometer results have been available from Churchill. Many of these data are now being placed on IBM punch-cards to facilitate analysis.

Some of the magnetic disturbances with aurora can be divided roughly into two types. One type suggests the presence of line currents in or close to the aurora and paralleling the lateral extent of the display in an east-west direction. Another type suggests the presence of a dipole field, the dipole either vertical or parallel to the lines of the earth's magnetic field and within the auroral display. Many of the magnetic disturbances with aurora

are too complex to be explained by any simple mechanism. This is not surprising, since a geomagnetic storm is sometimes characterized by simultaneous auroral displays along the same geomagnetic meridian at different latitudes.

Variations of the earth's magnetic field were examined using data of the Polar Year 1932—33. It was concluded that the auroral zone takes the form of two opposing Störmer-like spirals, one due to positive-particle precipitation and the other to negative-particle precipitation. These intersect at a high latitude at about 10 h. local geomagnetic time and at a lower latitude at about 22 h. and move around the earth with the sun.

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Ionospheric Inhomogeneities.

The equipment consists of two radar units operating on 106 and 56 Mc/s respectively, and with their antennas mounted on a rotatable tower so that both beams scan simultaneously the same part of the sky; an interference type of radio telescope for detecting the 50 Mc/s radio waves from the strong source in Cassiopeia; and receiving equipment to record the scatter from inhomogeneities in the ionosphere of radio waves transmitted between selected points in Western Canada.

An attempt is being made to correlate the occurrence and characteristics of echoes with data on auroral and magnetic disturbances obtained from all-sky cameras and magnetometers operating at Saskatoon, Flin Flon, and Churchill, and from patrol spectrographs operating at Saskatoon and Churchill. The majority of the auroral echoes occur from the region in the direction of Flin Flon and Churchill which are northeasterly from Saskatoon. Typical auroral echoes are occasionally observed from regions where the angle between the incident radio waves and the auroral structures (assumed parallel to the lines of the earth's magnetic field) departs notably from 90°.

Notable variations in the polarization of radio echoes from aurora have been observed using frequencies of 56 and 106 Mc/s. Radio echoes from aurora have not been observed on a frequency of 200 Mc/s. No significant relationship has been discovered between the amplitudes of the scintillations of the radio star in Cassiopeia and the occurrence and position of the aurora.

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Morphology of Auroral Displays.

Occurrences and position of aurora at Saskatoon have been recorded by various types of auroral intensity recorders during the past six years. These have scanned a meridional strip of the sky from the northern to southern horizons in sweeps of 10 minutes each. During the past two years they have been supplemented by all-sky camera records taken at one-minute intervals. Additional cameras have been operating for more than a year at Uranium City, Meanook, Flin Flon and Churchill. Hourly observations for aurora, in some cases going back for more than ten years, have been available from the ionosonde stations at Resolute, Baker Lake and Churchill.

While the coverage has never been sufficient to construct a series of maps for West-Central Canada showing the development and progress of an auroral display, it has demonstrated that occasions occur when displays are visible simultaneously all the way from the Canadian Arctic Archipelago to the United States border. There are also occasions when the displays appear to have spread out simultaneously northward and southward from the auroral zone.

During the past sunspot cycle, auroral frequency and intensity at Saskatoon rose to their maximum values soon after the solar maximum, and these decreased only slowly until near the solar minimum. Although solar activity is rapidly approaching another maximum, auroral frequencies and intensities at Saskatoon are still low. This suggests that there is a significant phase difference between the periodicities of auroral and solar activities.

Horizontal movements of aurora are being investigated by projecting series of all-sky camera photographs on a suitable grid and measuring displacements parallel and normal to the geomagnetic meridians. Preliminary observations on the east-west motion at Saskatoon showed no characteristic variation of direction and speed with time of night. Cases of arcs or bands moving in one direction with apparently constant speeds for periods exceeding 20 minutes are very frequent.

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CZECHOSLOVAKIA

Rapport sur les travaux dans les domaines du magnétisme et de l'électricité terrestres pour la période de 1954 à 1957

Par Jan Bouska

1) *Les cartes magnétiques fondamentales.*

La section géomagnétique de l'Institut Géophysique de l'Académie Tchécoslovaque des Sciences a complété les mesurages des éléments géomagnétiques, exécutés pendant les années précédantes aux 161 stations du premier ordre dans les régions de Bohême, par des mesurages ultérieurs exécutés à 149 stations du deuxième ordre. En Slovaquie le Laboratorie Géophysique de l'Académie Slovaque des Sciences — Observatoire à Hurbanovo — a effectué des mesurages magnétiques fondamentaux à 100 stations du premier ordre.

En collaboration avec les géomagnéticiens allemands on a effectué en 1955 des mesurages géomagnétiques de liaison sur les frontières entre la Tchécoslovaquie et la République Démocratique Allemande, et en 1957 on a réalisé des travaux analogues sur les frontières de la Tchécoslovaquie et de la Pologne en collaboration intime avec les savants polonais.

2) *Les cartes magnétiques.*

Les cartes magnétiques représentent pour les régions de Bohême et pour l'époque 1950,0 les isogones, les isoclines, les lignes isodynames des composantes H, X, Y, Z et de l'intensité totale T et les isopores de déclinaison ; on a publié ces cartes en 1956.

Par une méthode statistique nouvelle on a déterminé le champ géomagnétique normal dans les régions de Bohême pour la même époque 1950,0 ; les résultats obtenus ont été publiés provisoirement et seulement pour la composante Z.

On a élaboré les cartes magnétiques de la Slovaquie et le manuscrit est à l'impression. Une publication contenant des cartes magnétiques de la Tchécoslovaquie tout entiére est en train de préparation.

3) *Les observatoires magnétiques.*

En Tchécoslovaquie il y a en fonction permanente deux observatoires magnétiques : Pruhonice près de Prague, avec les succursales à Budkov, et Hurbanovo en Slovaquie. Les enregistrements sont traités d'une manière normale, et les résultats obtenus sont publiés régulièrement ; on fait parvenir les bulletins à tous les institutions intéressées en Tchécoslovaquie et à l'étranger. Les indices caractérisant l'activité géomagnétique sont envoyés régulièrement à De Bilt. On fait parvenir une documentation sur l'Année Géophysique Internationale au centre régional AGI à Moscou. L'équipement scientifique de la station à Budkov a été

complété par un appareillage à enregistrement rapide, fabriqué en Tchécoslovaquie, et par un appareillage danois, type la Cour, qui est destiné à l'enregistrement des pulsations géomagnétiques.

4) *Les travaux de laboratoire.*

Le personnel scientifique de l'Institut Géophysique, en collaboration étroite avec le personnel de l'Institut pour les Recherches et Essais Aéronautiques à Prague, a construit un magnétomètre portatif avec une sonde électromagnétique. En collaboration avec le personnel de l'entreprise industrielle Hradistan on a fabriqué sur le même principe un appareillage à enregistrement rapide destiné à la station de Budkov, où il fonctionne actuellement dans une installation d'essai.

5) *Les mesurages aéromagnétiques.*

En Tchécoslovaquie les mesurages aéromagnétiques sont effectués par la section géophysique de l'Institut Central de Géologie qui a fait des mesures sur tout le territoire du pays à l'aide d'un magnétomètre aérien d'origine soviétique ASGM 38. Il est envisagé de poursuivre ces travaux en 1958. Une partie des travaux sera liée aux mesurages radiométriques aériens, qui poursuivront l'enregistrement de la radiation gamma.

6) *Le champ magnétique extérieur.*

Sur la base du matériel mondial d'observation et du propre matériel géomagnétique et solaire on a étudié les problèmes suivants :

Identification des régions M de Bartels;
Influence des régions actives du soleil sur l'activité géomagnétique;
Rapport entre l'effet géomagnétique des éruptions chromosphériques et les éclats radioélectriques.

Pendant l'étude de la relation des protubérances du soleil avec les perturbations géomagnétiques on a effectué une répartition des protubérances en 3 types, conformément à leur forme, dont chacun a ses conséquences géomagnétiques particulières.

Il a été constaté, que les régions M de Bartels sont caractérisées par l'existence d'un certain type de protubérances, dont la forme porte témoignage, qu'aucun champ bipolaire ou multipolaire important n'existe dans leurs environs.

Il a été constaté pendant l'étude de l'influence des régions actives du soleil sur l'activité géomagnétique, qu'il a lieu un abaissement remarquable de l'activité géomagnétique pendant le passage de certaines régions actives à travers le méridien central. Ce sont avant tout les régions dans lesquelles on n'a observé aucune activité éruptive pendant leur passage à travers le méridien central.

Nous avons constaté, sur la base du matériel d'observation limité qui était à notre disposition, que tous les orages géo-

magnétiques demi-forts et forts, observés pendant la période étudiée, ont eu lieu aprés les éruptions accompagnées par des éclats radioélectriques.

Pour l'observatoire géomagnétique à Pruhonice on a determiné les courbes et les diagrammes vectoriels de la variation Sq et les courbes de la marche journalière de l'activité géomagnétique.

Pour la solution satisfaisante des problèmes concernant l'influence de l'activité du soleil sur l'activité géomagnétique on a commencé la construction d'un observatoire spécial.

7) *Les courants telluriques.*

L'Institut Géophysique de l'Académie Tchécoslovaque des Sciences a établi un nouvel observatoire tellurique à Budkov. Il est équipé d'un appareillage pour enregistrement ralenti des variations journalières des courants telluriques à une vitesse d'enregistrement de 90 mm/h sur des lignes NS et EW, longues de 1000 m. Pour l'enregistrement des variations à courte période des courants telluriques l'observatoire est équipé d'un appareillage à vitesse d'enregistrement de 30 mm/min. (avec un déroulement en spirale des enregistrements) sur des lignes NS et EW, longues de 100 m.

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DENMARK

Report on activities in geomagnetism and aeronomy during 1954—1956

By V. Laursen and J. Olsen

The magnetic observatory at *Rude Skov* has functioned without interruption during the three years. Normal speed records from sensitive and insensitive variometers as well as records from a la Cour quick-run magnetograph have been obtained. The orientation of the magnetic axes of the variometer-magnets has been controlled, and the absolute measurements of the magnetic

elements have been carried out as in former years. A great number of measurements have been made in order to determine the constants of magnetic instruments delivered by the Danish Meteorological Institute to foreign institutions and IGY-stations, and also the constants of QHM's belonging to the Association and used for international comparisons.

In 1955 measurements have been made at all of the eleven Danish secular variation stations.

Field observations have been made in 1954, 1955 and 1956 in order to make the magnetic survey more complete. The distance between the stations for horizontal and for vertical force was about 4 km and between stations for declination about 8 km. Using older determinations, corrected by means of the secular variation found from the measurements in 1955, a declination chart for the epoch 1960.0 has been worked out.

The magnetic observations from the observatory at Rude Skov and from the secular variation stations have been published in the Annuaire Magnétique, 1ère Partie, Le Danemark. The Annuaire Magnétique has been issued regularly, the observations from one year being published in the following year.

Greenland.

The magnetic observatory, the cosmic-ray observatory and the ionospheric station at *Godhavn* form parts of the Geophysical Observatory, Godhavn, operated by the Danish Meteorological Institute.

The magnetic observatory has been functioning without interruption during the period under review. Mr. K. Lassen, who for several years has been in charge of the station, returned to Denmark in the summer of 1956 and was replaced by Mr. Eric Wolff.

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, 2ème Partie, Le Groenland: A. Godhavn, of which the volume 1949 has been completed and published during the period while 1950 is in the press.

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

The ionospheric station at Godhavn has functioned throughout the period except during the intervals 12th August-11th December 1954, when the electricity supply failed, and 15th September-2nd

November 1956, when the equipment was transferred to a new building (see below). During the eclipse of the sun (81 % coverage), 30th June 1954, observations were made every five minutes from 10^h30^m to 13^h30^m GMT. The material was placed at the disposal of the Mixed Commission on the Ionosphere. From 29th January 1956 the number of hourly measurements was increased by one, the measurements being made at the following minutes: 14, 29, 44, 57, 58 and 59. During the summer of 1956 a new station was built 3,5 km ENE of the town with the following geographical and geomagnetic coordinates: $\varphi = 69°,26$ N; $\lambda = 306°,09$ E; $\Phi = 79°,88$ N; $\Lambda = 327°,43$ E. This station started working 2nd November 1956. The observer in charge, engineer J. K. Olesen, was replaced by engineer F. Iversen in October 1956.

During the IGY an extended program will be carried out. The attenuation of cosmic noise on the 10 meter band will be measured and at the same time observations of the dawn-chorus will be made. For that purpose two extra collaborators, engineer Eigil E. Ungstrup and undergraduate A. R. Petersen, have joined the station staff for the period of the IGY.

The magnetic observatory at *Thule,* which was closed down in the summer of 1952, was reestablished during August 1955 at the new settlement of Thule at 77° 29′ N, 290° 50′ E; $\Phi = 89°,0$ N, $\Lambda = 358°,0$ E.

The observatory has functioned without interruption since 1st September 1955. Records of normal speed from sensitive and insensitive variometers, as well as records from a la Cour quick-run have been obtained. Absolute values of D, H and Z are obtained by means of three QHM's and two BMZ's respectively, all of them adjusted at Rude Skov and controlled every year by a QHM and a BMZ sent from that observatory.

The magnetic observations for the years 1947, 1948 and 1949 from the Thule observatory at 76° 32′ N, 290° 56′ E have been made ready for publication.

During a visit to Greenland for inspection of the observatories at Godhavn and Thule Mr. Johannes Olsen made determinations of the diurnal variation of Z at Frederikshåb, Egedesminde, Umanak, Upernavik and Cape York.

A comparison between the variation of Z at Godhavn and Egedesminde — only 60 km apart — showed that the difference between the diurnal variations was considerable even on moderately disturbed days. An earlier comparison between the diurnal variations of D and H at the same two places showed no such difference.

Two new Danish magnetic stations with la Cour recorders will be in operation in Greenland during the IGY. A temporary observatory at Julianehåb will have a sensitive magnetograph and a storm magnetograph, both of them with normal speed recording,

and a 360 mm/h quick-run magnetograph. A variation station at Scoresbysund will have a normal speed storm magnetograph.

All-sky auroral cameras will be installed at Julianehåb, at Godhavn, at Scoresbysund and at Nord.

EGYPT

Report on geomagnetic work carried out from 1954 to 1957

By A. H. Samaha, Director, Helwan Observatory,

K. Wienert and M. Fahim

The new magnetic station.

During the period under review geomagnetic work was carried on at the Helwan Magnetic Observatory without any serious interruption or disturbance until the beginning of 1956, when the electrification of the suburban railway Cairo-Helwan was completed. During the test period of the railway, in the first half of 1956, the electric railway used to run for a few hours every day. On 1st July 1956 full electric traffic commenced so that only two hours of the day remained undisturbed. Absolute observations had to be shifted to this quiet interval.

Although the disturbance of the present observatory site by the electric railway had been anticipated and the plans for a new magnetic observatory were ready in 1955, adverse circumstances delayed the construction of a substitute for the Helwan Observatory.

It is intended to construct the new magnetic observatory at Missallat, a village on the northern rim of the Fayoum province about 75 kilometers south-west of Cairo. This site was chosen after several other sites had been investigated. The place is magnetically undisturbed and has good communication facilities.

It is hoped that the new observatory can be occupied by the end of 1957, with a normal running magnetograph for three elements and a quick running magnetograph for D and H. The old observatory will continue to function for another three years.

Observatory work.

1. *Normal run registration:*

From 1954 to 1955 magnetic work is based on the records of the Watson magnetograph which is operated at a speed of 15 mm/h and with scale values of 1 ′/mm for D and of approximately 6 γ/mm for H and Z.

In June 1955 a la Cour magnetograph was installed with a recording speed of 15 mm/h. This magnetograph works at scale values of 0.417 ′/mm, 2.60 γ/mm, and 3.00 γ/mm for D, H and Z, respectively. From 1st January 1956, onwards, hourly means were

derived from this magnetograph, while the records of the Watson magnetograph were used only for filling gaps in the records of the la Cour magnetograph.

The la Cour magnetograph was installed in an unconventional manner. The declination variometer is placed at a distance of approximately 400 centimeters from the recorder drum so as to arrive at a higher sensitivity and thus to match the sensitivity of the intensity variometers. In the Helwan installation the three variometers are far apart so that there is no interaction possible. The declination variometer is not influenced by the magnetism of the other two variometers. The three long focus cylindrical lenses were replaced by a single cylindrical lens of short focus in order to arrive at sharper traces. All three variometer traces are free to move over the full width of the recorder drum, as in the conventional types of magnetographs (Ruska, Askania, etc.).

The recording capacities are as follows:

declination:	$+60'$	to	$-60'$	without reserve spots
horizontal intensity:	$+700\gamma$	to	-1400γ	with two reserve spots
vertical intensity:	$+700\gamma$	to	-200γ	without reserve spots

These recording capacities are adequate to cope even with the severest magnetic storms encountered in the past 50 years.

The la Cour variometers worked for two years without erratic trace shifts except for one of the horizontal intensity variometer which was caused by an earthquake.

2. *Quick run registration:*

In 1950 a quick running la Cour recorder (180 mm/h) was purchased without its variometers. Therefore a D-variometer and an H-variometer were constructed in the observatory workshop. Both variometers meet the specifications for the International Geophysical Year.

The variometers were fitted with concave mirrors which were surface silvered. The use of concave mirrors results in extremely sharp photographic traces.

This equipment will be set up at the new magnetic observatory by the end of 1957.

3. *Absolute measurements:*

The base values were controlled by absolute measurements on an average once a week. The following instruments were in use:

Declination: Kew magnetometer No 87 has been the observatory standard since the opening of this observatory in 1906. Observations with this instrument were discontinued in February 1957. The standard deviation was $\pm 0.6'$.

Kew magnetometer No 88 was installed in July 1955 in order to investigate the unduly large errors of the Kew magnetometers.

Two years of experimental work revealed that the errors might be caused by electrostatic attraction. It is conceivable that in the extraordinary dry climate of Helwan electric charges are accumulated on the wooden box and the glass windows of the magnetometer by cleaning with at cloth. These charges are dissipating very slowly. Further experimental work with radioactive material in the magnet box is in progress.

An Askania magnetic theodolite with pivot declination attachment was used since November 1956. The standard deviation is $\pm 0.3'$. In future, base line values will be derived from this instrument. It was found necessary to observe both mirrors since there exists a marked difference between the two mirrors which is slightly variable. The mean of the two mirrors, however, is constant.

Horizontal Intensity: The Schuster-Smith magnetometer has been the standard instrument of this observatory since 1931. Observations were continued throughout the three years. In December 1955 a new standard cell was introduced, for it was suspected that the old standard cell was no more reliable. The difference (new cell minus old cell) amounted to $+13\gamma$. Henceforth, the old cell was used only for rough balancing of the potentiometer circuit in order to prevent overloading of the new cell. The standard deviation of the Schuster-Smith magnetometer is less than $\pm 2\gamma$.

The Schuster-Smith magnetometer has not been compared with any other observatory standard since its purchase. Therefore, there exists some uncertainty as to the validity of its constants. A comparison with Rude Škov by means of Association QHM's is planned.

Since July 1955 the QHM's Nos 157, 158 and 159, which were purchased in 1950, were regularly used for additional control of the H base-line values.

Vertical Intensity: Until the end of 1955 base line values of Z were derived from observations of the inclination by means of a Dover dip circle. The standard deviation in Z resulting from errors in inclination is $\pm 15\gamma$. Dip circle observations were discontinued at the end of 1956.

The Dye magnetometer which had served as the observatory standard for Z since 1935 was shelved in 1943 due to difficulties with the rotary converter. Experiments were made to replace the rotary converter by a blocking oscillator and later on by a vibrator. The vibrator proved to be of an excellent frequency stability.

The Dye magnetometer serves as observatory standard in Z since April 1956; the results obtained with this instrument are satisfactory, the standard deviation being less than $\pm 2\gamma$.

In addition and since July 1955, Z-observations were regularly taken by means of BMZ No 50, the standard deviation being less than $\pm 2\gamma$.

4. *Annual reports:*

Since 1954 the following annual reports were completed: 1946, 1947, 1948, 1949 and 1950. The reports for 1945 and 1946 were printed and dispatched, the remainder being in press. The reports for 1951 and 1956 are in hand and will go to press very soon.

Up to 1946 only monthly means were published, from 1947 onwards the reports contain hourly values. The report for 1956 will satisfy the recommendations of the International Association of Geomagnetism and Aeronomy.

5. *K-indices:*

Before 1956 the magnetic character numbers on scale 0, 1, 2 were regularly dispatched to De Bilt every month.

From 1956 onwards, the 3-hour-range K-indices have been introduced and after consultation with De Bilt the lower limit for the range R = 9 was taken as 300γ.

The K-indices as well as the character numbers are sent to De Bilt at the beginning of every month.

The magnetic survey of Egypt.

The last magnetic survey of Egypt was carried out in the years 1908-10 (H. E. Hurst, The Magnetic Survey of Egypt and the Sudan, Surv. Dept., Paper No 33). This publication also contains observations by Roessler, made in 1895 in the Red Sea area, and by Captain Lyons, made in 1893-94 in the Western Desert. All observations were reduced to the Epoch 1910. The 70 stations cover the Nile Valley, the Nile Delta, the Red Sea coast and a small portion of the Western Desert.

A few stations were reoccupied by observers of the Carnegie Institution of Washington between 1914 and 1918, and some declination observations were made by the Helwan observatory round Mersa Matruh and Solloum.

Although it has been felt long ago that a resurvey is necessary the task could not be tackled due to the lack of staff.

In 1955 plans for a complete magnetic survey of Egypt were made and field work was started in 1957, after some instruments had arrived from abroad.

While in the old survey the spacing of the absolute stations is approximately 40 kilometers, the spacing in the new survey has been reduced to 25 to 30 kilometers. The vertical intensity is observed every 5 kilometers while travelling from one station to another, and more vertical force stations are added on return journeys. The vertical intensity stations in between the network of absolute stations do not only help in selecting undisturbed places for the absolute stations but will later on also assist in drawing isomagnetic lines.

The magnetic homogeneity of the site of every absolute station is tested by three measurements of the vertical intensity by means

of an Askania field balance, the three balance stations being 25 meters apart.

At the absolute stations the declination is observed by means of an Askania magnetic theodolite with pivot declination attachment. The standard deviation of a full set is $\pm 0.3'$. The azimuth is derived from sun observations (time azimuth) with an Askania Midget theodolite, the standard deviation being $\pm 0.2'$. The chronometer correction is determined by means of BBC time signals.

The horizontal intensity is measured by means of QHM's Nos 157-159 mounted on the Askania theodolite base.

The vertical intensity is derived from observations with BMZ No 50. The instruments are compared every week with the observatory standards at Helwan. So far, no serious changes of instrument constants have occurred.

From January to May 1957 observations were made at 51 absolute stations and 350 vertical intensity stations, covering a large part of the Delta, the Suez Canal Area, and the Fayoum District.

Finally, Egypt will be covered by approximately 1000 absolute stations from which 20 to 25 will be selected for repeat stations. It is estimated that the magnetic survey of Egypt can be completed in about 5 years.

FINLAND

Report on Geomagnetism and Aeronomy 1955-57

By J. Keränen

The secretary of the National Committee, Dr. Eyvind Sucksdorff died on October 19, 1955. He has rendered for the Geophysics in Finland most valuable services, first as observer-in-charge at the Geophysical Observatory in Sodankylä 1927-1944, later as geophysicist at the Meteorological Central Office since 1945 and as secretary of the Observatory Committee of Sodankylä since 1946. His main scientific studies dealt with geomagnetic activity, pulsations and oscillations.

The Work of the Meteorological Central Office.

As geophysicist was appointed in June 1956 Mr. Christian Sucksdorff M.A.

Nurmijärvi Geophysical Observatory.

The geomagnetic registration has continued regularly by means of three La Cour variometer sets, for normal, quick-run and storm registration respectively. The measuring instruments have been compared once a year at the Rude Skov Observatory in Denmark. The registrations of the years 1953-1955 have been made ready for the printer.

The dwelling of the Observatory was built in 1956. From the beginning of 1957 Mr. Matti Kivinen M.A. has served as observer-in-charge at the Observatory.

A new ionospheric station has made soundings since January 1, 1957 with an apparatus made available by the Central Board of Post and Telegraphy.

Magnetic surveys.

Magnetic measurements have been made 1955-1956 in 15 secular points. On the base of these and earlier surveys Dr. J. Keränen has prepared geomagnetic maps of D, H and Z for the epoch 1955.0.

Sodankylä Geophysical Observatory.

Three sets of magnetic variometers have been regularly running. The measuring instruments have been compared in Nurmijärvi Observatory. The observational material from the years 1946-47 has been prepared and is ready for the printer.

The recording of earth currents has been reestablished and is running since January 1, 1957.

A seismograph station has been founded in 1956 with a Benioff vertical and a Sprengnether horizontal seismometer.

The Swedish all-sky auroral camera has been set up in February 1957.

During the International Geophysical Year the Observatory will operate an ionospheric station with instrumental equipment on loan from the "Institut für Ionosphärenforschung" at Lindau in Germany, and a radioastronomic station belonging to the University of Helsinki.

Mr. E. Kataja has served as observer-in-charge.

Publications.

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FRANCE

Rapport de la Section de Géomagnétisme et Aéronomie sur les travaux de 1954 à 1957

1ère PARTIE : GEOMAGNETISME

I. — *Magnétisme terrestre*

Observations et campagnes magnétiques — Prospection.

Le 1er Juillet 1957 des observations magnétiques régulières ont commencé au Centre d'Etudes Géophysiques de Garchy (Champfleury), nouvellement créé, dans le département de la Nièvre. Elles comportent des enregistrements des 3 composantes du champ, du type « La Cour » normal et des enregistrements des pulsations sur les 3 composantes par la méthode « barre-fluxmètre » de E. Selzer. Malheureusement les travaux de construction en cours gênent beaucoup ces mesures.

En Terre Adélie deux stations magnétiques fonctionnent depuis Mai 1957 : la station côtière « Dumont d'Urville » et la station-plateau « Charcot ». Des enregistrements normaux du champ (type « La Cour » ou balance Askania) et des enregistrements des pulsations par la méthode « barre-fluxmètre » y sont effectués respectivement par A. Lebeau et R. Schlich.

Des enregistrements analogues du champ et des pulsations ont été également commencés en 1957, aux Iles Kerguélen, par M. Bockel, S. Eschenbrenner et J. Panaro.

Dans les tomes 26, 27 et 28 des Annales de l'Institut de Physique du Globe de Paris ont été publiés :

1) les résultats des observations magnétiques régulières, effectuées ces dernières années, dans les Observatoires de Chambon-la-Forêt, Nantes, Tamanrasset, M'Bour, Bangui, Tananarive et Ksara.

2) les résultats de la 2ème série de mesures faites en 1952 aux stations de répétition du réseau français, E. Selzer (111), ainsi que les valeurs de Z, rapportées à 1954,0, déterminées par L. Godard (62) en quelques stations des Ardennes.

Dans d'autres publications ont été donnés les résultats de campagnes magnétiques faites dans les Ardennes par L. Godard (60, 61, 137), à Madagascar par le Père Cattala (23), en A.O.F. par R. Doniol (42), en diverses régions d'Afrique par J. Dubief (43, 44, 45) et A. Fourey (58), au Sahara et au nord du Tanezrouft par J. Castet, J. Dubief et J. Lagrula (21, 22).

Les chercheurs de l'O.R.S.T.O.M. ont poursuivi l'établissement, en Afrique, d'un réseau de bases magnétiques à intervalle moyen de 100 Km. En A.O.F. des mesures ont eu lieu aux stations Carnegie qui avaient été occupées en 1913 et 1926. Des centaines de nouvelles stations ont été occupées dans les régions suivantes :

Aféma, Moyen Congo, Togo, Dahomey, Haute-Volta, Côte d'Ivoire, Oubangui-Chari, Soudan, boucles du Niger, Tchad.

Melle Y. Crenn (35) a groupé dans une même publication, et interprété, les résultats des mesures magnétiques faites de 1953 à 1955, par les géophysiciens de l'O.R.S.T.O.M., dans la partie centrale de l'A.O.F.

Une nouvelle réoccupation des stations de répétition du réseau magnétique de la France métropolitaine a été assurée par E. Le Borgne, pendant l'été 1957. En 1957 également J. Dubief a effectué des mesures magnétiques de répétition à Tamanrasset et Idelès (Sahara) et le Père Cattala a réoccupé les stations du réseau Besairie dans le nord de Madagascar.

Les Missions hydrographiques de la Marine ont fait des mesures magnétiques en Afrique, à Madagascar et au Viet-Nam.

E. Le Borgne (75, 76, 77) a exposé dans un mémoire de thèse l'ensemble de ses travaux sur la susceptibilité magnétique du sol dont il a été rendu compte à l'Assemblée de Rome (1954).

Les Missions de la Compagnie générale de Géophysique ont effectué des campagnes de prospection magnétique en France, en Sicile et en Afrique.

Des abaques pour le calcul et l'interprétation des anomalies magnétiques ont été construits par V. Baranov (1) qui en a montré l'application pratique à partir de mesures faites dans les Pyrénées.

J. Chastenet de Géry et H. Naudy (25) ont proposé deux catégories d'abaques pour l'interprétation des anomalies. La première catégorie peut s'appliquer à la fois aux anomalies gravimétriques et aux anomalies magnétiques dites « pseudo-gravimétriques » obtenues par réduction au pôle des cartes aéromagnétiques, selon la méthode de V. Baranov (3). La deuxième catégorie est utilisable pour l'interprétation directe des cartes magnétiques.

Appareils de mesures.

E. Selzer (113, 115, 116) a mis au point une méthode d'enregistrement des variations rapides du champ magnétique terrestre, utilisant une bobine à noyau de mumétal-molybdène reliée à un fluxmètre. Le dispositif peut donner les variations des éléments H, Z ou D avec une sensibilité constante (à mieux de 10 % près) d'environ 0,06 γ/mm et cela pour des périodes comprises entre 2 s et 2 min. De tels dispositifs fonctionneront, pendant toute l'Année Géophysique, dans plusieurs stations françaises et étrangères.

G. Grenet (65) a repris, sous une autre forme, le problème, déjà traité par E. Selzer, de l'influence de la self-induction dans les bobinages à noyaux magnétiques utilisés pour l'enregistrement des variations rapides du champ magnétique terrestre.

A. Lebeau (74) a construit un variomètre, à aimant de dimensions très réduites, pour l'enregistrement des variations rapides de H et D (périodes : 1 seconde à quelques minutes). Un système

de 2 bobines d'Helmholtz, parcourues par le courant de compensation d'un variomètre électromagnétique du type Dürschner, permet de compenser les variations lentes du champ et par suite d'utiliser un enregistreur hélicoïdal.

A. Lebeau a étudié avec P. A. Blum (8) une autre méthode de compensation de la variation lente d'une composante du champ magnétique terrestre par utilisation d'un variomètre magnétique à longue période dont l'aimant crée, par sa rotation, le champ nécessaire.

Un nouveau variomètre électromagnétique, type B, pratiquement insensible à l'agitation microséismique, a été mis au point par G. Grenet et J. Castet (20).

P. A. Blum a transformé un Q.H.M. en appareil polaire, en utilisant un très petit aimant-miroir de façon à atteindre des valeurs de H très faibles, jusque vers 200 γ. L'appareil fonctionne actuellement en Terre Adélie.

R. Birebent (6) a appliqué à la mesure du champ magnétique terrestre un dispositif rappelant le galvanomètre à vibrations, avec mesure par quartz piézoélectrique.

Une étude a été faite par Mme F. Duclaux et B. Leprêtre (52) sur l'écart observé entre les valeurs de H déterminées à l'aide d'un théodolite Chasselon et d'un Q.H.M. en plusieurs stations, de Chambon-la-Forêt (France) vers le sud jusqu'à Tamanrasset (Sahara).

Variations du champ magnétique terrestre.

— *Variations lentes.*

Une étude de P. Bernard (5) traite de la variation undécennale de H, calculée d'après les moyennes mensuelles (1902—1939) de Paris, Bombay, Honolulu et Watheroo.

P. Herrinck (67) a consacré un mémoire de thèse à l'étude de diverses variations du champ magnétique terrestre. L'observation la plus originale est relative à la variation de jour en jour de H à minuit local. Traçant les courbes correspondantes pour plusieurs observatoires, P. Herrinck a montré qu'il apparaît des sortes d'oscillations de relaxation, de caractère mondial, dont le début correspond aux jours troublés et la fin aux jours calmes internationaux. Les orages magnétiques ne seraient que des cas particuliers intenses de ces oscillations. P. Herrinck a essayé d'expliquer ce phénomène à partir de la théorie de Chapman et Ferraro.

Des ionogrammes enregistrés en 1953—1954, à Dakar, K. Suchy et P. Vila (124) ont déduit l'intensité du champ magnétique terrestre dans la couche F_2 et les variations diurne et annuelle du champ à l'altitude de 300 Km.

J. Coulomb (29, 31) a calculé, sur un cas schématique, la variation magnétique séculaire que produirait un flux convergent ou

divergent de matière liquide et conductrice à la surface du noyau terrestre.

L. Cagniard (14) a discuté l'opinion de N. Stoyko (123) suivant laquelle les variations séculaire et annuelle du champ magnétique terrestre seraient étroitement liées aux fluctuations de la vitesse de rotation du Globe. Il n'exclut quand même pas absolument l'idée qu'il puisse exister une corrélation de ce genre et il suggère qu'elle pourrait être la conséquence d'un effet Rowland, la séparation des charges électriques dans l'intérieur du Globe pouvant être provoquée, selon lui, par le gradient de pression.

— *Agitation magnétique.*

P. Rougerie (105) a fait l'étude des baies relevées sur les enregistrements du Val-Joyeux, de 1901 à 1936. Il les a comparées aux baies enregistrées à Tortosa.

L'étude de l'évolution moyenne D_{st} des orages magnétiques a été reprise, par E. Thellier et Mme O. Thellier (128), pour la France, pour H seulement mais pour un grand nombre d'orages, en séparant les orages à début brusque et les orages à début progressif. Pour chaque type d'orages, les orages ont été classés suivant l'heure locale de leur début afin d'établir l'effet de l'heure locale sur le déroulement de la perturbation.

Le Père Mayaud a publié (84, 85, 87) le résultat de l'étude des enregistrements et des observations du champ magnétique qu'il fit en Terre Adélie en 1951—1952. Sur ces enregistrements et sur les enregistrements polaires antérieurs, le Père Mayaud a observé deux types d'agitation magnétique : N, à maximum diurne la nuit et J, à maximum diurne le jour, dont il a étudié les propriétés. Les propriétés de l'activité J, à l'intérieur de la zone aurorale, s'expliqueraient par les « horns » se formant dans le front corpusculaire neutre (théorie de Chapman et Ferraro) au moment de son approche de la Terre. A l'extérieur de la zone aurorale l'activité J serait due à un transport, vers les latitudes moyennes, de la perturbation créée à l'intérieur de la zone. On pourrait expliquer l'activité N par un schéma du type « anneau-équatorial ». L'ensemble de ce travail a fait l'objet d'un mémoire de thèse (86).

J. F. Denisse et l'Abbé Simon (40) ont montré que les observations de la raie jaune coronale ont permis d'identifier des centres Y d'activité solaire dont le passage au méridien central du soleil s'accompagnait d'une recrudescence de l'activité géomagnétique.

L'étude des relations entre l'activité solaire et l'activité géomagnétique a été poursuivie par les mêmes auteurs (39, 117, 118, 120, 121). Dans un mémoire de thèse (119) l'Abbé Simon a exposé, successivement, les relations entre les propriétés radioélectriques, optiques et géomagnétiques des taches, les relations entre les éruptions les plus intenses sur ces taches et l'activité géomagnétique, les relations entre l'activité radioélectrique des taches et la couche F_2 de l'ionosphère. Depuis le milieu de l'année

1956 la position des centres d'activité radioélectrique sur le soleil est déterminée au moyen du grand interféromètre de Nançay.

B. Leprêtre (81) a relié aux mouvements de 2 taches solaires des perturbations géomagnétiques enregistrées en 1949 à Tamanrasset.

K. Burkhart et E. Selzer (13) ont analysé, sur les enregistrements de 14 observatoires européens, la variation de forme sinusoïdale apparue sur D le 11 avril 1954, mettant ainsi en évidence le développement d'une perturbation semi-locale, cyclonique, de l'ionosphère, dans les régions bordant les limites Sud de la zone aurorale.

Utilisant les enregistrements de 2 variomètres Grenet, Mme F. Duclaux, J. Lacaze et B. Leprêtre (47) ont étudié le champ magnétique d'un orage météorologique observé à Tamanrasset.

G. Dugast (53) a recherché les coïncidences entre les débuts brusque d'orages magnétiques, publiés en 1950 et 1951 dans les Bulletins de l'I.A.T.M.E., et les perturbations relevées sur les enregistrements d'un variomètre électromagnétique et d'un variomètre La Cour, à Tamanrasset.

O. Sipahioglu (122) a établi la répartition dans le temps des s.s.c. et s.i. apparaissant dans les 5 jours qui suivent le début d'un s.f.e.. La corrélation, dans le temps, entre le s.f.e. et l'orage est très floue, mais la durée de l'intervalle séparant un s.i. d'un s.f.e. est mieux définie et présente un maximum entre 25 et 30 heures.

J. L. Bureau (12) a interprété, par la théorie du nuage ionisé de Chapman et Ferraro, le début brusque d'un orage magnétique enregistré à Tamanrasset le 21 Octobre 1952. Il a ainsi calculé les valeurs numériques caractérisant, en fonction du temps, la position et la vitesse de la face avant du nuage.

Les enregistrements de H, effectués en 1954, à Port-aux-Français (Iles Kerguélen) par la Mission de l'Armée de l'Air ont été comparés par A. Luchet (82) à ceux obtenus à Heard Island par l'Australian National Antarctic Research Expedition.

— *Pulsations.*

J. Coulomb (27) a comparé les périodes et les amplitudes des pulsations enregistrées sur H, du 6 au 11 Décembre 1953, simultanément en 2 stations françaises distantes de 500 km : Chambon-la-Forêt et St-Michel-de-Provence. Il a montré, d'autre part (30), que les observations faites à Kartoum par Astbury et à Bangui par Mme F. Duclaux et L. Le Donche (46), au cours de l'éclipse totale de Soleil du 25 Février 1952, confirment l'hypothèse que les pulsations magnétiques seraient dues à des variations de courants dans l'ionosphère provoquées par des variations de conductibilité locale.

Partant de l'hypothèse que les « pulsations géantes » et les « trains de pulsations » (p.t.) pouvaient être engendrés au cours

des aurores, J. Coulomb (34) a établi une théorie de la propagation, des zones aurorales vers les règions de plus basses latitudes. La comparaison des amplitudes calculées et des amplitudes observées montre qu'il y a accord dans le cas des « pulsations géantes », désaccord dans celui des « p.t. ».

G. Gibault a signalé (59) le décalage observé, sur les enregistrements magnétiques de Chambon-la-Forêt, entre l'apparition de micropulsations, les éruptions chromosphériques des 14 et 15 Octobre 1953 et le début brusque de la tempête magnétique qui a suivi.

A l'Institut de Météorologie et de Physique du Globe de l'Algérie s'est poursuivie l'étude des pulsations enregistrées à Tamanrasset avec les variomètres électromagnétiques Grenet :

J. L. Bureau (9, 10, 11) s'est attaché au dépouillement et à l'étude détaillée des p.s.c. enregistrées de 1952 à 1954.

G. Grenet (63) a mis en évidence, en collaboration avec des chercheurs japonais, que des pulsations polaires liées aux baies, quand elles étaient enregistrées simultanément à Tamanrasset et à Onagawa, étaient en phase et commençaient également par un accroissement progressif de dH/dt. D'autre part, G. Grenet (64) a cherché à expliquer, par la théorie de Chapman et Ferraro, la partie initiale croissante de ces pulsations.

Aimantation des roches et des terres cuites. Paléomagnétisme.

E. Thellier et Mme O. Thellier (129) ont donné de noveaux résultats sur la direction du champ magnétique terrestre 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.

E. Thellier et Melle Rimbert (98, 99, 100, 130, 131) ont attiré l'attention sur l'aimantation rémanente anhystérétique que peuvent acquérir les roches et les terres cuites par action de champs magnétiques alternatifs en présence du champ magnétique terrestre. Ils ont examiné le problème de la séparation, par champs alternatifs, de divers types d'aimantations (rémanente isotherme, thermorémanente, anhystérétique, de viscosité) que peuvent porter les roches et les terres cuites. Les essais ont tout d'abord porté sur des corps mieux définis : magnétite et sesquioxyde de fer.

A. Roche a poursuivi ses recherches sur l'aimantation rémanente, normale ou inversée, des roches volcaniques. Il a étudié successivement (101, 102, 103, 104) des unités volcaniques d'Auvergne, du Velay, de l'Ahaggar et de l'Estérel. Les résultats concernant des observations sur 18 coulées basaltiques d'Auvergne l'ont, en particulier, conduit à conclure que, si l'aimantation inversée des roches est due à l'inversion du champ ayant agi au refroidissement, la dernière inversion du champ serait produite au milieu du Pléistocène inférieur.

Des essais ont été effectués par Melle J. Roquet (108) sur

certaines roches tertiaires, à aimantation rémanente inversée, récoltées dans l'Ahaggar et en Auvergne par A. Roche. Ces roches ont acquis, au laboratoire, des aimantations thermorémanentes de sens normal mais ont été plus ou moins profondément modifiées par les réchauffements. Melle J. Roquet s'est aussi intéressée (109) aux modifications, par réchauffements, des propriétés magnétiques de pyrite naturelle pulvérisée.

Plusieurs études théoriques ont été faites, par L. Néel (93, 94, 95), sur la structure cristalline et les propriétés magnétiques des ferro-, anti-ferro- et ferri-magnétiques, avec application à divers problèmes de paléomagnétisme dont ceux concernant les principales propriétés magnétiques des roches et les différents mécanismes susceptibles de provoquer dans une roche une aimantation thermorémanente en sens inverse du champ ayant agi au refroidissement.

II — *Courants telluriques*

Prospection. Méthodes d'interprétation.

Les Missions telluriques de la Compagnie générale de Géophysique ont effectué des travaux de prospection en France, en Sicile, en Autriche, en Afrique du nord, au Sahara, au Sénégal et à Madagascar.

R. Godivier a fait des sondages électriques au Tchad. La méthode de superposition des états d'équilibre a été appliquée par G. Kunetz (69) à la résolution du problème de la distribution des potentiels, due à un champ uniforme à l'infini, au-dessus d'un anticlinal infiniment résistant, sous une couverture horizontale discordante.

R. Utzmann et B. Favre d'une part (134, 135), L. Cagniard et R. Neale d'autre part (19, 92) ont mis au point de nouvelles techniques de mesures électriques, en cuve électrolytique, pour l'interprétation, sur modèles réduits, des résultats de prospection électrique ou tellurique.

Utilisant sa technique des modèles réduits, R. Utzmann a déterminé, avec B. Favre, (136) le champ et « l'aire » telluriques au-dessus d'anticlinaux résistants, allongés et étroits. Les mesures permettent de définir à partir de quelle valeur de sa longueur (évaluée par rapport à la profondeur du substratum) un anticlinal se comporte comme une structure cylindrique. Dans le cas d'anticlinaux non cylindriques on peut les localiser et évaluer leur orientation et leur forme générale.

G. Kunetz et J. Chastenet de Géry (71) ont montré les possibilités d'application de la méthode de la représentation conforme à divers problèmes de distribution du potentiel, en particulier dans le cas de terrains homogènes de conductivités différentes séparés par des surfaces de formes variées.

J. Martin a donné (83) les résultats obtenus dans la détermination de la vitesse des courants marins, avec l'appareil G.E.K.,

utilisé en 1955 devant Cherbourg, puis dans l'Océan Indien et l'Océan Austral.

L. Cagniard (17) a présenté, sous une forme nouvelle, la théorie de la mesure électromagnétique de la vitesse des courants marins et montré comment on pourrait déterminer la vitesse en fonction de la profondeur, réalisant ainsi ce qu'il a appelé un « carottage océanographique » des vitesses.

Appareils de mesures.

Pour avoir des corrélations plus significatives et plus précises en prospection par courants telluriques, R. F. Forbes (57) a proposé un dispositif d'enregistrement sélectif de ces courants à l'aide d'un système électromécanique au voisinage de la résonance.

Un suiveur de spot à pistes multiples a été définitivement mis au point par A. Blum et D. Monneau (7).

E. Selzer (114) a fait une étude des contacts électriques imparfaits avec application au cas des prises de terre. Depuis Mai 1955, il a expérimenté, à l'Observatoire de Chambon-la-Forêt, des montages d'enregistrement des courants telluriques ne mettant en oeuvre que des lignes extra-courtes (moins de 50 m. entre les électrodes) ; la compensation des montages usuels étant ici remplacée par une compensation mécanique : torsion convenable du fil de suspension du galvanomètre.

Des essais satisfaisants (78, 79) ont été effectués, en Juin 1956, au Grand Glacier d'Aletsch (Suisse) par Melle C. Lefèvre, A. Bauer et H. Fournier, avec un dispositif mis au point, sous la direction de L. Cagniard, avec le concours de P. Albertinoli et A. Blum. Ce dispositif, qui comporte une amplificateur électrométrique, permet de faire des enregistrements telluriques sur les glaciers malgré la résistivité très élevée de la glace, et d'utiliser les méthodes de prospection par courants continus. La méthode peut être appliquée à divers problèmes concernant glaciers, inlandsis, banquises et sols gelés.

Melle L. Dupuy a présenté (56) un diplôme d'études supérieures, à la Faculté des Sciences d'Alger, sur la mise au point d'un appareil destiné à éliminer les variations lentes des courants telluriques afin de permettre leur enregistrement facile.

Variations des courants telluriques.

G. Kunetz (68) a comparé les enregistrements telluriques effectués à l'occasion de l'éclipse de soleil de Février 1952, simultanément en France, en Italie, au Sahara, en A.E.F., au Vénézuéla et aux Etats-Unis. Les enregistrements du Gabon, où l'éclipse était totale, et de la Sicile, où l'éclipse était de 33 % et décalée de plus d'une heure par rapport au Gabon, ne montrent aucun effet d'éclipse sur l'intensité ou la fréquence des variations telluriques.

G. Kunetz (70) a, d'autre part, étudié les variations rapides des courants telluriques enregistrés en 1951—1952, en France, en Italie, en Algérie, au Maroc, au Gabon et à Madagascar.

Théories.

J. D'Hoeraene (41) a montré que le vecteur représentant le champ tellurique à la surface du sol se comporte comme un vecteur aléatoire à deux dimensions dont la répartition est elliptique et obéit sensiblement à une loi de Gauss quand on considère des intervalles de temps suffisamment longs. Il a étudié, sur un exemple, les variations en fonction du temps, de l'ellipse de probabilité.

A. Belluigi (4) a établi quelques propriétés des champs géo-électromagnétiques de différents émetteurs alternatifs et indiqué une solution pour le problème de l'émetteur à une électrode.

On trouvera, dans la bibliographie, les références concernant des articles et conférences de plusieurs auteurs.

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2ème PARTIE : AERONOMIE

Ce rapport résume les travaux qui ont été faits en France depuis l'Assemblée Générale de Rome en 1954.

Nous ne retiendrons que les résultats les plus importants.

Ciel nocturne.

Barbier a pu montrer que certains domaines spectraux présentent des variations simultanées. Il a ainsi réuni les radiations en groupes covariants :

1) Raie verte, raie bleue, bandes de Herzberg, spectre continu ;
2) Raies rouges de OI, raie D, bandes de OH.

Jean Dufay, en collaboration avec Tcheng Mao-Lin, a également mesuré l'altitude d'émission des raies verte, jaune et rouges, d'après d'anciennes mesures, et ils concluent à une altitude voisine de 200 km pour la raie verte, un peu supérieure pour la raie jaune, et 250 à 280 km pour la raie rouge.

Berthier, dans sa thèse de doctorat, a étudié les variations de l'intensité des bandes du proche infra-rouge de OH et de O_2 atmosphériques. Les bandes de OH ont une variation diurne particulière ; elles décroissent au début de la nuit, puis recommencent à croître à partir de 23^h30. Pendant les nuits d'hiver, qui sont plus longues, on observe en fin de nuit un maximum suivi d'une chute brusque. Les bandes de O_2 ont une variation irrégulière. La variation annuelle a également été étudiée. L'émission de OH est minimum en été et maximum en hiver ; comme celle des raies du sodium, l'émission de O_2, beaucoup plus accidentée, présente 4 maxima au cours de l'année. L'altitude d'émission de ces deux groupes de bandes a été située entre 150 et 200 km.

Un certain nombre d'études spectroscopiques ont été faites. MM. Cabannes et J. Dufay ont mesuré avec l'étalon Perot-Fabry les longueurs d'onde des deux raies rouges avec une excellente précision ; ils ont trouvé 6300,308 et 6363,790 $\pm$ 0,004 A.

Karandikar a commencé la mise au point d'un interféromètre enregistreur pour la mesure de la largeur de la raie verte.

M. et Mme Herman ont mesuré avec précision les longueurs d'onde de la bande de OH dans le rouge.

Phénomènes crépusculaires.

Maurice Dufay a publié sous forme de thèse de doctorat un important travail consacré aux bandes de N_2^+ et au doublet de NI 5199 A. Les bandes de N_2^+ que l'on observe tous les jours, ont une intensité très variable en rapport étroit avec l'activité magnétique. L'altitude est comprise entre 90 et 125 km, la température de rotation est de 400°K. Ces bandes paraissent avoir également une émission nocturne. Le doublet interdit de NI s'observe à une altitude voisine de celle de N_2^+. On l'observe beaucoup mieux en été qu'en hiver, et mieux le soir que le matin ; il est nettement absent la nuit. L'examen des mécanismes d'excitation permet de conclure en faveur d'un mécanisme de résonance optique pour N_2^+, et d'un phénomène de fluorescence pour la raie 5199.

Robley a utilisé les résultats obtenus aux hautes latitudes (Groënland et Terre Adélie) concernant l'émission crépusculaire du sodium pour déterminer l'altitude de la couche, et il a montré en collaboration avec Mayaud que cette émission, fort intense au cours de l'hiver austral, a tendance à présenter un maximum en juin-juillet (hiver austral).

Blamont a donné la description de plusieurs ingénieux dispositifs pour l'étude des raies D du sodium au crépuscule. Il a fait quelques essais à très haute altitude en vue de rechercher l'émission diurne.

Aurores polaires.

Le spectre des aurores a été étudié par M. Dufay et ses collaborateurs quand les circonstances le permettaient, et Barbier a mis au point un appareil pour la détection des aurores.

L'ionosphère.

En ce qui concerne l'altitude des diverses couches ionosphériques, Bouquin étudiant ses mesures en Terre Adélie a exposé l'ensemble des résultats obtenus parmi lesquels nous noterons particulièrement l'existence de la couche G et la présence de triple décomposition.

Busch et Luchet ont relevé sur les radio-sondages des Iles Kerguélen des échos provenant d'une couche non-absorbante située vers 60 km d'altitude.

Dans le domaine de l'absorption, des mesures ont été faites à Domont par le Père Lejay, et ses collaborateurs, avec une méthode permettant de tenir compte des variations rapides et qui a montré un maximum d'absorption dans l'après-midi. Steinberg et ses collaborateurs, mesurant l'absorption sur une fréquence

émise par le soleil, ont trouvé une valeur supérieure à la valeur calculée ; l'absorption due à l'oxygène et à la vapeur d'eau n'explique que 65 % de l'atténuation. Vieira a également mesuré l'absorption ionosphérique, grâce au rayonnement galactique sur 30 Mc/sec, et il a pu distinguer entre l'occultation et l'absorption proprement dite ; l'absorption a été mesurée pour la couche F_2 et pour la couche D, dont l'absorption diurne a pu être décelée.

Le Père Lejay et Melle Durand, d'une part, Estrabaud d'autre part, étudiant l'éclipse du 25 février 1952, ont examiné particulièrement la région F_2 qui s'est révelée complexe ; une deuxième couche apparaissait au-dessous de la couche normale ; de plus l'ancienne couche F s'élève rapidement à une altitude de 800 km.

Les relations entre l'ionosphère et divers phénomènes solaires ou terrestres ont été étudiées. Delobeau et Suchy ont mis en évidence une relation entre l'absorption et le nombre de taches solaires.

Delobeau et Gallet ont montré des variations de structure de l'atmosphère en fonction de la déclinaison du soleil. Mme Stoyko a montré que les cas de super-propagation sont liés à une activité solaire importante. A propos d'étude de l'émission des taches solaires, Simon a pu distinguer entre les taches solaires radio-électriquement actives, qui sont aussi magnétiquement actives, et celles non radio-électriquement actives, qui sont accompagnées d'une faible diminution de l'activité géomagnétique. Denisse et Kundu ont montré que l'ionisation de la couche E est en liaison avec le flux de rayonnement solaire radio-électrique.

Dans le domaine de la propagation, Rivault a continué ses travaux sur les sifflements radio-électriques.

En ce qui concerne les études théoriques, Jancel et Kahan ont étudié les plasmas, et, dans le cas de plasmas inhomogènes et anisotropes, ont pu retrouver des effets tels que la triple décomposition. Denisse, Bayet et Delcroix ont donné une théorie approfondie des plasmas qui s'applique en particulier à l'effet Luxembourg.

Diverses études de Argence et de Poincelot, ont porté sur la propagation et la réflexion des ondes planes dans un milieu ionisé avec diverses applications, par exemple, à la propagation oblique le long de l'équateur magnétique.

Enfin, Lepechinsky dans un important travail, a résumé plusieurs études concernant les divers types de propagation (longitudinale ou transversale) et montré l'influence de l'inclinaison du champ terrestre et du nombre de chocs sur les conditions de propagation. Le niveau de séparation entre les deux zones a été calculé ; certains aspects de la variation diurne de F_{0E} ont pu être expliqués.

Fusées.

Depuis le congrès de Rome, deux types de fusées françaises ont pu être expérimentés; les premiers tirs d'engins «Véronique», équipés d'appareils scientifiques, ont eu lieu les 17 et 19 octobre 1954 au Sahara, et la petite fusée « Monica » a été expérimentée en 1955 et a pu atteindre 80 km.

On a mesuré jusqu'à l'altitude de 135 km le champ d'émetteurs situés au sol. Les résultats ont été présentés à l'Assemblée de l'URSI à Boulder (août 1957).

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GREAT BRITAIN

British National Report on Geomagnetism and Aurora
1955/57

1. *Observatories and Magnetic Charts.*

1.1 *Lerwick and Eskdalemuir (Meteorological Office).*

The la Cour ordinary and quick-run magnetographs continued at both observatories. Frequent inter-comparisons of the H and V standard absolute instruments were made by travelling QHM and BMZ instruments; comparisons were also made with the Rude Skov and Abinger standards for horizontal force.

At Lerwick preparations were made for installing two Askania magnetographs at supplementary stations for measurement of gradients of the magnetic field during the IGY.

At Eskdalemuir a highly sensitive declination variometer was operated for a few days in June 1954 about the time of the solar eclipse. No clear evidence of any eclipse was found.

At the same observatory a direct reading H-force variometer was brought into regular use.

1.2 *Abinger and Hartland (Royal Greenwich Observatory).*

Hartland (51°00′N, 355°30′E) became the main observatory on 1st January, 1957, when regular recording using la Cour variometers was started. Recording will continue at Abinger only till about mid 1957; it will not be practicable for the two observatories to function together throughout IGY.

The absolute instruments (Schuster-Smith and Dye coils) have been transferred to Hartland, after intercomparisons between Abinger and Hartland with subsidiary standards.

1.3 *Stonyhurst College Observatory* (53°51′N, 357°32′E).

Observations were made here from 1866 to 1945. Continuous recording of the three components started again on an experimental basis on 1st January, 1957, using the original D and H Kew variometers and a Watson type Z. These old instruments will be replaced by la Cour variometers during 1957.

Absolute observations, weekly as from 1st April, 1957, will be made using QHM and BMZ instruments and the original Kew D declinometer.

1.4 *World Magnetic Charts, 1955.0.*

World charts for 1955.0 prepared by the Royal Greenwich Observatory were published by the Hydrographic Department, Admiralty, during 1954 and 1955. The epoch was chosen in accordance with the recommendations of the Committee on Magnetic Charts and is the same as that employed in the world magnetic charts published by the U.S. Hydrographic Office. The British charts cover the elements D, H, Z, I, X, Y and F, the first appearing also in an enlarged form in which the region between latitudes +71° and −65° is displayed in three sections. This is the first occasion upon which the British charts have given all seven magnetic elements, and the first also on which spherical harmonic analysis of the data has been employed in their preparation.

1.5 *Publications.*

"The Geomagnetic Post-Perturbation Effect" by R. P. Waldo Lewis. (Journal of Atmospheric and Terrestrial Physics).

"The Annual Variation of the Magnetic Elements" by R. P. Waldo Lewis, D. H. McIntosh and R. A. Watson. (Journal of Geophysical Research).

"The Earth's Main Magnetic Field: Epoch 1955.0" by H. F. Finch and B. R. Leaton. (Geophysical supplement, Royal Astronomical Society).

"Improving World Magnetic Charts" by B. R. Leaton. (Geophysical supplement, Royal Astronomical Society).

2. *Aurora.*

2.1 *Visual Work.*

2.1.1 *Observations.*

The Aurora Survey, covering the region from Iceland to the English Channel, which began in 1952, has been continued. The number of observers has increased steadily and the quality of the observations has improved as a result of practice in observing the more frequent displays of recent months. An improvement in accuracy has followed the issue to some observers of portable alidades for the measurement of elevations. Hourly observations are now made at stations of the British Meteorological Office and of the Irish Meteorological Service, Crews of selected ships and of BOAC, BEA, and RAF aircraft also provide valuable observations.

In connection with the IGY, during which the Balfour Stewart Auroral Laboratory of Edinburgh University is to be the World Data Centre C for visual auroral observations, illustrated instructions

and report sheets have been prepared for each type of observer. Ample quantities of these have been printed for distribution to National Auroral Reporters of other countries who may decide to supply them to their observers. Notes on the observations of luminous night clouds and mother-of-pearl clouds have also been prepared for issue to each observer.

2.1.2 *Data Reduction.*

It is proposed to plot nightly charts showing the position and development of aurora in each of three meridional zones covering the area allotted to the Centre. These charts are for observers placed south of geomagnetic latitude 65°. It is hoped that sufficient data will be available to plot a separate chart for the arctic region north of geomagnetic latitude 65°. For nights of great displays, additional charts with expanded time scales will be used to permit the plotting of the material in full detail.

All the charts will be reproduced on microfilm and copies supplied to the World Data Centre C for instrumental auroral observations (at Stockholm) and to the World Data Centres A (in USA) and B (in USSR) for auroral observations.

2.2 *Photography.*

2.2.1 *Parallactic Photographs.*

The main station continues at Abernethy, Perthshire, with a subsidiary station at Newton Stewart, Wigtownshire. The Roseneath station has had to be discontinued but two new stations will be opened at Whickham, Northumberland, and Keyingham, Yorkshire. A short base-line station 30/50 Km from Abernethy is being sought to supply information for the auroral spectroscopic work at St. Andrews University.

2.2.2 *All-sky Photographs.*

An all-sky camera of Swedish type is in operation at the Observatory of St. Andrews University, Fife.

2.3 *Spectroscopy.*

2.3.1 *St. Andrews University.*

An auroral spectrograph loaned by the Cambridge Research Center is in operation at St. Andrews. It will be used to investigate airglow and noctilucent clouds as well as aurora.

2.3.2 *Belfast.*

Spectroscopic and interferometric work on airglow and aurora continues at Belfast.

2.4 *Radio Echo Work.*

Equipment similar to that operating at the Jodrell Bank Experimental Station of Manchester University is expected to be in operation at St. Andrews before 1st July, 1957.

3. *Geomagnetic Survey.*

3.1 *Secular Variation Survey.*

During 1955—6 the Geological Survey of Great Britain made observations at magnetic stations previously observed for horizontal component, dip and declination by G. W. Walker in 1915 and repeated for declination only by Ordnance Survey officers in 1948. About twenty-five stations, well distributed over Great Britain, were selected for observation comprising vertical and horizontal force components using BMZ and QHM magnetometers and declination using a Wingfield Standard Compass. The main calibration of instruments was undertaken at Abinger Magnetic Observatory and the field measurements included direct links from Abinger to Eskdalemuir Observatory. Observations were reduced to epoch 1956.0 from comparisons with simultaneous values at Abinger, Eskdalemuir, Lerwick and Valentia observatories.

No results have yet been published but they show that during the past eight years the westerly declination has decreased uniformly throughout Great Britain with a mean rate of about eight minutes annually. From 1915 to 1956 overall changes in the vertical force component show a decrease in the north-west and an increase in the south-east, whereas the overall changes in the horizontal force component show a decrease in the north-east and an increase in the south-west. For both components the changes range from 250 gammas positive to 250 gammas negative. During the intervening period force measurements were made by the Ordnance Survey between 1926 and 1929 at twelve of Walker's stations in England which were reoccupied during 1955—6. At all of these stations both vertical and horizontal force components show a decrease from 1915 to 1926—9 followed by an increase from 1926—9 to 1956.

3.2 *Airborne Magnetometer Survey.*

During 1955 the Nuffield Foundation financed a pilot total-force aeromagnetic survey designed to provide an

assessment of the value of aeromagnetic surveying as a further geological aid in an area where the surface geology has been mapped in considerable detail and a large amount of underground geological information is available. Preliminary results from the pilot scheme were considered to justify more extended work and the Geological Survey have now undertaken further surveys covering 26,000 square miles. The aeromagnetic surveys have been followed-up by detailed vertical force variometer surveys on the ground in areas of special geological and magnetic interest.

3.3 *Investigations in the Atlantic.*

In July and August, 1956, the R.R.S. Discovery II made a six weeks' cruise in the North Atlantic, the main purpose of which was to study the ocean floor. During this cruise, towed magnetometers were used continuously. The magnetometers were of two types, a fluxgate magnetometer built by the Imperial College of Science and Technology and a nuclear spin magnetometer built by the Department of Geodesy and Geophysics at Cambridge. The comparison of the results between the two showed excellent agreement. The nuclear spin magnetometer, however, was much more easily handled. Detailed surveys were made in several areas of the Mid-Atlantic Ridge and over seamounts between the Azores and Madeira. The magnetic results are of considerable interest since it seems likely that they will show up main structural trends beneath the sediments. Interpretations of these surveys and the comparison between topography and magnetic field whilst on passage are now being made. A preliminary outline of the magnetic measurements was given by Sir Edward Bullard and Dr. M. N. Hill at a Royal Society discussion in May, 1957.

The nuclear spin magnetometer is at present being redesigned so as to be automatically recording.

3.4 *Regional Variometer Surveys.*

Vertical force variometer surveys have been made by workers from Cambridge University to supplement gravity surveys over areas of negative gravity anomaly in North-East (1) and South-West England. The results have been compared with results from surveys over exposed mineralized granites elsewhere.

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HUNGARY

Report on Geomagnetic and Telluric Research carried out in Hungary during the period 1954—1957

By Gy. Barta

Geomagnetic research is carried out in Hungary by the Geomagnetic Department of the Geophysical Institute Roland Eötvös, telluric current investigations by the Electrical Department of the same Institute as well as by the Geophysical Research Laboratory of the Hungarian Academy of Sciences in Sopron, and ionospheric researches by the Ionosphere Department of the Hungarian Meteorological Institute. The results of the ionospheric research are to be read in the report presented to the Meteorological Association.

Activity of the Geomagnetic Observatory and Magnetic Measurements

Magnetic observations started in the Observatory of Budakeszi in 1948 and were continued until October 1955. In November 1954 the Observatory of Tihany started its activity (φ=46°54,0′N, λ=18°53,8′E Gr). The two Observatories were working simultaneously during a whole year in order to make possible a precise reduction of the corresponding data. The actual normal-speed recording of the magnetic elements will be supplemented in the course of the Geophysical Year by high-speed recording of the magnetic elements and telluric currents.

A reconnaissance survey of the Great Hungarian Plain with a station interval of 1,5 km was started in 1951 and has been completed on the territory between the Danube, the northern highlands, the eastern and southern frontiers. In several places the survey revealed anomalies indicating covered eruptives.

In prospecting for ore we carried out detailed measurements in different areas of the country with 500—200 m, 50—20—10 m or even smaller intervals. Experiments were also carried out with magnetometers of the soft iron core type. In addition the Geophysical Departments of the University Roland Eötvös in Budapest and of the Technical University in Sopron carried out earth magnetic measurements on a smaller scale.

The Association of Hungarian Geophysicists held conferences in September 23—24, 1955 and September 24—25, 1956 with the participation of foreign research workers in order to discuss problems in terrestrial magnetism.

Studies of telluric currents

The Hungarian Geophysical Institute Roland Eötvös carried out measurements over gravity anomalies in order to explore

the deep structure of the Great Plain. Trial measurements were effected in the vicinity of the Magnetic Observatory in Tihany for the establishment of permanent recording of telluric currents.

The Geophysical Department of the Technical University in Sopron as well as the Geophysical Research Laboratory of the Hungarian Academy of Sciences have been carrying out experimental measurements since 1952, chiefly for practical purposes, namely for the development and the testing of measuring methods and instruments. Meanwhile certain results were obtained bearing on the interrelation between telluric currents and magnetic variations. The instruments constructed were also tested in 1956 on the territory of the People's Republic of China. The measurements are fitting well into the results of international researches of similar character.

Summary of the theoretical researches

G. Barta continued his researches on the secular variation of the geomagnetic field, after having determined that in the secular course at most observatories a superposed wave of a period of 40—50 years is detectable by means of approximations using power-polynomials in all the three magnetic elements.

The representation by means of vector diagrams gave a deeper view of the structure of the phenomenon and shoved that the space curve described by the end point of the magnetic field-vector helically envelops the approximate power curve as a result of the superposed wave (transversal effect); it also appears that the actual change, as compared with the adjusted one, is more or less late or fast respectively (longitudinal effect). These results make obvious that the secular variation — in spite of the many local characteristics appearing on isopor maps — is a general process concerning the whole Earth.

A very clair picture of the phenomenon is obtained by plotting the vectors representing the secular variation in a uniform coordinate system one axis of which is the axis of rotation of the Earth, whereas the two other axes are directed towards the points 291°E and 21°E Gr. of the Equator. The vectors, orthogonally projected to the planes of this coordinate system, show some regularities indicating that the centre of symmetry of the phenomenon is around Pakistan. If the coordinate system is rotated so that the centre of the projected picture is shifted to Pakistan, it can be proved that the vectors around the centre of the picture are pointing towards the centre, while at the edges of the picture they are directed outwards. As a matter of course, the picture as well as the respective lateral views would lead to the assumption that there is a current circuit centred about Pakistan, which has a radius of about 3000 km and a depth of about 3000 km; the direction of this circuit is clockwise, as seen from Pakistan, its intensity being about 10^7—10^8 ampère. The secular

variation is due to the change in time of the position and intensity of the circuit.*)

It is known that the magnetic centre of the Earth lies excentrically towards the Marshall-Islands and its surface projection is moving towards N-NW with a velocity of 10 km/year. If we assume that the Earth's magnetism originates in its core, then this variation is equivalent to a motion of the Earth's core. This movement causes an increase of pressure and spreading out of material around a spot below Pakistan. If the moving is electrically charged, the resulting convection current may cause the secular variation of the magnetic field.

From the velocity of motion we infer that the magnetic centre of the Earth revolves around the axis of rotation of the Earth in 4000 years, which estimation is not in accord with the secular period of about 500 years of the long declination-series for London. But we may presume that the movement of the Earth's core is oscillatory with a period of 4—500 years. The precession of the axis of the eddy may cause the superposed wave and the helical course observed in the secular variation. In order to unravel this complex of problems, further researches are in course.

G. Barta pointed out in a recent paper that the 50 years period found in the velocity of rotation of the Earth (Brouwer, 1952) may be attributed to the movement of the Earth's core in the interior of the Earth, while the core according to Vestine also contains the source of the earth's magnetism. A further consequence of the supposed re-arrangement of the masses is that the gravity field should have a variation with the same period. It is further reasonable to assume that the main period of the secular magnetic variation itself is the result of a motion in the core with a corresponding period and thus this variation has to appear in the variation of the velocity of rotation of the Earth as well as in the secular variation of the gravity field.

The writer proposes to examine the variations of the level surface of the gravitational field in order to avoid technical difficulties in measuring the field itself. The level surface may be determined and its variation followed, even in the past, with the help of annual mean sea-level data measured at the tide-gauge stations.

The writer also points out that in case of very accurate measurements attention must be paid to the gravitational effect of the re-arrangements of masses connected with atmospheric processes.

L. Egyed has developed a new dynamic theory of the internal constitution of the Earth. The theory starts from the basic assumption that the material in the core is in a degenerate state,

*) A vector diagram accompanying the report, but not reproduced here, can be found in Acta Technica Academiae Scientiarum Hungaricae, Tom XVIII, Fasc. 1—2, p. 164, or in Geofizikai Közlemények, Vol. VI, p. 17.

where the nuclei forming the core and their electron-shells become independent from each other. It is supposed that the elementary particles are arranged according to the direction of their moments, and hence summing up their magnetic moments we may obtain a quantitative interpretation of the magnetic field of the Earth.

I. B. Haáz has developed a method for calculating the position, dimensions and density or susceptibility of covered masses (inclined layers with gravity or magnetic anomaly) on the basis of the abscissae of the extreme values of measured anomalies Z and H, or on the basis of the extreme values of the anomalies. He also worked out a simple technique for the evaluation of the temperature corrections for BMZ instruments.

K. Kántás has investigated theoretically the potentialities of the introduction of a new branch of applied geophysics, a modified magnetotellurics, on the basis of the connections between the telluric and the magnetic field. Works are in progress aiming at a verification of the results of these investigations with model-experiments and field-surveys.

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Earth currents

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— Results of the simultaneous measurements of telluric currents between Peking (China) and Sopron (Hungary) executed from 9th to 14th January 1956. (English) Soproni Egyetem Közleményei, 1956.

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INDIA

National Report on Work done in Geomagnetism and Aeronomy in India during 1954-56

Geomagnetism

1. *India Meteorological Department.*

Alibag Magnetic Observatory.

The Alibag Observatory (Geographic Lat. 18° 38′ N. Geographic Long. 72° 52′ E; Geomagnetic Lat. 9°.5 N, Geomagnetic Long. 143°.6 E) is a primary magnetic observatory which was established in 1904.

The Kew Pattern Magnetometers as modified by the Indian Trigonometrical Survey were used for weekly absolute observations of H and D. Daily observations of I were made with the Earth Inductors made by Schulze and Toepfer. The variations in the earth's magnetic field (H, V and D) were continuously recorded photographically with Watson Magnetographs. Less sensitive magnetometers permanently fixed were used for recording visual check readings five times a day and to watch the progress of magnetic phenomena. Ordinarily the Watson magnetographs were run at normal paper speed of 15 mm/hour, but for obtaining extended records for more detailed study of the variations in the

Earth's magnetic field, particularly the short period fluctuations, quick run records at 180 mm/hour were obtained as and when necessary. For some years La Cour normal run (15 mm/hour) magnetographs for continuous photo-recording of H, V and D have also been in use at Alibag. La Cour quick-run (180 mm/hour) magnetographs which are awaiting installation at Alibag, were used at the Colaba Observatory for trial. One standard Earth Magnetic Theodolite with large Earth Inductor and two Magnetic Field Balances for H and V by Askania Werke are expected to be obtained shortly. A set of Eschenhagen magnetograph (H and V) has been improvised for field stations. A set of La Cour Quartz Horizontal Magnetometer and La Cour Balance Magnétométrique Zéro are periodically cheked at Alibag. Being portable, they can be used at field stations and are issued, as and when necessary, to survey and expedition parties for studies of special phenomena.

Telegraphic reports of magnetic storms were sent from the Alibag Observatory to the All India Radio Research Station, New Delhi, to enable special studies to be made during such storms. Requests for magnetic data from a number of scientific institutions and bodies all over the world were received and complied with.

Quarterly statements of daily magnetic character figures and three-hourly K indices were published in the Indian Journal of Meteorology and Geophysics. Similar statements were also published in the International Union of Geodesy and Geophysics publication for C and K indices and were supplied to Dr. Romañá, Chairman, Committee on Rapid Variations and Earth Currents, the President, International Union of Geodesy and Geophysics, and to various other Magnetic Observatories. Quarterly statements of principal magnetic storms recorded at Alibag were also supplied regularly to the Editor, Journal of Geophysical Research, Washington, for publication.

The data of the Observatory are published in the form of an Annual Volume.

Golden Jubilee of the Alibag Observatory.

The Alibag Magnetic Observatory completed its 50th year in 1954. To commemorate the occasion, a Symposium on "Geomagnetic Activity and Solar-Terrestrial Relationships" was held under the presidentship of Dr. K. R. Ramanathan, President, International Union of Geodesy and Geophysics, which was attended by scientists of repute. A special number of the "Indian Journal of Meteorology and Geophysics" containing articles on geomagnetism and allied subjects by workers from several countries and a special souvenir pamphlet giving a brief review of the history and work of the Alibag Observatory, were also issued.

Kodaikanal Observatory.

The Magnetic Observatory at Kodaikanal started functioning in 1902. After being closed down in 1923, it was restarted in 1949.

Routine photographic recording of H, Z and D elements with La Cour and Watson Variometers and directly visible recording of H with an Askania Magnetic Field Balance were continued during the period 1954-56. A quick-run recorder was also installed for use with the Askania Horizontal Field Balance. Absolute measurements of horizontal and vertical components of the geomagnetic field were made weekly, using a set of QHM and BMZ instruments.

Geomagnetic observations during total solar eclipses.

Special geomagnetic observations were made during the total solar eclipses which took place on 30th June, 1954, and 20th June, 1955. A field station was set up at Phalodi in West Rajasthan in the track of totality of the former eclipse. This field station functioned from 18th June to 8th July, 1954, and photographic records and intensive eye observations of the magnetic field were obtained. Ionospheric observations were also recorded at this field observatory.

An expedition was sent to Hingurakgoda (Ceylon) for making geomagnetic observations during the second eclipse mentioned above. The observations were successfully made along with ionospheric observations.

Plans for the International Geophysical Year.

Sites were selected for two additional field magnetic stations north and south of the Geomagnetic Equator which passes through South India. The stations selected for the purpose are Trivandrum (Geomagnetic Lat. 0°.9 S, Geomagnetic Long. 146°.3 E) and Chidambaram (Annamalainagar) (Geomagnetic Lat. 1°.8 N, Geomagnetic Long. 149°.4 E).

2. *Survey of India.*

Magnetic Observatory.

The Magnetic Observatory at Dehra Dun ceased working on 15th August, 1943, due to heavy flooding of its underground chambers. The site has become unusable due to buildings constructed around it during World War II.

It has not yet been possible to restart the magnetic observatory outside Dehra Dun owing to delays in construction of buildings. A magnetograph (La Cour type) manufactured by Andersson and Sörensen for Declination, Horizontal Force and Vertical Force complete with photographic accessories, has been received for this Observatory. A new Earth Magnetic Variograph by Askania is also on order for the Observatory.

Magnetic Observations.

To replace the Kew Pattern unifilar magnetometers so far in use, a set of La Cour QHM and BMZ instruments was also procured for field measurements.

Magnetic observations were taken with Vertical Force Variometers at 195 stations in parts of Assam, with Wild Compass Theodolites and Vertical Force Variometers at 55 stations in parts of Rajasthan, with QHM and V.F. Variometers at 78 stations in parts of West Bengal, Bihar, Orissa, Kerala, Andhra and Madras States, and with Wild Compass Theodolite at 3 stations in Himachal Pradesh. For absolute values of vertical force, dip circles are still being used at repeat stations which are out of range of BMZ. Observations for all magnetic elements were also taken at 7 repeat stations during this period. A start has been made on occupying repeat stations at periodic intervals of 5 years or so in order to keep magnetic charts up-to-date and to provide reliable data for the study of the earth's magnetic field, its variations, periodicity, etc.

Magnetic anomalies at all field stations are worked out for locating disturbed areas for geophysical prospecting.

Aeronomy

The number of centres of work on the physics of the Ionosphere and the scope of investigations undertaken in them have increased. In addition to the Research Department of the All India Radio and the Institution of Radio Physics and Electronics under Professor S. K. Mitra in Calcutta, new centres have developed at the Physical Research Laboratory, Ahmedabad, at the National Physical Laboratory, Delhi, at the Solar Physics Laboratory, Kodaikanal, at the Banaras Hindu University, at the Andhra University, Waltair, and at the College of Engineering, Poona. There are new vertical pulse sounding ionospheric stations at Delhi, Calcutta, Ahmedabad, Bombay, Madras, Tiruchirapalli and Kodaikanal, and a station at Trivandrum will be in operation before the beginning of the International Geophysical Year. Of these stations, Calcutta, Ahmedabad and Kodaikanal have automatic equipment. The stations in South India in the neighbourhood of the geomagnetic equator are expected to be very useful additions to the ionospheric network.

Ionospheric drift measurements with spaced receivers are being made at Ahmedabad and Waltair, absorption measurements at Delhi, recording of Cosmic Radio Noise at Ahmedabad and Delhi and of Solar Radio Noise at Kodaikanal. Absorption measurements will be commenced at Ahmedabad and Calcutta before the beginning of the International Geophysical Year. Quantitative measurements on the radio noise spectrum of thunderstorms are being made by Professor Aiya and his students in

Poona; wave-form studies of atmospherics are being carried out at Banaras under Professor S. R. Khastgir.

An analysis of the variation of the noon critical frequencies of F_2 with lunar phase at the Indian ionospheric stations (Kotadia and Ramanathan) showed that the semidiurnal tidal variations at Delhi, Ahmedabad and Bombay agreed in phase with those observed in middle latitudes, a reversal of phase was shown at Madras and Tiruchirapalli in agreement with those observed at Huancayo, Ibadan and Singapore.

Night air-glow and twilight sky observations with photomultipliers are being taken at Abu by workers in the Physical Research Laboratory and at Poona and Sinhagad by Dr. Chiplonkar and his students. Narrow band interference filters isolating 5577, 5893 and 5300 are used at Mt. Abu. Equipment for studying the intensity variation of infra-red OH bands is under construction for use at Mt. Abu.

Dr. Ramanathan and Mr. Dave have continued their studies on the light from the twilight skies and shown that the variation of intensity and polarization of the light from the twilight sky can be explained satisfactorily if secondary scattering is taken into account.

A list of papers on geomagnetism, the high atmosphere and related subjects published during the period 1954-1957 is appended.

I. Geomagnetism

Papers published in the Geomagnetic Number of the Indian Journal of Meteorology and Geophysics (1954, Vol. 5, Special Number)

1. S. Chapman: Notes on the Theory of Magnetic Storms.
2. J. A. Fleming: International Aspects of Geomagnetism in India.
3. R. P. Waldo Lewis and D. H. McIntosh: The Relation between the Geomagnetic Field and Range Disturbance in various latitudes.
4. S. K. Chakrabarty: The Spherical Harmonic Analysis of the Earth's Main Magnetic Field.
5. Julius Bartels: The contrast between Geomagnetic S and L at Huancayo.
6. T. Nagata and N. Fukushima: Characteristics of Polar Magnetic Storms.
7. A. A. de Mendonça Dias: A Hypothetical Model of the Geomagnetic Secular Variation in Western Europe and the North Atlantic.
8. A. M. Van Wijk: Notes on the Determination of the Temperature and Induction Coefficients of Magnetometer Magnets.
9. K. F. Wasserfall: Professor Dr. Christopher Hansteen.
10. J. Custodio de Morais: Observations of Terrestrial Magnetism made on the west coast of India by D. Joao de Castro in 1538—39.
11. S. L. Malurkar: The Geomagnetic Importance of Andamans in Bay of Bengal.
12. S. E. Forbush and E. H. Vestine: Ionospheric Magnetic Fields during Marked Decreases in Cosmic Rays.
13. K. R. Ramanathan and K. M. Kotadia: The Ionospheric F_2 Layer over India in Minimum Sunspot Year 1953.

14. S. K. Banerji and D. V. Kamat: Measurement of Air-earth Electric Current at Poona.
15. H. Alfvén: Magneto-hydrodynamic waves and Solar Prominences.
16. A. Vassy et E. Vassy: Activité Aurorale aux Latitudes Moyennes.
17. A. K. Das: Solar Radiation in the Far Ultraviolet and some Related Geophysical Phenomena.
18. Masatoshi Kitamura: What Types of Magnetic Storms are Accompanied by the Decreases of the Intensity of Cosmic Rays.
19. V. C. A. Ferraro: On the Emission of Electric Currents from the Sun.
20. S. K. Pramanik and M. K. Ganguli: Sunspots and Geomagnetic Variation.
21. P. K. Sen Gupta: Magnetic Storms and Solar M-Regions.
22. R. Pratap: The Dynamo Action of the Diurnal Atmospheric Oscillation.
23. Ali M. Naqvi and B. N. Bhargava: Recurrence Tendency of Geomagnetic Activity during the Current Sunspot Minimum.
24. J. Veldkamp and J. G. Scholte: Some remarks on the Equatorial Electrojet, as revealed by the analysis of Solar-Flare Effects.
25. S. L. Malurkar: Geomagnetic Records (at Colaba and Alibag) on days of Solar Eclipse.

Other Publications.

1. S. L. Malurkar: Transients of Magnetographs and Instantaneous values from recordings. Proc. Nat. Inst. of Sci. (India), 20, 567 (1954).
2. — Solar Flare Effect at Alibag of June 13th 1951. Annali di Geofisica, Roma, 7, 215 (1954).
3. — Geomagnetic Variations and diurnal range of Atmospheric Ozone. Annali di Geofisica, Roma, 7, 209 (1954).
4. — Daily Total Cosmic Ray Indices at Huancayo and World Geomagnetic Indices and Magnetic Storms. Acta Physica Hungarica, 5, 241 (1955).
5. A. S. Chaubal, D. K. Deshmukh and S. L. Malurkar: Minor Oscillations of Magnetographs, Nature, 176, 876 (1955).
6. B. N. Bhargava and A. M. Naqvi: Very Long Sequence of Geomagnetic Activity and its Annual Variation. Nature, 173, March 1954.
7. A. Thiruvengadathan: Diurnal Variation of Horizontal Magnetic Force at Kodaikanal. Indian Jour. of Met. & Geophys., Vol. 5, No. 3, 1954.
8. A. K. Das: Geomagnetic Disturbances Associated with M-Regions and Suddenly Disappearing Prominences (Presented at the Symposium on "Geomagnetism" held at Bombay). Indian Jour. of Met. & Geophys., Vol. 6, No. 1, January 1955.
9. A. Thiruvengadathan: Magnetic Disturbance Field at Kodaikanal. Indian Jour. of Met. & Geophys., Vol. 7, No. 4, 1956.
10. India Meteorological Department: A study of the Geomagnetic Variations during the total solar eclipse of June 20, 1955. Kodaikanal Observatory Bulletin No. 144, in the press.
11. A. K. Das: Effect of Lightning Discharges on Magnetographs. Nature, in the press.

II. High Atmosphere

1. Banerjee S. S. and Banerjee D. K.: Effect of thickness of ionospheric layer on the multiple splitting and scattering of radio waves. Jour. Sci. Industrial Res., (India), 13 B, 587 (1954).
2. — — Variation of the angle of arrival of down-coming radio waves from the ionosphere with the appearance of scattered signals. Jour. Sci. Industr. Res., (India), 13 B, 881 (1954).

3. Chatterjee B.: Regularities in the F-region of the ionosphere. Nature, 173, 263 (1954).
4. Mitra S. N. and Mazumdar S. C.: Effect of solar activity on ionosphere and earth's magnetic field. Ind. Jour. Phys., 28, 563 (1954).
5. Mitra S. K.: Note on some anomalies in region F_2 and on sporadic E movements. Proc. Mixed Commission on the Ionosphere, Bruxelles (1954), 139.
6. Chatterjee B.: Ionization distribution in the F-region. Ind. Jour. Phys., 28, 53 (1954).
7. Ramanathan K. R. and Kotadia K. M.: The ionospheric F_2 layer over India in minimum sunspot year 1953. Indian Jour. Met. & Geophys., 5, 117 (1954).
8. Rangarajan, S.: The sporadic E layer at Kodaikanal. Jour. Geophys. Res., 59, 239 (1954).
9. Rastogi R. G.: Intermediate layers of ionization between the E and F_1 layers of the ionosphere over Ahmedabad (23° N, 72.6° E). Proc. Ind. Acad. Sci., 40, 158 (1954).
10. Saha M. N.: Determination of electron concentration and collision frequency in the ionospheric layers from polarization pattern of the o and x waves. Proc. Mixed Commission on the Ionosphere (1954), 211.
11. Baral S. S.: Studies in the sunrise effect in the regions E and F. Jour. Atmos. Terres. Phys., 6, 160 (1955).
12. Datta S.: Electrical collision frequency in the F region over Calcutta. Ind. Jour. Phys., 29, 279 (1955).
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14. Mitra S. N.: Self-gyrointeraction. Physics of the ionosphere. Cambridge, 71 (1955).
15. — and Srivastava R. B. L.: Analysis of sky wave field intensity, Part I. Ind. Jour. Phys., 29, 167 (1955).
16. — — Analysis of sky wave field intensity, Part II. Ind. Jour. Phys., 29, 227 (1955).
17. Mitra A. P.: A method of determining the relative amounts of D and E region absorptions of medium and short radio waves. Ind. Jour. Phys., 30, 518 (1955).
18. Ray R. and Varma J. K. D.: Polarization of electromagnetic waves for vertical propagation in ionosphere. Jour. Geophys. Res., 60, 457 (1955).
19. Saha A. K. and Ray S.: Some features of the E_2 layer observed at the Ionospheric Field Station, Calcutta. Jour. Atmos. Terres. Phys., 7, 107 (1955).
20. — — Some features of P'—f records obtained at Haringhata. Science and Culture, 21, 111 (1955).
21. Sheriff R. M.: A study of the total electron contents of the F-region of the ionosphere over Ahmedabad, India. Jour. Atmos. Terres. Phys., 8, 91 (1955).
22. Banerjee S. S. and Surange P. G.: Scattering of radio waves and the horizontal gradient of ionization in the ionosphere. Science and Culture, 21, 750 (1956).
23. Baral S. S.: Ionospheric prediction methods and the probable sources of errors. Ind. Jour. Phys., 30, 169 (1956).
24. Kotadia K. M.: Sporadic echoes from the E region over Ahmedabad. Jour. Atmos. Terres. Phys., 8, 91 (1956).

25. Kotadia K. M.: Ionospheric F_2 layer over Ahmedabad, Delhi and Trichy during minimum sunspot period 1953—54. Jour. Sci. Ind. Res. (India), 15A, 543 (1956).
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27. Rao B. R. and Raman K. V. V.: Simultaneous signal strength measurements on continuous and pulsed radio waves transmission reflected from the ionosphere. Current Science, 25, 284 (1956).
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32. Sarma N. V. G. and Mitra A. P.: Some aspects of the geomagnetic distortion of the F_2 region in the equatorial latitude. Jour. Sci. Industr. Res. (India), 15B, 320 (1956).
33. Sivaramkrishnan M. V.: A comparative study of geomagnetic and ionospheric changes at Kodaikanal and Huancayo. Ind. Jour. Met. & Geophys., 7, 137 (1956).
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III. Ionospheric Drifts and Tides

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7. Kotadia K. M. and Ramanathan K. R.: Variation with lunar phase of midday critical frequencies and heights of the F_2 layer over Ahmedabad and other low latitude stations. Proc. Ind. Acad. Sci., 43, 394 (1956).

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IV. Eclipse Studies

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2. Rastogi R. G. and Sheriff R. M.: A note on radio field strength observations made at Ahmedabad during the total solar eclipse on 30 June, 1954. Jour. Sci. Ind. Res., (India), 14 A (1955).
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V. Lightning, Atmospherics and E_s

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2. — Distribution of thunderstorm days on the landmass of India. Jour. Sci. Industr. Res., 13 A, 314 (1954).
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4. — and Phadke K. R.: Atmospheric noise interference to broadcasting in 3 Mc/s band at Poona. Jour. Atmos. Terres. Phys., 7, 254 (1955).
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VI. Atmospheric Optics and Airglow

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2. — On the intensity and polarization of the light from the sky during twilight, Part II. Proc. Ind. Acad. Sci., 43 A, 336 (1956).
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INDONESIA

National report on the activities in the field of terrestrial magnetism in Indonesia 1954—1957

Our magnetic station is situated on the Isle of Kuyper at about 18 km distance WNW from the capital in the Bay of Djakarta. (Pos. 6° 2′ S, 106° 44′ E).

The following recording instruments are now used:

Balance de Godhavn	No 84
Declinometer de Copenhague	No D 69
Variometer de Copenhague	No H 66

Paper speed: 15 mm/hour.

Timing: breaks every hour; clock compared with time signals from the Meteorological and Geophysical Institute by radio.

Absolute observations are made once a week with the following instruments:

BMZ, QHM } la Cour type
Declinometer of Eliott type
Askania Earth Inductor.

1. During the report period recording has been stopped several times, due to lack of recording paper or unifilar bulbs. Since October 1956 we use pilot bulb instead of unifilar bulb as spare parts are not available.

   In March 1957 unifilar bulbs and recording paper have been ordered from the Danish Meteorological Institute.

   Owing to the use of many kinds of photographic paper the recording is not satisfactory, but it is hoped to be better in a near future when we are in posession of unifilar bulbs and sensitive recording paper.

2. The transfer of Kuyper to a land-station, located at Tangerang (Pos. 6° 12′ S, 106° 43′ E), is still in planning, and it is hoped that the installation will be completed within 2 years. The instrumental equipment consisting of Ruska type variometers and magnetometers are on order.
3. Field observations with the BMZ, QHM and declinometer have been made at several places in Sumatra, Java and Kalimantan. Within this year when more personnel is available this work should be extended to other parts of Indonesia.

IRELAND

Report of Work on Geomagnetism and Aeronomy 1954—1957

(a) *Meteorological Service.*

A set of La Cour variometers with 180 mm recorder was installed at Valentia Observatory in December, 1955, and continuous recording commenced on 1st January, 1956.

A new absolute observations hut has been built. This hut completely encloses the site of the hut previously used and the two instrument pillars used in the old hut have been retained in the new hut in order to preserve unchanged the "set-up" for the absolute instruments used since 1899. In addition six new observing pillars are provided. The new building is provided with double walls and roof for insulation, and thermostatically controlled heaters are fitted to the inner wall to provide a uniform internal temperature. Shuttered windows are provided along the full length of two sides. The new building has been in use since October, 1956.

A new Askania Earth Inductor is being used for observation of Inclination in the new hut, and it is expected to obtain delivery in the near future of a Ruska Observatory Magnetometer (design approved by the U.S. Coast and Geodetic Survey), which will be used for H and D base line determinations.

The ordinary programme of work described in previous reports has been continued.

Publications (by Meteorological Service).

(1) Magnetic Observations at Valentia Observatory 1941/1953.
(2) — 1954.
(3) — 1955.
(4) — 1956 (in preparation).

(b) *Dublin Institute for Advanced Studies, School of Cosmic Physics.*

Publication.

Thomas Murphy: A Vertical Force magnetic survey of the counties Roscommon, Longford, Westmeath and Meath. Geophysical Bulletin No 11.

JAPAN

Japanese National Report on Geomagnetism and Aeronomy

National Committee for Geodesy and Geophysics, Science Council of Japan

Geomagnetism

Magnetic Observatories.

Three standing magnetic observatories, Kakioka (36°14′N, 140°11′E), Aso (32°53′N, 130°01′E) and Memambetsu (43°55′N, 144°12′E), have continued regular observations, while several temporary observatories carried out magnetic observations for their respective special purposes.

Magnetic Surveys.

Magnetic surveys have been regularly made by the Geographical Survey Institute at 20 points specially selected among the 91 magnetic stations of the first order. As a result of the second order magnetic surveys which have been undertaken since 1953, marked magnetic anomalies were found in Hokkaido.

Instruments.

Y. Kato, Z. Abe and A. Sakurai constructed a new visual magnetic variometer which is composed of detectors with ferromagnetic cores, amplifiers and pen-writing recorders. Changes in the earth's magnetic field are detected as amplitude differences of alternating impulses of electric current. The variometer was used at the magnetic observation camp of Ceylon at the time of the solar eclipse on June 20, 1955, as well as in the Antarctic.

Daily Variations.

On analysing world-wide data, H. Maeda obtained the daily variation of the electrical conductivity in the ionosphere. H. Maeda and S. Kato determined the horizontal wind-system from the electric field obtained by H. Maeda. M. Hirono and T. Kitamura solved the dynamo equation with the aid of an integro-differential analyser, where anisotropy of the conductivity was taken into account. These authors extended their results to the studies of drift motion of charges in the ionosphere.

M. Ota obtained a simple expression for the S_q in middle and low latitudes by use of Fourier coefficients. T. Nagata and H. Mizuno defined absolutely quiet days.

Solar Eclipse Effect.

T. Nagata, Y. Nakata, T. Rikitake and I. Yokoyama studied the effect of solar eclipses on geomagnetism. They made clear that the eclipsed area in the ionosphere E region is much larger

than that which had been hitherto supposed. The magnetic effect is likely to be explained by the distortion of the S_q current-system as has been suggested by S. Chapman. M. Ota and S. Hashizume obtained the northern half of the current-system due to the eclipse effect on June 20, 1955 from the Japanese observations, while Y. Kato, J. Ossaka and A. Sakurai made an observation at Ceylon situated on the path of totality on the same occasion.

Magnetic Storms.

Morphological studies of SC* were made by T. Nagata and S. Abe who showed the equivalent current-system of SC*. T. Oguti discussed the progressive change in the average SC* current-system. He and T. Nagata showed that SC* current-systems can not be explained by the ionospheric shielding effect, while T. Nagata and S. Abe supposed that the current-system would be caused by the dynamo-action in the ionosphere wherein an area of high conductivity is existing. S. Matsushita classified SC into three groups, some statistical studies being made by him. More detailed analyses were made independently by T. Oguti who investigated equivalent current-systems for the beginning, intermediate and final stages of SC. T. Yumura showed that the mean ratio of the amplitude of the vertical component to that of the horizontal vector of SC is distributed roughly regularly in respect to the geomagnetic latitude. K. Sinno pointed out that the radio wave propagation disturbances accompanied by 27-day recurring type storms are severer than those accompanied by non-recurrent storms.

T. Nagata obtained an intuitive description of the initial phase. He supposed an equilibrium between the kinetic pressure of the corpuscular stream and the magnetic pressure of the geomagnetic field, the principal results of the Chapman-Ferraro theory being deduced without using troublesome mathematics. S. Akasofu considered that a solar stream would form a hydromagnetic shock front. Across the shock front the magnetic field intensity increases abruptly, causing the SC. The decrease of cosmic ray intensity seems likely to be also explained by this theory.

Micropulsations.

The possibility of occurrence of hydromagnetic oscillations that give rise to geomagnetic micropulsations in the ionosphere has been suggested by Y. Kato, T. Watanabe and T. Tamao. Y. Kato and S. Akasofu also suggested that micropulsations would be caused by a hydromagnetic oscillation of the outer atmosphere surrounding the earth with a radius several times larger than that of the earth. Pulsations accompanied by bay disturbances were studied by G. Grenet, Y. Kato and others. They found that dH/dt curves of pulsations always start with positive values simultaneously at Onagawa (Japan) and Tamanrasset (Algeria).

Y. Kato and others analysed the daily variation of the vectorial behaviour of the disturbing horizontal force. They also supposed that it might be caused by the outer atmospheric magnetic field modified by the ionospheric shielding effect. Some further statistical studies were also made by them. Giant pulsations were studied by Y. Kato and T. Watanabe from the viewpoint of toroidal oscillations of the outer atmosphere.

Main Field and Secular Variation.

Relating to the Elsasser-Bullard dynamo of the earth's magnetic field, T. Rikitake discussed small oscillations in a non-rotating earth's core and pointed out that the toroidal magnetic field would not be so large as has been supposed by Bullard and others, this conclusion being deduced from the stability of small oscillations. Taking into account the earth's rotation, however, he found that the small oscillations become very stable. The above-mentioned conclusion should not therefore be applied to the real earth. He also showed that the dynamo considered by Bullard and others can grow from the state of infinitesimal field. A possibility of reversals of the earth's polarity was also suggested by him on the basis of a hydromagnetic study on finite oscillations. H. Takeuchi and Y. Shimazu developed their dynamo theory in which they showed that the self-exciting dynamo process is possible even if magnetic fields of higher degree were taken into account. H. Takeuchi gave a new interpretation of the eigen values related to the steady dynamo. He also proposed a mechanism of reversals of the earth's magnetic field. H. Takeuchi, Y. Shimazu and T. Namikawa studied some theoretical problems related to hydromagnetic oscillations and convections in rotating fluids. From the study of the electromagnetic torque near the boundary of the core, H. Takeuchi and W. M. Elsasser pointed out that moderate fluctuations of the toroidal field are large enough to produce the observed changes in the rate of the earth's rotation.

Electromagnetic Induction within the Earth.

T. Rikitake and his co-workers have been continuing studies on the anomalous behaviour of short-period geomagnetic variations in Japan. They concluded that the observed phenomena can not be explained by the effect of the electric current induced in the sea. In order to explain the anomalous behaviour in question, we must suppose an anomalous distribution of the electrical conductivity under the central part of Japan. They also studied the anomaly of the S_q in Japan and its relation to the subterranean structure.

Local Anomalous Changes.

I. Yokoyama continued his studies on the relation between the volcanic activity of Mt. Mihara and the changes in the geomag-

netic field there. He showed that heating and cooling in the interior of the volcano can approximately account for the geomagnetic changes. He also developed energetics of active volcanoes on the basis of this study. W. Yoda carried out a survey around Mt. Mayuyama, and compared the results with those of the first survey which had been carried out by him 29 years ago. No marked changes were found.

Rock Magnetism.

Palaeomagnetic studies on Quarternary and Tertiary igneous rocks were made by T. Nagata, E. Asami and others. They found several reversely magnetized rocks in late Tertiary or early Quarternary ages. T. Nagata proposed certain criteria for the stability test of the natural remanent magnetism. Detailed studies on the magnetic interaction between ferromagnetic minerals contained in rocks were carried out chiefly by S. Uyeda in connection with the interpretation of the anomalous behaviour of thermoremanent magnetism. N. Kawai and others made a systematic study on the exsolution of titanomagnetite and its time effect on rock magnetism. Comparative studies on the magnetic properties of ferromagnetic minerals of FeO-Fe_2O_3-TiO_2 ternary system were made by S. Akimoto and others. Through the studies general magnetic characters of ilmenite-hematite solid solution series became clear.

Earth Currents

T. Yoshimatsu studied general and local characteristics of so-called universal earth currents in respect to their principal directions, amplitudes, underground structure and so on. He also analysed the seasonal and secular inequalities of the daily variation at Kakioka. Changes in earth currents associated with sudden commencements of magnetic storms were also examined by him. K. Yanagihara studied the disturbance-daily variation of earth currents at Kakioka for the 11-year period, 1934—1944. He found a marked secondary minimum around 10 h local time, a minimum which has been confirmed at both Tucson and Watheroo. He also made some statistical studies on the annual frequency of the occurrence of earth current pulsations.

Ionosphere and Upper Atmosphere Physics

Observations.

The routine hourly observations of the ionosphere have been continued at Wakkanai (45°24′N, 141°41′E), Akita (39°44′N, 140°08′E), Kokubunji (35°42′N, 139°42′E) and Yamagawa (31°13′N, 130°38′E).

Ionospheric Drift Measurement.

A possible way of measuring ionospheric drift in the E region was suggested by T. Obayashi from the observations of fading pattern of medium broadcasting radio waves.

The measurement of ionospheric drift by means of a radio transmitter and receivers will be carried out at Yamagawa during the International Geophysical Year.

Continuous Ionospheric Observation.

From the continuous records of h' and fc of the ionosphere, the sunrise effect in the ionospheric region, the deflection of the Poynting vector from the vertical and a mechanism of the selective fading were examined by Y. Nakata and H. Uyeda.

Ionospheric Disturbances.

The world patterns of the averaged ionospheric disturbances such as $D_{st}(F2)$, $D_s(F2)$, and $D(F2)$ variations were investigated by T. Obayashi, while K. Sinno examined the phase variation in the case of $S_D(F2)$ with respect to sunspot activities. T. Sato tried to explain ionospheric disturbances by an electromagnetic drift theory.

Geomagnetic Distribution and Dynamo Theory in the Ionosphere.

The geomagnetic distortion in the $F2$ layer was extensively studied by K. Maeda, H. Maeda and M. Hirono in regard to its latitudinal distribution, daily variation and the effect of vertical and horizontal drifts of electrons. Wind systems in the ionosphere were obtained for both the cases of isotropic and anisotropic conductivity.

Physical Processes in the Ionosphere.

T. Yonezawa proposed a new theory concerning the formation of the ionosphere. He showed (1) that the height distribution of electron density is mainly determined by the dissociative recombination process in the lower part af the $F2$ layer and (2) that it is determined by the electronic diffusion in the earth's gravitational field in the upper part of the layer. He also suggested that the maximum density would be produced at an intermediate height on account of both processes.

Atmospheric Electricity

Observatories.

The routine observation of the atmospheric electric potential gradient, space charge and ion numbers has been continued at Kakioka Magnetic Observatory and that of the potential gradient has been continued at Memambetsu Magnetic Observatory.

Experimental and theoretical studies.

M. Kawano discussed the diurnal variation of the atmospheric electric field in large cities and found that the value of eddy

diffusivity amounts to 5×10^3—1×10^5 cm²/sec. Y. Tamura observed and discussed the disturbances of the electric field caused by shower clouds in cold fronts.

N. Kitagawa investigated the junction process in the multiple ground flash and concluded that the process producing these slow field changes develops continuously in the cloud and that several or scores of small rapid discharges of dart leader type overlaps these processes with irregular time intervals.

Atmospherics

A. Kimpara and other members of the Research Institute of Atmospherics, Nagoya University, made many series of direction finding of atmospherics and investigated the distribution of their origins in connection with meteorological disturbances. They also analysed extensively the wave-forms of atmospherics. H. Ishikawa and M. Takagi investigated the fine structure of wave-forms of atmospherics from near thunderstorms in relation to the mechanism of lightning discharges. A. Iwai, K. Ito and T. Kamada developed recording instruments for atmospherics to be used in thunderstorm observations including local lightning flash counters.

The observation of whistling atmospherics has been carried out at Toyokawa by the Research Institute of Atmospherics, Nagoya University, and such an observation will be made also at some other stations during the International Geophysical Year. A theoretical examination of the propagation path of the whistling atmospherics was made by K. Maeda and I. Kimura.

Aurora and Airglow

The height and shifting of the 5577Å line in the night airglow have been studied by use of two sets of scanning photoelectric photometers, one in Hokkaido and the other near Tokyo, since the fall of 1953. Some improvements of the photometer were recently completed. With these photometers observations are being carried out at seven stations.

Cosmic Rays

During the last three years efforts have been devoted to the construction of a standard meson monitor and a standard neutron monitor. Observations of anisotropy of cosmic rays have also been continued with two alt-azimuth telescopes at Nagoya University.

Temperature effect on the hard component was statistically and theoretically studied by K. Maeda, M. Wada and others. H. Komori studied the energy balance of cosmic rays at various latitudes.

The relation between cosmic ray storms, solar phenomena

and magnetic storms was studied by Y. Sekido and others. They concluded that occurrences of magnetic storms associated with cosmic ray storms are closely related to meridian passage of sunspots. The study of diurnal variation associated with magnetic storms has been developed. S. Yoshida found that the anomalous diurnal variation is formed as a result of the superposition of anisotropy which may be caused by magnetic clouds from the sun. Y. Sekido and K. Murakami explained unusual increase in cosmic ray intensity by introducing inner and outer trapping regions.

The telescope observation suggested a point source for cosmic rays, its mean energy approximately amounting to 280 BeV. S. Hayakawa suggested a supernova origin of cosmic rays from the difference between cosmic ray abundance and cosmic abundance of elements. He and K. Kitao also calculated injection energies of cosmic rays.

Obituary Note

Dr. Takematsu Okada, Member of the Japanese National Academy of Science, died on September 2, 1956, at the age of 82. Dr. Okada died at his home in Fusa, Chiba Prefecture, where he had lived since his retirement in 1941 from the post as Director of the Central Meteorological Observatory. He was well known internationally in the field of meteorology. He also had deep interest in geomagnetism and geoelectricity, laying a strong foundation for the observational and research work carried out at the Kakioka Magnetic Observatory. On the occasion of the Second Polar Year, 1932-33, the Toyohara Magnetic Observatory was established in Saghalien under his direction.

LIST OF PUBLICATIONS

(Nov. 1953—Dec. 1956)

Abbreviations

BERI	Bulletin of the Earthquake Research Institute, Tokyo University.
BGSI	Bulletin of the Geographical Survey Institute.
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.
JRRL	Journal of Radio Wave Laboratories.
JSRI	Journal of the Scientific Research Institute.
MMO	Memoirs of the Kakioka Magnetic Observatory. (in Japanese)
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.
SRTU The Science Reports of the Tohoku University, Fifth Series.

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MEXICO

Mexican National Report on Geomagnetism and Aeronomy Program for the IGY

Geomagnetism.

The Institute of Geophysics of the National University of Mexico has a Magnetic Observatory installed in Teoloyucan, Mexico, with the following instruments: a declinometer, a variograph for the horizontal component, a balance for the vertical intensity and a photographic recorder, all of Askania manufacture. This equipment was recently sent to Washington for comparison with the international pattern of Cheltenham. Also a C.I.W. theodolite magnetometer and a C.I.W. earth inductor are being used to determine the base lines. We are planning to possibly substitute this C.I.W. equipment by Ruska instruments.

We shall install an H magnetograph of Askania manufacture in the National Astronomical Observatory of Tonanzintla. This instrument consists of a visible recorder and an alarm to call the attention of the solar activity observers when a magnetic storm takes place.

Position of the Magnetic Observatories:

	Geographic		Magnetic	
	Lat. N	Long. W	Lat. N	Long.
Teoloyucan, Mex.	19°45′	99°11′	29°.6	328°.2
Tonanzintla, Pue.	19°02′	98°18′	29°.0	329°.2

Aurora and airglow.

A recompilation is being made of the data from auroras which occurred in the past, and a net of visual aurora observers is being organized for the IGY. All of the data will be concentrated and studied at the Institute of Geophysics.

With the cooperation of the U.S. National Committee, the study of night airglow will be undertaken with an airglow recording photometer, which will be installed in the National Astronomical Observatory in Tonanzintla.

Ionosphere.

The ionospheric observations will be undertaken by the Dirección General de Telecomunicaciones of the Secretaria de Comu-

nicaciones y Obras Públicas (SCOP), who is installing a station at Cerrillo which will consist of an automatic ionospheric recorder, Model C-4, of Barker and Williamson manufacture, with which vertical ionospheric soundings will be carried on. Also a fixed frequency back-scatter equipment, on loan from the U.S. National Committee, will be installed at the same station.

Position of the station at Cerrillo:

	Geographic		Magnetic	
	Lat. N	Long. W	Lat. N	Long.
El Cerrillo, Mex.	19°19′	99°08′	29°.1	327°.8

Solar activity.

A Lyot-type filter with thermostat and its accessories has been installed in the National Astronomical Observatory in Tonanzintla to be used with a telescope of 12 cm opening and 180 cm focal distance for the solar surface observations. The main purpose will be to study the flares and brilliant filaments of the solar surface.

THE NETHERLANDS

Report on Geomagnetism and Aeronomy for the period 1954-1957

A. *Geomagnetism.*

A number of measurements of H and Z have been made at various places in 1954 in order to check the secular variation in different parts of the Netherlands, and for improving the map of geomagnetic anomalies, as issued in the publication no 134 of the Royal Netherlands Meteorological Institute.[1])

An investigation of geomagnetic and geoelectric variations was made at the geomagnetic observatory Witteveen.[2])

Character-figures from 50-80 geomagnetic observatories were collected for the Permanent Service of Geomagnetic Indices. Data for 1954 and 1955 have been published in the IAGA (IATME) Bulletins.[3])

An Astatic Magnetometer and some auxiliary instruments were developed for measuring magnetic moments as small as 10^{-6} to 10^{-7} e.m.u. Palaeomagnetic investigations in France and in Norway were carried out by means of these instruments in cooperation with the Geological Institute of the State University at Utrecht.

A Proton Precession Magnetometer was constructed for measuring total field-strengths in the air and at sea.

New magnetic observatories were set up at Paramaribo (Surinam) and Hollandia (Netherlands New Guinea).

B. *Aeronomy.*

A panoramic ionospheric recorder for the frequency range 1,4 Mc/sec to 20 Mc/sec with peakpower 10 kW was built at the Meteorological Institute at De Bilt. Half-hourly vertical soundings were regularly made.[4])

Daily absorption measurements were made at De Bilt on 4 different frequencies.[5])

The daily absorption-index A was published in the Netherlands Ionospheric Bulletin.[4])

For carrying out drift measurements during the IGY an instrument was developed which compares the signals received by three receivers set up at distances of 100 m in a triangle.

A theoretical investigation of the equatorial electrojet was carried out; the current system of the diurnal variation was calculated for an oblique dipole axis.[6])

Double and triple magnetic reflections in the ionosphere above De Bilt were compared with the calculated gyro-frequencies. Formulas were derived for the reflection of ordinary and extraordinary rays for vertical incidence in an electron-ion ionosphere, with allowance for collisions of electrons and ions.[7])

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NEW ZEALAND

Christchurch Geophysical Observatory
Report for 1954-57
by J. W. Beagley

Intensive planning and instrumental development for the 1957-58 International Geophysical Year have occupied the time and energy of the staff of the Christchurch Geophysical Observatory during the years covered by this report. At the same time Ionosphere service activities have been maintained and further contributions made to upper atmospheric research. Vertical sounding ionosphere stations at Godley Head, Rarotonga and Campbell Island have operated and data for prediction purposes have been sent out monthly. During the IGY two further stations will be involved in this programme, Scott Base and Cape Adare (the joint United States of America and New Zealand station) both in Antarctica.

The cosmic ray programme at Christchurch has been maintained over the whole period, the most notable event recorded being a spectacular increase of 19 % in intensity of hard component radiation between 3h.46m. and 4h.00m. G.M.T., February 23rd, 1956. During the IGY meson telescopes will be set up at Christchurch and Invercargill.

Instrumental development.

The prototype New Zealand built panoramic ionosonde engineered at Dominon Physical Laboratory became the standard recording equipment at Godley Head in July, 1956 after a brief testing period. Further modifications will be made to the circuitry of this instrument, but it can be considered to have made a satis-- factory start as an observatory continuously recording instument. A second panoramic recorder engineered by Canterbury College Industrial Development Laboratory assisted by Observatory physicists showed some improvement in circuitry on the prototype and has been shipped for service at Scott Base. Rarotonga station will be the location of a third panoramic due for testing in early 1957.

Since March, 1955 a J. 28 automatic ionosonde, range 1-13 mc/s has operated at Rarotonga. It has been supplemented by a manual recorder, range 1.5-20 mc/s during daylight hours as its frequency coverage became inadequate with the increase in sunspot number.

The J. 28 instrument formerly at Godley Head has been redesigned and rebuilt in the Observatory workshop for service at Campbell Island during the International Geophysical Year, replacing a manual ionosonde as the standard recording equipment there.

Cosmic radiation.

The Blackett M.U. 2. Intensity Recorder is being adapted for use as a standard meson telescope at Christchurch and a second meson telescope is being built for installation at Invercargill on the other side of the "energy cut-off" latitude from Christchurch. All new equipment will be operating at the required location at the beginning of the International Geophysical Year.

Research projects.

Projects on electron distribution in the Ionosphere have been effectively extended. A method for computing true ionospheric heights from virtual height graphs, including the effect of the earth's magnetic field, was developed and has been used to investigate the structure of the F2 layer and also for the study of the Ionosphere under calm and stormy conditions. F2 characteristics at the magnetically conjugate stations of Maui and Rarotonga have also been examined.

Geomagnetic sudden commencements have been investigated further and their value as precursors of ionospheric storms assessed. A simplified model of the Earth-Ionosphere system was constructed to find a satisfactory theoretical explanation of an observed diurnal variation in amplitudes of sudden commencements. This investigation brings fresh evidence concerning the location of current systems in the upper atmosphere. A detailed analysis of night-time storm characteristics at Lincoln and Godley Head has also been made for the years 1947-50 inclusive.

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1. Solar, Magnetic and Ionospheric Data (Storm Data). April 1954—October 1955.
2. Ionospheric Data (Hourly Value Tabulations). 1955, 1956.

PAKISTAN

Geomagnetism

National Report for the period 1954-57

A magnetic observatory was in continuous operation at Quetta throughout this period. The observatory is situated on the slope of a hill about six miles west of the city. The altitude of the observatory is 5700 ft a.s.l.

Continuous photographic registration of the variations in the three magnetic elements (declination, horizontal intensity and vertical intensity) is being made with one set of Ruska normal magnetograph (speed 20 mm/h) and one set of La Cour quick-run magnetograph (drum speed 180 mm/h).

For base-value control absolute observations are made once a week using a set of 3 QHMs, 2 BMZs and an Askania earth inductor. Observations are taken on quiet days for which a single component Askania photoelectric recorder remains in continuous operation.

Details about the location of the observatory building, the instrumental equipment and its installation can be found in the first annual report of the observatory, issued in 1955.

Instrumental Modifications and Improved Techniques:

— Ruska magnetograph:

Slight modifications have been made in the initial installation of the declination variometer. Since the declination variations (both diurnal as well as quick magnetic variations) at our latitude are very small, the sensitivity of this variometer was doubled by placing it at a distance of 350 cm from the recorder instead of the prescribed distance of 175 cm. This change has the added advantage of removing the D-variometer away from the magnetic influence of the two force variometers and their sensitivity magnets.

With the present arrangement the Ruska magnetograph has the following scale values and recording ranges:

	Scale value.	*Recording range.*
D	0.51′/mm	−50′ to +50′
	(4.9 γ/mm)	(−500 γ to +500 γ approx.)
H	3.0 γ/mm	−1000 γ to +800 γ
Z	3.7 γ/mm	−1200 γ to +1200 γ

— La Cour quick-run magnetograph:

Since the quick-run magnetograph is primarily intended for the study of micropulsations which are not conspicuous enough on normal-run magnetograms, the sensitivities have been increased high enough to give details of the micropulsations. The increase is effected by fixing magnets in an appropriate way to

the different variometers, thus reducing considerably the normal field around them and thereby increasing the period of oscillation of the recording magnets. This modification has produced the desired effect, the three traces on the magnetograms now showing measurable micropulsations at the same time.

With the modified arrangement, the scale values and range of recording of the different variometers are as follows:

	Scale value.	*Recording range.*
D	1.0′/mm	−200′ to +200′
	(9.9 γ/mm)	(−2000 γ to +2000 γ approx.)
H	1.2 γ/mm	−150 γ to +150 γ
Z	3.5 γ/mm	−500 γ to +500 γ

One disadvantage of such a modification will be that under the influence of so many magnets the D-variometer may begin to behave as a force variometer. Because of the complete elimination, in the variometer house, of the effects of the diurnal variation of the outside temperature, this disadvantage will not seriously affect the accuracy of the recording.

— *G.S.I. Japanese magnetometer:*

A new electromagnetic magnetometer manufactured by the Geographical Survey Institute of Japan in 1950 is in operation on trial at the observatory.

From the results so far obtained, the following accuracy of measurements has been derived.

H and Z: $\pm$ 3 γ

Declination and Dip: $\pm$ 0.6′

This accuracy, though not ideal when compared with the generally recognized magnetic standards, is good enough for base-value control and field surveys. The instrument will, however, remain under investigation for some time more before being used as a secondary standard.

Bulletins and Publications:

Routine monthly bulletins containing character figures, 3-hourly K-Indices, special magnetic phenomena and monthly means are being issued from the observatory since November 1954. These are being distributed to observatories and interested institutions all over the world.

An annual summary of geomagnetic observations made at Quetta in 1953—54 has also been compiled and printed in a booklet form. This will be a regular feature of the observatory publication. A subsequent issue for 1955 is under preparation.

Magnetic Field Surveys:

Soon after the establishment of the magnetic observatory at

Quetta, an attempt was made to reoccupy all the old stations of the surveys of India and establish some new stations with a view to the preparation of iso-magnetic charts of Pakistan. During 1953—54 K. A. Wienert, the UNESCO Adviser, in co-operation with the staff of the Survey of Pakistan occupied a number of old stations in the southern part of West Pakistan, using QHMs and BMZs. In all complete observations were made at 23 places including seven places for which old observations from the survey of India are available. The results obtained at these latter stations give a fairly good idea of the secular variation in the southern part of West Pakistan. Values of the annual change of the three magnetic elements at the seven stations are quoted in the below table:

Station	Lat.	Long.	Declination		Horizontal intensity		Vertical intensity	
			1909 -20	1920 -54	1909 -20	1920 -54	1909 -20	1920 -54
					γ	γ	γ	γ
Quetta	30°11′N	66°57′E	-0′.6	-2′.4	-39	+30	+112	+62
Sibi	29°33′N	67°52′E	-1′.0	-2′.4	-36	+30	+113	+65
Belpat	29°00′N	68°01′E	-1′.2	-2′.4	-31	+38	+114	+57
Ruk	27°49′N	68°39′E	-1′.5	-2′.2	-29	+38	+113	+56
Mirpur Khas	25°32′N	69°01′E	-1′.9	-2′.2	-22	+40	+111	+49
Hyderabad (Sind)	25°23′N	68°22′E	-1′.8	-2′.2	-23	+41	+118	+48
Karachi	24°51′N	67°02′E	-1′.4	-2′.2	-21	+42	+114	+50

Secular variation graphs for Quetta for the period 1940—1954 are available in our Annual Summary (1953—54).

Prospecting Surveys:

During the period 1951—53, a few magnetic surveys for mineral deposits were conducted by K. A. Wienert and S. A. Tahir, using Askania Field Magnetometer. The hematite deposit of Abbottabad, the magnetite deposit of Kiara and the chromite deposit of Hindubagh areas in West Pakistan were investigated.

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2. Time relationship of small magnetic disturbances in Arctic and Antarctic by S. J. Ahmed and W. E. Scott. J. G. R. Vol. 60, No. 2, June 1955.
3. Magnetic observations during the sun eclipse of 30th June 1954 at the magnetic observatory of Quetta by S. A. A. Kazmi and K. A. Wienert. J. G. R. Vol. 60, No. 1, March 1955.

4. Prospecting for iron-ore deposits in Pakistan by S. A. Tahir. Proceedings Vth Pakistan Science Conference, Lahore, 1953.
5. Accuracy limit of Quetta magnetic observatory measurements by S. A. A. Kazmi. Proceeding VIth Pakistan Science Conference, Karachi, 1954 (Observatory Record).
6. Limitations of QHM-measurements for intercomparison between observatories by S. A. A. Kazmi. Proceedings VIIIth Pakistan Science Conference, Dacca, 1956 (Observatory Record).
7. Role of applied geomagnetism in the exploration of mineral and oil resources of the country by S. A. A. Kazmi. Symposia IXth Pakistan Science Conference, Peshawar, 1957 (Observatory Record).
8. Report of magnetic survey in Dhak and Kappar area by S. M. Rahim. (Observatory Record).

In conclusion it will be pertinent to say a few words about the plans of the Pakistan Meteorological Service for the future geomagnetic programme.

In response to Resolution 6 of the CSAGI, appearing under para 2 of the revised CSAGI geomagnetic programme, vide their No.Co.-57(7)/5794, dated 24th April, 1956, inviting the "Government of Pakistan to consider the possibility of establishing a magnetic station in Eastern Pakistan, at least for the period of the AGI 1957—58, in order to complete the net of the stations already existing in this part of the world" efforts are in progress to set up a geomagnetic observatory in a rented building at Chittagong before 1st of July 1957.

The Pakistan Meteorological Service is planning to set up a geomagnetic observatory in the northern region of West Pakistan at or near Gilgit. (Lat. 35°55′N, Long. 74°18′E). Advantage will be taken of the higher altitude and higher latitude to obtain data also on auroral displays.

Arrangements have been completed for full participation in the geomagnetic investigations during the I.G.Y. The following programme of observations has been adopted:

i) Recording of variations of geomagnetic elements (normal speed).
ii) Recording of absolute values of geomagnetic elements.
iii) Quick run recording for the study of micropulsations.

PERU

National Report

General.

During the period 1954—1957 most of the geophysical experimental research in Peru was carried out, as heretofore, by the Instituto Geofísico de Huancayo. The routine program was considerably increased specially during the past few months, in connection with the International Geophysical Year activities. Be-

sides the work at Huancayo, the Instituto expanded its activities to several other localities within Peru.

Geomagnetism.

Photographic registration of the three magnetic elements was continued at Huancayo using the Eschenhagen variometers for D and H and La Cour vertical force variometer for Z. Absolute observations of declination, inclination and horizontal force were made each week using DTMCIW magnetometer No. 10 and earth inductor No. 5.

Investigations of the corrections to International Magnetic Standard were made and final hourly values were computed from 1948 onwards. The reduction of these data is about to be completed and is being prepared for publication in a very near future. K-indices of magnetic activity for every three hour interval were derived currently and distributed to various international agencies.

The rapid run La Cour variograph was inoperative during the period but remains installed at Huancayo.

Another rapid run H-variograph, recording on 70-mm film, is in process of installation; the project being sponsored by the Geophysics Research Directorate.

With the cooperation of various Peruvian entities and with the help given by the Interamerican Geodetic Survey — loan of field instruments and funds to cover transportation costs — the Instituto carried out a magnetic survey of Peru and published the Iso-magnetic chart of Peru, Epoch 1955.0. The total number of stations occupied was 57, many of these secular variation stations which have been occupied during several years, and many other new stations in formerly inaccesible sites in the Amazon jungle.

A visible recording H-magnetograph was installed at Huancayo to provide current information on magnetic activity, in connection with ionospheric soundings.

A project sponsored by the United States National IGY Committee, through the Carnegie Institution of Washington, was initiated during the beginning af 1957 and involved a survey of the diurnal variation of the three magnetic elements, D. H and Z, utilizing Askania recording variographs. Stations were occupied from a point north of Antofagasta, Chile, to a point near Quito, Ecuador, practically repeating the survey originally made by the Instituto in 1951—1953, with QHM's. The results of this survey were used to determine the most appropriate site for the installation of semi-permanent observatories that will study the characteristics of the equatorial electrojet.

From the above the Instituto has already in operation two new Askania equipped magnetic observatories at Talara and Chi-

clayo. At this moment the third and fourth observatory, at Yauca and Chimbote respectively, are in process of installation.

Ionosphere.

Ionospheric vertical incidence soundings were carried out on a routine basis at Huancayo and at Talara, under a cooperative agreement with the National Bureau of Standards. Both stations are equipped with a C-3 recorder with quarterly hour sweeps 1—25 mc/s taking 15 seconds. Hourly values of ionospheric characteristics from both stations have been published currently.

In connection with the International Geophysical Year two new stations began routine operations during the month of July, 1957. The Huancayo C-3 was installed at Chiclayo, and C-4's were installed at Chimbote and at Huancayo. These four stations constitute a close chain for a fine-grain study of the ionosphere in the equatorial zone.

The Instituto has also assumed the responsibility of supervising on behalf of the National Bureau of Standards, as a regional sub-center, the operation of new ionospheric stations at Bogotá, La Paz, Concepción and Natal. Personnel from these localities were trained at Huancayo and the installation, operation and data analysis of the new stations will be a concern of the Instituto.

Field intensity recorders are operating at all four ionospheric stations. Study of absorption under oblique incidence conditions will be initiated. Furthermore these recorders give immediate SID information.

The University of Stanford has provided equipment for a back-scatter experiment at Huancayo. The equipment has been installed and is operating since July 1957. Continuous recordings are made with a rotating antenna on 12, 18 and 30 mc/s.

In connection with the VHF forward-scatter experiment in the equatorial region, sponsored by the National Bureau of Standards as part of the IGY program, Huancayo is a mid-point for the experiment which involves a total of seven stations, three of which are in Peru. A transmitter will be installed at Arequipa, a receiver at Trujillo and a receiver and small transmitter at Huancayo.

At the request of the USNC-IGY the Instituto has installed, and will operate at Huancayo a whistler recorder, although it is not expected that whistlers will be heard there; should any be heard it will be necessary to change the present interpretation of this phenomenon.

Cosmic Radiation.

The operation of the Carnegie Institution Compton-Bennett Cosmic Ray meter was continued and data dispatched regularly

to CIW. Publication of the Huancayo results will be made very soon, by the Carnegie Institution.

A large neutron monitor station, sponsored by the Enrico Fermi Institute for nuclear studies, University of Chicago, replaced a smaller similar station early in 1956. Continuous operation of this new station has been accomplished and the data have been forwarded regularly to Chicago.

Aurora and Airglow.

Night airglow measurements will be made at Huancayo as part of the North-south chain of stations sponsored by the USNC-IGY. A special laboratory has been constructed at Huancayo on the top of a conveniently located hill, and the equipment which will measure three frequencies has been installed, but is not yet operating satisfactorily.

In addition the Instituto has also installed another photometer, sponsored by the Geophysics Research Directorate, and investigations will be made to study the relationship between night airglow, magnetic and ionospheric phenomena — including the back-scatter data.

Solar Activity.

Continued observations of solar flares and prominences were made at Huancayo with the spectrohelioscope, in the H-Alfa line.

At the beginning of 1957, a small experimental coronograph was installed at Huancayo under a cooperative agreement with the University of Kyoto, Japan. For the first time, excluding eclipses, the solar corona was observed from the southern hemisphere. These observations and the spectrohelioscope work are now part of the regular observatory program.

Atmospheric Electricity.

Measurements of the atmospheric electric potential gradient and electric conductivity, which were discontinued at Huancayo in 1947, will be reinitiated during the last quarter of 1957 under a cooperative agreement with Professor H. Israel.

Laboratory Facilities.

Facilities at Huancayo have improved with the construction of more laboratory areas. Through the cooperation of the National Bureau of Standards the power plant has tripled its capacity. Communications have improved. Guest rooms are available where visiting scientists are always welcome.

During the period under review the President of the Comité Geofísico Peruano continued to be Dr. Jorge A. Broggi, and the Technical Director of the Instituto Geofísico de Huancayo is Albert A. Giesecke, Jr.

POLAND

Rapport sur l'activité scientifique en magnétisme terrestre et électricité atmosphérique pendant la période 1954—1957

par Prof. T. Olczak

Introduction

Au cours de la période 1954—1957 les recherches dans le domaine du magnétisme terrestre et de l'électricité atmosphérique en Pologne ont considérablement avancé. Entre autres circonstances favorables cela a été dû à la création par l'Académie Polonaise des Sciences, de l'Institut de Géophysique à Varsovie auquel ont été rattachés tous les observatoires et stations géophysiques du pays. L'Institut de Géophysique a commencé son activité le 1er Juin 1953 sous la direction du Prof. T. Olczak et du Prof. E. Stenz comme directeur adjoint. Après la mort de ce dernier en 1956, les fonctions de directeur adjoint ont été confiées à M. Wieladek.

Un progrès considérable dans le domaine des recherches sur le champ magnétique terrestre en Pologne a été réalisé également par l'Institut Géologique National. Cet Institut, dans sa Section de Géophysique Appliquée, non seulement effectue des travaux géophysiques de prospection, mais encore surveille et coordonne tous les travaux de prospection effectués sur le territoire du pays par différentes compagnies et entreprises géophysiques.

Les mesures de la déclinaison magnétique sont effectuées en Pologne par l'Institut de Géodésie et de Cartographie.

1. *Observatoires magnétiques.*

a. L'Observatoire de Swider ($\varphi = 52°06',9$, $\lambda = 21°15',2$, $\Phi = 50°,6$, $\Lambda = 104°,6$) a fonctionné sans interruption de même que les années précédentes. Cet Observatoire dispose d'un enregistreur à marche normale, 20 mm/h, et d'un jeu de variomètres du type Eschenhagen-Schmidt de la maison O. Toepfer und Sohn. Les valeurs d'échelle sont pour D : 3,7 γ/mm, pour H : 3,7 γ/mm et pour Z : 4,3 γ/mm. En 1957 dans le cadre des préparatifs pour l'Année Géophysique Internationale, un deuxième jeu complet de variographes avec enregistreur à marche rapide a été mis en service dans le pavillon d'enregistrement. Le bureau de l'Observatoire a été agrandi de plus de deux fois comparativement à la période précédente. Il est installé dans un bâtiment nouvellement obtenu, à proximité des pavillons magnétiques. En 1956, les résultats d'enregistrement de 1953 et 1954 ont été élaborés et seront bientôt publiés. L'Observatoire est dirigé par Mlle Z. Kalinowska.

b. L'Observatoire de la presqu'île de Hel ($\varphi = 54°36',5$, $\lambda = 18°49',0$, $\Phi = 53°,4$, $\Lambda = 103°,7$), détruit pendant la guerre, est maintenant reconstruit. En 1953, un nouveau pavillon d'enregistrement a été construit par les soins de l'Institut National d'Hy-

drologie et de Météorologie. Il a été ensuite transmis, avec le terrain de l'Observatoire et les maisons d'habitation, à l'Académie Polonaise des Sciences. L'Institut de Géophysique a terminé l'organisation de l'Observatoire en mettant en service régulier dans le pavillon d'enregistrement un magnétographe à marche rapide La Cour : vitesse 180 mm/h, valeurs d'échelle pour D : 6,1 γ/mm, pour H : 4,9 γ/mm, et pour Z : 7,0 γ/mm. Dernièrement, dans le cadre des préparatifs pour l'Année Géophysique Internationale, deux autres pavillons pour les mesures absolues ont été construits ainsi qu'un deuxième dispositif d'enregistrement à vitesse normale 20 mm/h. La mise en service de l'Observatoire de Hel était dirigée par M. Przybyszewski de la Section de magnétisme terrestre de l'Institut de Géophysique. Il a effectué au moyen de magnétomètres QHM et BMZ la comparaison des lignes de base dans les deux Observatoires de Swider et de Hel. Les résultats de ce travail sont publiés dans Acta Geoph. Polon., Vol. 5, 1957. L'Observatoire de Hel est dirigé par Mme Z. Czyszek.

2. *Etudes sur les variations séculaires.*

L'Institut de Géophysique en collaboration avec M. Krzemiński de l'Institut de Géodésie et de Cartographie, a organisé un réseau de 23 stations de répétition sur le territoire de la Pologne. Toutes ces stations sont éloignées des perturbations locales et bien repérées. Dans la plupart d'entre elles, les répétitions de mesures ont été faites fréquemment à partir de la fin du siècle dernièr ou depuis le début de ce siècle. Des séries plus longues de mesures magnétiques existent également dans quelques observatoires géophysiques polonais (Swider, Hel, Racibórz), et dans les observatoires astronomiques (Cracovie, Poznań, Wroclaw).

Les variations séculaires de la déclinaison magnétique, observées à Gdańsk depuis la première moitié du XVIème siècle jusqu'à nos jours, où elles sont contrôlées dans l'Observatoire de Hel, peu éloigné de Gdańsk, ont été l'objet d'une étude détaillée, publiée par T. Olczak dans Acta Geophys. Polon., Vol. 3, 1955. Les variations séculaires de D, I, H, Z, dans la période 1921—1950 à Swider, ont été publiées par Mlle Z. Kalinowska dans Acta Geophys. Polon., Vol. 1, 1953. Selon cet auteur, les valeurs annuelles moyennes de D. H. Z, à Swider, dans la période 1951—1955, étaient les suivantes :

Année	D	H (γ)	Z (γ)
1951	0°37′,3	(18222)	(44696)
1952	43′,5	(229)	(706)
1953	48′,8	238	752
1954	54′,0	249	781
1955	59′,7	254	825

Les données entre parenthèses sont provisoires et peuvent subir de légers changements.

Les valeurs approximatives des variations de la composante horizontale H sur tout le territoire de la Pologne dans la période 1928 — 1949 ont été publiées par S. Pawlowski dans le Bulletin de l'Institut Géologique, intitulé : « Kilka zagadnień geofizycznych w Polsce » (Quelques problèmes géophysiques en Pologne).

Les valeurs approximatives des variations annuelles des éléments du champ magnétique sur tout le territoire de la Pologne dans la période 1901 — 1935, avec les cartes des isopores D, I, H, Z, ont été publiées par T. Olczak dans Acta Geophys. Polon., Vol. 3, 1955.

Sur l'initiative du Prof. S. Pawlowski et de M. Skorupa, l'Institut Géologique National a établi, sur le territoire de la Pologne, un réseau de points de repère pour la composante verticale Z (partiellement aussi pour la composante horizontale H) qui constitue la base du levé détaillé de cette composante sur le territoire du pays. Ce réseau compte quelques centaines de points. Les mesures dans les points de ce réseau sont effectuées à intervalles de quelques années. La publication de ce travail est en préparation.

3. *Cartographie magnétique.*

Une carte détaillée des anomalies de la composante verticale Z sur le territoire de la Pologne, a été mise au point à l'Institut Géologique National sous la rédaction de M. Dabrowski. Cette carte est basée sur les nombreux levés magnétiques régionaux effectués au cours des vingt dernières années au moyen de balances magnétiques Z du type Schmidt par plusieurs auteurs : S. Daszyński, S. Pawlowski, H. Orkisz, J. Skorupa, A. Dabrowski, S. Maloszewski, et d'autres. La densité de ces mesures était pour le moins de l'ordre de 120 — 300 points pour 1000 km², et beaucoup plus dans les régions intéressantes du point de vue géologique. Comme il a été mentionné plus haut, le réseau de base pour ces mesures est l'objet d'un contrôle systématique afin de prendre en considération les variations séculaires du champ terrestre.

L'élaboration dans l'Institut de Géodésie et de Cartographie d'une carte de la déclinaison magnétique pour le territoire de la Pologne, rapportée à 1955.0, est une autre réalisation non moins importante. Ce travail projeté il y a quelques années par une commission de spécialistes de différents instituts scientifiques et effectué avec la participation partielle de ces instituts, a été terminé en 1956 sous rédaction de M. Krzemiński.

4. *Electricité atmosphérique.*

Les travaux sur la théorie de la formation et du développement de la foudre et les travaux expérimentaux correspondants ont été continués par le Prof. S. Szpor de l'Ecole Polytechnique de Gdańsk. L'enregistrement du gradient de potentiel du champ

électrique terrestre a été continué à l'Observatoire de Swider au moyen d'électrographes de Benndorf. M. Michnowski a construit et installé à l'Observatoire de Swider un appareil pour mesurer la densité de la charge spatiale totale. A la session scientifique du 20.11.1956, organisée à l'Académie Polonaise des Sciences par le Prof. J. L. Jakubowski et le Prof. T. Olczak, à l'occasion du 250ème anniversaire de la naissance de Benjamin Franklin, de nombreux auteurs ont rapporté les résultats de leurs derniers travaux dans le domaine de l'électricité atmosphérique.

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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 1954-57, as submitted by Serviço Meteorológico Nacional, Instituto Geofísico da Universidade do Porto and Instituto Geofísico da Universidade de Coimbra.

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. Geomagnetic equipment of La Cour type was installed in 1954. The values of geomagnetic elements observed are published in the "Boletim Geomagnético Preliminar" since 1951 and in non-periodic publications of this Service (MEM 65, 71, 73, 74, 75, 76, 85 and 86).

Geomagnetic surveys. The geomagnetic surveys of the Portuguese Territory in the Iberian Peninsula (Continental Europe) is presently concluded. We are preparing the values and charts for publication.

The geomagnetic surveys of the Portuguese Territories in India, Portuguese Timor (Australasia) and Macao (China) are planned to start in Oct. 1957. The observations are to be made with Askania theodolites, La Cour magnetometers and portable magnetograph Askania.

The geomagnetic survey of Sal Island (Cape Verde) was carried out in 1956.

Before starting the geomagnetic survey of Angola and Mozambique two geomagnetic observatories are being installed.

Due to subsequent petroleum exploration near Luanda, the geomagnetic observatory of Angola is not in continuous operation.

Atmospheric electricity and earth-currents. In the year 1955 a geoelectric station was installed near Lisbon. The values of the geoelectric elements observed are published since March 1955 in "Boletim Geoeléctrico".

Ionosphere. During June 1957 we intend to start ionospheric observations in Lisbon with an ionospheric recorder Cossor.

Cosmic radiation. During June 1957 we intend to start the measurement of cosmic radiation in Lisbon. A meson-telescope is to be installed.

Auroral observations. During the period 1955-1957 visual obser-

vations have been made at the climatological stations in connection with meteorological observations.

Other geophysical work. During the period 1954-1957, the geophysical activities in the meteorological observatory of Macao were held up by difficulties with instruments. New instruments for ionospheric research, radio noise observations and measurement of cosmic radiation are being acquired and installed.

2. *Instituto Geofísico da Universidade do Porto.*

Director: Prof. M. Marques Teixeira.

Activity of the geoelectric section in the period 1954-1957. The routine observations of potential gradient have been continued, with occasional observations of atmospheric electric conductivity and ionisation. The results are published in "Observações do Campo Eléctrico da Atmosfera" since 1953.

3. *Instituto Geofísico da Universidade de Coimbra.*

Director: Prof. J. Custódio de Morais.

Activity of the geomagnetic section in the period 1954-57. The routine observations of geomagnetic elements have been continued. For determination of declination a new Askania declinometer was acquired. The results are published in "Observações Meteorológicas, Magnéticas e Sismológicas — 2a parte, Magnetismo terrestre".

SPAIN

Commission Nationale de Géodésie et de Géophysique
Section de Géomagnétisme et d'Aéronomie
Rapport National
par
José Rodriguez-Navarro de Fuentes

En exécution des accords de la Section, le soussigné, Secrétaire de la dite Section, a l'honneur d'exposer les activités se rapportant au Géomagnétisme et à l'Aéronomie, déployées en Espagne de 1954 à 1957 par les différents Centres Scientifiques qui s'occupent de ces études et de leurs applications.

1. — *Institut Géographique et Cadastral*

Les Observatoires Géophysiques et les Brigades de Campagne dépendent du Service de Magnétisme et d'Electricité Terrestres

qui, à son tour, est intégré dans la Section de Géodésie, de Géophysique et de Métrologie de cet Institut.

1.11. — *Observatoire Central Géophysique de Tolède*

Comme nous l'avons déjà signalé dans des rapports antérieurs, cet Observatoire est situé à environ quatre kilomètres au NW. de Tolède et les coordonnées géographiques de son pilier principal sont les suivantes :

Latitude ..... 39°52′58″ N.
Longitude ..... 4°02′48″ W. Gr.
Altitude ..... 501 mètres.

Dans les rapports antérieurs, et notamment dans celui qui a été présenté à la IXe Assemblée de l'U.G.G.I., qui a eu lieu à Bruxelles en 1951, on a fait la description générale de cet Observatoire dans lequel existent les installations de Géomagnétisme, de Géoélectricité, de Sismologie et de Météorologie. Nous allons nous occuper brièvement de l'activité des deux premières installations pendant ces trois dernières années.

1.111. — *Géomagnétisme*

Les équipements de mesures absolues ont continué à fonctionner comme pendant les années précédentes. Ils sont les suivants :

Théodolite magnétique normal Schmidt (No. 81196 d'Askania-Werke).
Boîte d'oscillations à utiliser avec le théodolite.
Inducteur terrestre magistral (No. 70660 d'Askania-Werke).
Galvanomètre Edelmann, à aimant mobile et à haute sensibilité, à utiliser avec l'inducteur.
B.M.Z. No. 78 et Q.H.M. No. 218.

Avec ces instruments on a fait les déterminations suivantes :

Mesures de D : 107 (avec théodolite).
Mesures de H : 141 (avec théodolite et Q.H.M.).
Mesures de I : 46 (avec inducteur).
Mesures de Z : 112 (avec B.M.Z.).

Des équipements magnétiques de campagne, employés pour la Carte Magnétique Nationale, ont été vérifiés à plusieurs reprises.

On a continué à faire fonctionner d'une manière continue les variomètres Askania et Töpfer, dont les caractéristiques sont les suivantes :

Equipement Askania composé des variomètres de D, H et Z, avec un enregistreur de 20 mm/heure. Sensibilité normale (7,9; 5,4; 3,5 γ/mm).

Equipement Töpfer, composé des variomètres de D, H et Z, avec un enregistreur de 30 mm/heure. Grande sensibilité (2,8; 2,8; 2,8 γ/mm).

L'installation de variomètres a été complétée d'un équipement de haute sensibilité et de grande vitesse (quick-run), à savoir l'équipement La Cour 180, composé des variomètres de D, H et Z, et d'un enregistreur de 180 mm/heure. Sensibilité supranormale (1,0; 1,3; 1,2 γ/mm). Il enregistre provisoirement à partir du mois d'Août 1956.

Cet Observatoire a, par conséquent, un jeu complet de variomètres avec lequel il peut bien travailler, tant en époque normale que pendant la prochaine A. G. I. Pendant cette période, il sera peut-être convenable de diminuer la sensibilité des variomètres Askania pour que le magnétographe puisse servir de variographe d'orages magnétiques.

La position correcte des aiguilles des variomètres a été ajustée, en vérifiant postérieurement la position obtenue.

L'équipement La Cour 180 a été installé, en faisant les montages nécessaires pour obtenir la sensibilité requise et pour l'accouplement d'amortisseurs en cuivre.

Publications

L'Ingénieur Géographe M. Juan Sancho San Román, chargé du Géomagnétisme à l'Observatoire, a fait les travaux suivants :

Géomagnétisme 1950. — Valeurs horaires moyennes, maximum et minimum journaliers, moyennes journalières et mensuelles, variations diurnes, index et phénomènes d'activité, graphiques d'orages.

Géomagnétisme 1951. — Analogue à celui de 1950, complété de quelques données supplémentaires.

Géomagnétisme 1952. — Idem.

Géomagnétisme 1953. — Idem.

Géomagnétisme 1954. — Idem.

Géomagnétisme 1955. — Idem.

Comparaison entre les variations moyennes diurnes et annuelles du champ magnétique terrestre, enregistrées dans les divers Observatoires ibériques.

1.112. — *Géoélectricité*

Courants telluriques. — Cette installation, décrite aussi dans des rapports antérieurs, n'a pas subi de variations essentielles.

On a continué le double enregistrement avec deux installations indépendantes.

1ère installation : Ligne aérienne.

Distance entre les électrodes: N.-S. = 1.884 m.
E.-W. = 1.792 m.

Enregistrement lent, 20 mm/heure.
Enregistrement rapide, 160 mm/heure.

2ème installation : Ligne souterraine.
Distance entre les électrodes : N.-S. = 1.570 m.
E.-W. = 1.520 m.
Enregistrement lent, 20 mm/heure.

Calculs réalisés: Valeurs moyennes horaires; valeurs moyennes mensuelles, trimestrielles et annuelles de la variation journalière.
Indices trihoraires.
Sauts brusques et perturbations.

Ionisation. — Cette installation dont la description a été déjà faite dans le Rapport National présenté à la Xe Assemblée de l'Union à Rome, Septembre 1954, a commencé à fonctionner cette année-là avec l'enregistreur automatique qui fournit les données provenant des appareils Ebert et Gerdien.
L'enregistrement continu a donné les valeurs horaires des éléments suivants:
Densité des ions positifs et négatifs par le procédé Ebert.
Conductivité positive et négative avec condensateur Gerdien.
Mobilité positive et négative des ions, déduite des valeurs précédentes.
On a calculé les valeurs moyennes journalières et les valeurs moyennes mensuelles de la variation journalière de chacun des éléments.

Potentiel atmosphérique. — Cette installation fonctionne depuis 1955.
Le potentiel atmosphérique en volts par mètre a été déterminé par un enregistrement continu.
Appareil employé : Sonde radioactive de polonium et électromètre enregistreur de quadrant de Benndorf.
Calcul des valeurs moyennes journalières, valeurs maximum et minimum, caractères d'activité et valeur moyenne mensuelle de la variation journalière.

Parasites atmosphériques. — L'installation, qui a été déjà décrite dans le Rapport National présenté à Rome, a continué à fonctionner avec le même enregistreur de grande vitesse, c'est-à-dire, 120 millimètres par minute. L'enregistreur ne fonctionne que pendant dix minutes chaque heure, d'où l'on déduit la valeur moyenne dans chaque intervalle horaire.

Ionosphère. — Un sondeur d'enregistrement automatique et d'incidence verticale est en période d'essai.

Fréquences : balayage continu de 1 à 20 Mc.
Puissance : 1 KW.

On effectue un enregistrement tous les 20 minutes.

Publications

L'Ingénieur Géographe M. Luis de Miguel González Miranda a préparé pour publication les travaux suivants :

Courants telluriques, 1951.
Courants telluriques, 1952.
Courants telluriques, 1953.
Sauts brusques en courants telluriques et leur relation avec les impulsions brusques magnétiques.
Orages en courants telluriques.
Courants telluriques, 1954.
Courants telluriques, 1955.
Appareil compteur d'ions automatique.
Ionisation, 1954.

1.12. — *Observatoire Géophysique d'Alméria*

Il est situé aux environs d'Alméria dans une zone complétement exempte de perturbations qui pourraient influer sur les installations sismologiques et magnétiques.

Les coordonnées géographiques du pavillon de magnétisme sont les suivantes :

Latitude	36°51′09″ N.
Longitude	2°27′35″ W. Gr.
Altitude	environ 65 mètres.

Dans cet Observatoire fonctionnaient les installations de Sismologie et de Météorologie, et l'on vient d'installer celles de Géomagnétisme que nous allons décrire brièvement :

Le pavillon des variomètres, demi-enterré sur la pente d'une petite colline, a les dimensions suivantes : 13,10 × 10 m. Il est constitué par deux salles intérieures, protégées par un couloir de circonvallation et, pour sa construction, on a employé des murs et des voûtes de grande épaisseur. On a pris toutes les précautions pour augmenter son isolement thermique en employant des couches de fibres de verre, des chambres à air, des planchers de liège et des portes et des fenêtres doubles dans tous les accés. On a construit encore un mur extérieur en remplissant de cailloux exempts de terre le creux entre ce dernier mur et le mur de la façade. Avec ces précautions on a obtenu que la variation diurne de la température est totalement négligeable et que la plus grande variation qui s'est produite l'année dernière était de 11,3°C, tandis qu'à l'extérieur de l'édifice il y a eu des variations supérieures à 50°C.

Un couloir couvert, de 14 mètres de longueur, sépare ce pavillon de celui qui est destiné aux déterminations absolues. Ce pavillon est construit sur le terrain, ayant une ample visibilité sur l'extérieur aux secteurs N., E., S. pour l'observation de mires. Il a une salle de 14,90 m. de longueur et 10 m. de largeur avec 8 piliers d'observation et une plateforme pour des trépieds.

Dans le pavillon des variomètres on trouve un déclinomètre de Copenhague No 66 pour la déclinaison ; un variomètre de Copenhague No 90 pour la composante horizontale et une balance de Godhavn No 109 pour la composante verticale. Les données des trois variomètres sont enregistrées sur un enregistreur photographique de 15 mm/h.

Tout l'équipement est construit par Det Danske Meteorologiske Institut de Charlottenlund (Danemark) sous la direction du Professeur Laursen.

Pour les déterminations des valeurs absolues, il existe un équipement de magnétomètres construit dans les ateliers de l'Institut Géographique et Cadastral en utilisant des limbes qui procèdent d'appareils géodésiques et un équipement magnétique Sartorius ; cet équipement a été complété par un magnétomètre La Cour Q.H.M. No 217 et une balance verticale B.M.Z. No 49.

Les instruments ont été montés en 1954 et ils commencèrent à fonctionner d'une manière régulière en 1955 ; une fois le calcul de ces observations terminé on procédera à la publication des Annuaires pour 1955 et 1956.

1.13. — *Observatoire Géophysique de Logroño*

Il est situé à 4 km. au W. de la ville, et y seront installées les Sections de Sismologie et de Géomagnétisme. Ses coordonnées approximatives sont les suivantes :

Latitude ..... 42°27′28″ N.
Longitude ..... 2°30′12″ W. Gr.
Altitude ..... 445 mètres.

Le pavillon des variomètres, demi-enterré dans le terrain, aura les dimensions suivantes : 11,20 m. de longueur et 8,10 de largeur. Il sera analogue à celui d'Alméria et, par conséquent, un couloir de circonvallation servira d'isolement pour les deux salles de variomètres. Un édifice intermédiaire, de 16 m. de longueur, dédié au magasin et aux services, servira de séparation de l'édifice des variomètres de la salle d'observations absolues, dont voici les dimensions totales : 15,10 m. de longueur et 8,10 m. de largeur. Sont installés dans cet édifice les piliers d'observation et la platforme pour le trépied, avec une visibilité suffisante pour l'observation des mires.

L'équipement de variomètres sera tout à fait identique à celui qui a été installé à Alméria, et l'équipement pour les mesures absolues sera analogue à celui construit pour Alméria dans les ateliers de l'Institut Géographique et Cadastral.

Cet Observatoire est en période d'installation et nous espérons qu'il pourra fonctionner normalement dans un bref délai.

1.14. — *Observatoire Géophysique de Santiago de Compostela*

Cet Observatoire sera situé aux environs de la ville et sa situation géographique sera à peu près la suivante :

Latitude ..... 42°53′16″ N.
Longitude ..... 8°33′06″ W. Gr.
Altitude ..... 245 mètres.

On y pense installer les Sections de Magnétisme et de Sismologie, mais des difficultés pas encore surmontées ont empêché la construction de cet Observatoire.

1.15. — *Observatoire Géophysique de Santa Cruz de Tenerife*

Il est situé aux environs de la Capitale dans un terrain cédé par la Municipalité de celle-ci. Ses coordonnées géographiques seront à peu près les suivantes :

Latitude ..... 28°28′37″ N.
Longitude ..... 16°16′38″ W. Gr.
Altitude ..... 400 mètres.

On est en train de faire l'installation des pavillons provisoires où l'on pense installer les Sections de Magnétisme et de Géoélectricité, qui doivent fonctionner pendant la prochaine Année Géophysique Internationale.

L'équipement de variomètres sera du type La Cour et tout à fait analogue à ceux installés à Alméria et à Logroño. L'équipement d'absolues sera constitué par un magnétomètre Askania.

1.16. — *Observatoire Géophysique de Moca (Fernando Póo)*

Pour pouvoir exécuter les observations recommandées à l'Espagne dans les accords internationaux pour l'A.G.I., l'Institut Géographique et Cadastral est en train de construire cet Observatoire Géophysique, où seront installées les Sections de Météorologie, Sismologie et Géomagnétisme, les équipements correspondants étant déjà commandés.

Il sera situé aux environs du bourg de Moca, dans l'île de Fernando Póo, sur des terrains d'une altitude suffisante pour que les conditions de vie requises pour l'Observatoire et son personnel y soient favorables. Il ne sera pas trop loin des terrains de l'Observatoire provisoire qui fût installé pendant la IIe Année Polaire, et dans lequel furent faites des observations de Météorologie et de Géomagnétisme. L'équipement d'absolues sera constitué par un magnétomètre Askania et celui de variomètres sera du type La Cour et analogue à ceux d'Alméria et de Logroño, avec des enregistrements normaux de 15 mm/heure.

L'Institut Géographique et Cadastral projette que cet Observatoire continue à fonctionner après l'A.G.I. avec un caractère permanent, car il pense que sa situation est d'un intérêt interna-

tional, étant donnée sa proximité aux Equateurs géographique et magnétique. On espère qu'il pourra fonctionner dés le commencement de l'A.G.I.

1.2. — *Travaux de Campagne*

Les Brigades de Campagne du Service de Magnétisme et d'Electricité Terrestres continuent à employer les magnétomètres Askania, complétés par B.M.Z. et Q.H.M., pour les travaux de relévement de la Carte Magnétique de la Péninsule Ibérique en collaboration avec le Service Météorologique National Portugais. Nous sommes très heureux de la collaboration existant entre nos deux pays qui utilisent les mêmes instruments et font un usage commun tant de l'Observatoire portugais de Coimbre que des Observatoires espagnols de Tolède, Logroño, Alméria et Santiago de Compostela, qui appartiennent à l'Institut Géographique, et de ceux de l'Ebre des P. P. Jésuites et de San Fernando de l'Institut de la Marine ; ils ont ainsi une ample base pour l'appui des observations de campagne et la conservation de la carte mentionnée.

En prenant comme base chacun des Observatoires mentionnés, on a divisé le territoire de la Péninsule en sept zones, en faisant abstraction de la frontière afin que le travail qui en résulte soit une véritable collaboration entre les deux pays ; d'après ce qui a été projeté, les corrections de chaque station seront faites d'accord avec l'Observatoire de la zone en les réduisant ensuite par les isopores correspondantes, à une même époque et à l'Observatoire de Tolède, en considération de la position centrale de cet Observatoire.

Les stations observées en Espagne pendant les années 1955, 1956 et jusqu'au 15 mars 1957, sont les suivantes:

ZONES	Stations normales		Stations séculaires		OBSERVATIONS
	Faites	Manquent	Faites	Manquent	
1. Santiago	0	226	0	4	Non commencées
2. Logroño	92	273	0	6	Non terminées
3. Ebre	329	59	5	3	Complètes
4. Coimbre	100	0	2	0	—
5. Tolède	495	0	7	0	—
6. S. Fernando .	183	0	3	0	—
7. Alméria	0	248	0	5	Non commencées
TOTAUX ...	1.199	806	17	18	

Les vérifications nécessaires des magnétomètres de campagne sont et seront faites dans les Observatoires de base.

L'observation des stations situées dans le territoire portugais a été terminée ; le travail a été effectué de la manière suivante :

1953. 62 stations normales dans la Zone de San Fernando.
1954. 200 stations normales dans la Zone de Coimbre.
1955. 113 stations normales dans les Zones de Coimbre et de Santiago de Compostela.

Sept stations séculaires ont été observées en plus, et l'on a fait les vérifications d'instruments nécessaires dans l'Observatoire de Coimbre et dans l'Observatoire Central de Tolède.

2. — *Observatoire de l'Ebre (Tortosa)*

Durant ces trois derniéres années, les Sections Magnétiques et Telluriques de l'Observatoire de l'Ebre ont continué leur marche normale et l'on y a mené à bonne fin quelques travaux extraordinaires.

On a continué l'enregistrement des trois composantes magnétiques et des deux telluriques ainsi que du potentiel atmosphérique. On a fait des essais d'enregistrement rapide de courants telluriques afin de pouvoir étudier, avec plus de détails, les variations rapides que montrent les composantes du champ électrique terrestre ; les résultats satisfaisants, obtenus dans les essais, nous font espérer que l'enregistrement mentionné sera en fonctionnement au commencement de l'A. G. I.

Avec l'aide du Ministère de l'Air, on a installé un sondeur ionospérique à incidence verticale pour mesurer la hauteur et la fréquence critique des couches E et F. Les sondages commencés à titre d'essai, ont continué normalement sans arrêt depuis le mois de Janvier 1956, sauf quelques petites interruptions pour la mise au point et l'entretien de l'appareil.

On a continué à réduire les valeurs magnétiques en retard et on espère recommencer bientôt la publication des données magnétiques.

On a poursuivi la collaboration avec le Comité pour la caractérisation magnétique des jours, par la rédaction des indices K et des numéros C, de même qu'avec le Comité 10 de l'AIGA pour l'étude des variations rapides. Afin de satisfaire à la demande de l'AIGA de centraliser, dans l'Observatoire de l'Ebre, les renseignements correspondant aux variations rapides : ssc, psc et pulsations, on a installé le Service nécessaire et l'on a été en rapport constant avec les divers Observatoires participants.

Le calcul de l'influence lunaire dans la composante magnétique D et la réduction des renseignements obtenus en Guinée Espagnole ont été terminés pendant cette période.

Le P. Romañá a étudié quelques enregistrements de courants

telluriques, effectués à Tortosa en 1887 et en 1898 par M. J. Landerer, et a comparé ses résultats avec ceux obtenus à la même époque sur les lignes télégraphiques allemandes. Le P. Galdón fait l'étude des premiers résultats obtenus avec le sondeur ionosphérique. Le P. Cardús a publié, dans la Revue de Géophysique, un article intitulé « Sondages ionosphériques » et, dans Urania, un autre article sur « L'amplitude de la variation diurne près de l'Equateur, observations magnétiques en Guinée Espagnole ». Ces travaux figurent dans la série de Miscellanées de l'Observatoire de l'Ebre sous les numéros 13 et 14. Le Docteur José M. Princet a continué à étudier la loi de succession diurne des baies géomagnétiques, ayant publiée dans la Revue de Géophysique (Miscellanées de l'Observatoire de l'Ebre no. 12) un travail intitulé « Distribution diurne des types fondamentaux de baies géomagnétiques dans les Observatoires de Tortosa, Cheltenham, Tucson et San Juan ».

3. — *Institut et Observatoire de la Marine de San Fernando (Cádiz)*

Durant les années 1954-55-56 on a fait 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.

Les observations absolues de la déclinaison on été effectuées avec l'Elliott No 173 ; celles de la force horizontale avec l'Elliott No 173 et les Q.H.M. Nos 168 et 249 ; celles de l'inclinaison avec l'inducteur terrestre « The Precise Instrument Co, No 103 ».

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 les restrictions électriques dans le réseau électrique extérieur ; l'énergie est actuellement prise de batteries électriques appartenant à l'Observatoire, et les interruptions de courant sont pratiquement éliminées.

La perturbation causée par la ligne électrique de tramways, qui passe à quelque 500 mètres de la station, a été diminuée sensiblement par suite de la diminution du trafic de la ligne qui va être substituée par une autre de trolleybus. Cette diminution de la perturbation permettra peut-être l'installation de nouveau d'une balance d'inclinaison ; on s'éfforce d'y parvenir. C'est, naturellement, pour ces raisons que l'enregistrement en H et en D a été amélioré.

Les Annales Géomagnétiques correspondant aux années 1951-52-53-54 ont été publiées et, à partir de 1956, la publication sera

faite de la manière recommandée dans les résolutions de Rome, Septembre 1954.

On a continué la collaboration à la publication internationale du caractère magnétique C et des indices trihoraires K, ainsi qu'à celle des *ssc* et *psc* ; la perturbation ci-dessus mentionnée empêche la pleine collaboration dans l'investigation des *p* et des *sfe* ; de plus, on ne possède pas l'enregistrement rapide nécessaire.

4. — *Institut Géologique et Minier*

La Section de Géophysique de cet Institut a réalisé, pendant les deux dernières années, les travaux magnétiques et électriques mentionnés ci-dessous :

Investigation magnétique et électrique dans le bassin de retenue de Valdeluengo à Jerez de Los Caballeros (Badajoz)

Afin de déterminer la direction et les dimensions de quelques masses de minérai de fer magnétique dans le bassin de retenue de Valdeluengo, cette Section de Géophysique a effectué une prospection magnétique, en employant un magnétomètre Askania. Ce travail a été effectué en collaboration avec la Compagnie Geoprosco, qui a son siège social à Madrid.

Les résultats ont été très satisfaisants et le nombre de stations magnétiques mesurées a été de 361 pour une surface de 500 sur 750 m.

On a réalisé comme complément une prospection électrique par la méthode de sondages de résistivités qui donna un haut rendement pour la roche encaissante qui, en général, est granitique et un rendement relativement bas pour le minerai de fer, ainsi que pour les filons stériles. En tout on a réalisé 71 sondages électriques.

Investigation géophysique à la Mancha

Sur une zone de la Mancha (Ciudad Real) qui comprend les villages d'Almagro et de Bolaños, on a réalisé une investigation gravimétrique de 1.502 stations dont le complément a été une étude électrique sous forme de sondages, afin de déterminer le contact du Tertiaire avec le Paléozoïque. Le nombre de sondages effectués a été de 64 avec une profondeur moyenne d'environ 150 mètres. La détermination des résistivités des divers horizons est intéressante.

Investigation hydrologique par la méthode électrique à La Grajera, Velada (Tolède)

Dans un lieu nommé La Grajera, situé au NE. d'Oropesa, on a réalisé une investigation hydrologique par la méthode électrique des résistivités sous forme de sondages verticaux. On a employé le courant continu et le nombre des sondages effectués a été de

20, à 150 mètres de profondeur et distribués sur le terrain sous forme de profils.

Investigation électrique à « El Dehesón del Encinar », Oropesa (Tolède)

Dans un pàturage de l'Etat, nommé « El Dehesón del Encinar », on a réalisé une prospection électrique avec les mêmes caractéristiques que celle mentionnée plus haut. Le nombre de sondages à été de 60 et la profondeur moyenne de 160 m. Il a été intéressant de comparer les résistivités obtenues pour les groupes géologiques miocènes, très argileux, avec celles des bancs d'oligocènes sableuses qui ont donné des résistivités relativement hautes.

Investigation magnétique à Santiago de Compostela

Dans la Mine « María de los Reyes » à Santiago de Compostela, on a réalisé une prospection magnétique. A cette fin, on a employé un variomètre magnétique Askania. On a éffectué un total d'environ 1.800 stations magnétiques sous forme de quadrillage de 50 mètres de côté. Ce travail a été effectué afin de localiser des masses de pyrrotite d'une susceptibilité relativement haute.

Les valeurs absolues obtenues s'étendent d'un maximum de 47.030 gammas à un minimum de 33.461 gammas, la valeur normale d'un point central de la zone étant de 38.740 gammas.

SWEDEN

Progress of work in geomagnetism and aeronomy in 1954—1957

By Harald Norinder

In the Swedish national report to the Rome Assembly the plans of a new geophysical observatory at Kiruna (geographic coordinates 67.8°N, 20.4°E; geomagnetic coordinates 65.3°N, 115.5°E) were mentioned. This observatory which is operated under the auspices of the Royal Swedish Academy of Sciences (Kungl. Svenska Vetenskapsakademien), Stockholm, has earlier been provided only with provisional buildings. From 1st July 1957 a new well equipped institute building has been erected that will extremely facilitate the solution of different kinds of research problems related to the Association of Geomagnetism and Aeronomy. The observatory can in spite of its arctic location, in the vicinity of the town Kiruna, be reached by train from Stockholm within 24 hours.

At Lurbo, Uppsala, there has also been erected a permanent ionospheric observatory, the Uppsala Ionosphere Observatory, under the auspices of the Research Institute of National Defence.

To this observatory is linked a new permanent research station at the town Lycksele (lat. 64°37′N, long. 18°45′E), the aim of which is ionospheric research in relation to the Uppsala Ionosphere Observatory as well as to the Kiruna Observatory.

Further detailed information of investigations carried out in Sweden within the domains of the Association will be given in the following Special Reports.

Report for the period 1954—1957 from
the Royal Institute of Technology (Kungl. Tekniska Högskolan),
Department of Electronics, Stockholm
By Hannes Alfvén

The electric field theory of magnetic storms and aurora has been further developed (2). One of the results is the prediction of an "inner" auroral zone at the polar distance of about 5°.

Åström (11) gives the formal proof of the circular current around the earth discussed by Alfvén (2).

Block (3, 7) has continued his scale model experiments on magnetic storms and aurora. The significance of the experiment for the phenomena in nature has been further investigated.

Block and Herlofson (6) have integrated geomagnetic field lines taking into account also the quadrupole terms of the potential. This is of special interest for several purposes, such as choosing the right place for magnetic and auroral observations, because it is important to know quite precisely how points in one hemisphere are connected with points in the other hemisphere.

The problem whether the Chapman-Ferraro ring current is stable or not has been solved by Herlofson who has shown that a ring current of this type is *not* stable.

The solar magnetic field has been discussed by Alfvén (4). It is pointed out that in absence of a theory of the Zeeman-effect in a turbulent atmosphere it is at present impossible to derive a value of the sun's general magnetic field from spectroscopic measurements. The magnetic field outside the sun is certainly not a dipole field. An approximate model of the field is suggested. The model is in agreement with information derived from studies of magnetic storms and cosmic ray intensity variations.

Brunberg and Dattner (1) have investigated a simple model, suggested to explain the main features of the variations of cosmic ray intensity during magnetic storms. In this model cosmic ray particles are accelerated or retarded in the electric field of ionized beams which are sent out from the sun. A beam length of a few times the orbital radius of the earth and particles with momenta in the range 20—40 GeV/c give time variations in cosmic ray intensity similar to the variations measured during a magnetic storm.

The relation between variations in the geomagnetic field and cosmic ray intensity has been investigated by Venkatesan (14). A correlation is found between Kp and the relative decrease in cosmic ray intensity per day in addition to the correlation between Kp and cosmic ray intensity. This indicates the presence of electric and magnetic fields within certain regions in space and makes it possible to estimate the magnitude of these fields. This work is in further progress (15, 16).

The results of scale model experiments with electron orbits in a magnetic dipole field have been given by Brunberg (8) in form of diagrams on big globes. By using these globes it is possible to find the asymptotic direction of cosmic ray orbits as a function of momentum and direction of incidence at a cosmic ray recording station.

The unusual increase in cosmic ray intensity on Febr. 23rd 1956 has been analysed by Brunberg and Eckhartt (13). One of the results is the indication of an interplanetary magnetic field with a value of at least 6.10^{-6} gauss between sun and earth. Further work is in progress (17).

A symposium on "Electromagnetic Phenomena in Cosmical Physics" was held in Stockholm in August 1956. Among the subjects discussed were magnetic storms, aurora and cosmic ray intensity variations. The symposium was in part sponsored by UGGI.

Publications

1. E. Å. Brunberg and A. Dattner: Variations of cosmic ray intensity during magnetic storms. Tellus, 6, No 3, 1954.
2. H. Alfvén: On the electric field theory of magnetic storms and aurora. Tellus, 7, No 1, 1955.
3. L. Block: Model experiments on aurora and magnetic storms. Tellus, 7, No 1, 1955.
4. H. Alfvén: The sun's general magnetic field. Tellus, 8, No 1, 1956.
5. — On the theory of sunspots. Tellus, 8, No 2, 1956.
6. L. Block and N. Herlofson: Numerical integration of geomagnetic field lines. Tellus, 8, No 2, 1956.
7. — On the scale of the auroral model experiments. Tellus, 8, No 2, 1956.
8. E. Å. Brunberg: Cosmic ray in the terrestrial magnetic dipole field. Tellus, 8, No 2, 1956.
9. N. Herlofson: Accelerated dust grains and the highest cosmic ray energies. Tellus, 8, No 2, 1956.
10. B. Lehnert: Magneto-hydrodynamic waves in the ionosphere and their applications to giant pulsations. Tellus, 8, No 2, 1956.
11. E. Åström: On the theory of magnetic storms and aurora. Tellus, 8, No 2, 1956.
12. — Focusing of paraxial rays in a magnetic dipole field. Tellus, 8, No 2, 1956.
13. E. Å. Brunberg and D. Eckhartt: Some remarks on the sudden cosmic ray increase on Febr. 23rd 1956. Tellus, 8, No 4, 1956.

14. D. Venkatesan: Magnetic storm effects and the interplanetary electromagnetic state. Due to appear in Tellus 1957.
15. — Amplitude of the 27-day variation in cosmic ray intensity and solar activity. In course of preparation.
16. — Solar activity, magnetic storm effects and the interplanetary electromagnetic state. In course of preparation.
17. D. Eckhartt: On the different onset times of the solar flare increase in cosmic ray intensity on Febr. 23rd 1956. In course of preparation.

Report for the period 1954—1957 from the Geomagnetic Section of the Royal Board of Shipping and Navigation (Kungl. Sjöfartsstyrelsen), Stockholm.

By Nils Ambolt

During the period 1954—1957 ordinary geomagnetic registrations in Sweden have been made at the three stations Lovö, Kiruna and Abisko. Lovö is the Swedish main station and is operated by the Geomagnetic Section of the formerly Hydrographic Office now Royal Board of Shipping and Navigation. The two other stations belong to the Swedish Academy of Sciences and are operated by the Academy as far as routine work is concerned. Scientifically they too are controlled by the Geomagnetic Section.

At Lovö experiments have been made with a new quick-run film recorder designed by Dr. F. Eleman. When the mentioned apparatus is ready for use — probably rather soon — it will not be put up for work at Lovö but at Kiruna. The reason for this decision is that during the last years the development of the tram-net of Stockholm close to Lovö and the enlargement of the pipeline-system of the town have begun to cause great magnetic disturbances at the Lovö observatory due to leak-currents. Happily the main part of the disturbances could be eliminated by inserting an insulating coupling-box in the pipeline system. But small rapid disturbances of about $\pm 2\gamma$ are still left and badly influence the recording of the fine structure of smaller pulsations. The tram-company is trying to make some improvements in the current supply system which may further diminish the disturbances.

As in previous report periods absolute determinations of H and Z at all three stations are carried out by means of QHM and BMZ instruments, which are compared annually at Rude Skov. For determination of D an Askania-theodolite is used.

Publications

1. F. Eleman and K. Borg: Ergebnisse der Beobachtungen des Magnetischen Observatoriums zu Lovö (Stockholm) im Jahre 1952 (1954), 1953 (1955), 1954 (1956), 1955 (in the press).
2. — A 16 m/m film recorder for studies of rapid geomagnetic variations (in the press).
3. K. Borg: Results of geomagnetic observations at Abisko 1946-1950 (in the press).

Report for the period 1954-1957 from the Research Institute of National Defence, Stockholm, and from Uppsala Ionosphere Observatory, Section of the Research Institute of National Defence

By Martin Fehrm and Willy Stoffregen

The Uppsala Ionosphere Observatory, since 1955 established in a new observatory building, reports from the period 1954-57 the following activity:

The total solar eclipse 1954 has been studied at Uppsala and at Ekenäs in the zone of totality. Results have been published (1, 2) and it has been found that some solar control exists on the summer sporadic E-layer at this latitude, but that no effect is noticeable unless the eclipse is at least 90 %. Field-strength-records, of stations passing the shadow belt, show increase of field strength on very low frequencies (16 kc/s) and frequencies about 500-1500 Mc/s. On frequencies 150-500 Mc/s this increase is small or absent.

A special program will be carried out during the IGY. A new ionosphere station has been started at Lycksele, lat. 64°37′ N, long. 18°45′ E, for continuous recording of the ionosphere. Two high-power ionosondes on the frequency range 0.33-22 Mc/s are constructed for Uppsala and Lycksele. The extension of the frequency range to 0.33 Mc/s is designed to study the lower frequencies especially during the night.

A modified "All-Sky Camera" is constructed at Uppsala (3) with a small plane mirror mounted over the spherical mirror, the image is passed through a hole in the spherical mirror to the film camera. This arrangement is rigid and compact and the film camera is well protected. Six cameras have been made for domestic use and fourteen cameras for other countries. Three of these are intended for the Norwegian, French and Belgian expeditions to the Antarctic while the remaining cameras will cover the European sector of the arctic region. Aurora filming has been made in Sweden during the last three winters, and the results of this work will be published soon.

The All-Sky Camera is a valuable instrument for studying the aurora together with ionospheric records and even to study the various movements of the aurorae. An acceptable explanation of the different forms and movements of the aurora is still lacking.

Publications

1. W. Stoffregen: Variation of fEs during solar eclipses. Nature, Vol. 176, Sept. 24, 1955, p. 610.
2. — Solar Eclipses and the Ionosphere, Pergamon Press, London 1956.
3. — All-Sky Camera auroral research during the third geophysical year 1957-58. Tellus, Vol. 7, No 4, 1955.

Report for the period 1954-1957 from the Kiruna Geophysical Observatory

By Bengt Hultqvist

The Kiruna Geophysical Observatory is operated under the auspices of the Royal Swedish Academy of Sciences (Kungl. Svenska Vetenskapsakademien), Stockholm. The construction of the main building of this geophysical observatory (Geographic coordinates 67.8°N, 20.4°E; geomagnetic coordinates 65.3°N, 115.5°E) will be completed at the end of May 1957 and the scope of research work conducted there since several years will be widened.

During the IGY the geomagnetic quick-run recorder will be operated with double velocity, and a new magnetometer, extremely rapid and sensitive, will be working besides those of common type.

Under the auspices of the Research Institute of National Defence, Stockholm, ionospheric investigations will be carried out at the observatory during the IGY. A panoramic ionosonde will be recording each quarter of an hour through day and night. Soundings will also be made for two fixed frequencies.

A Stoffregen camera will be photographing the whole of the sky each half-minute during clear nights.

A long distance fixed frequency recording will be carried out on the path Kiruna-Stockholm.

In cooperation with the Geophysical Institute at College, Alaska, measurements of ionospheric absorption of cosmic radio-frequency radiation will be made.

The background noise in the frequency range 35-100 Mc/s will be studied and reflections from aurora of 35-100 Mc/s radiation from southern transmitters will be recorded with an antenna pointing north. The effect of aurora on transpolar transmissions within the range 2-30 Mc/s will be studied by monitoring the communication net and special transmitters. The radio-structure of aurora will be investigated by means of a sweep receiver, covering the frequency band 35-65 Mc/s.

Measurements of earth currents and rapid magnetic variations are also planned.

In cooperation with the Institute of High Tension Research, University of Uppsala, atmospherics and whistlers will be studied during IGY.

Report for the period 1954-1957 from the Institute of High Tension Research (Institutet för Högspänningsforskning) at the University of Uppsala

By Harald Norinder

Investigations of thunderstorms and related phenomena

1. *Electromagnetic field variations.*

Investigations of lightning discharges as a source of electromagnetic variations have been carried out with the electric as well as with the magnetic field method. Open antennas or shielded frame aerials in combination with amplifiers and recording cathode-ray oscillographs have been used in these investigations.

Analyses have been undertaken especially of the magnetic field components of lightning strokes in their vicinity region. In these measurements three simultaneously recording field stations within a region of 20 kilometres have been used. Simultaneously with the oscillograms of the lightning discharges their paths have been photographed in full daylight by a specially designed electronic thyratron circuit in combination with photographic cameras.

At a separate station provided with loop-antennas of considerable diameters and placed on the bottom of a lake, special investigations have been carried out in order to analyse magnetic field components from distant lightning discharges. Full accordance with corresponding variations of the electric field components was obtained.

Preliminary investigations in the interests of the IGY of whistlers in relation to thunderstorms and auroras have been undertaken at the station mentioned.

Investigations of a new and special type of atmospherics located by direction finders and emitted from distant snow squalls and occlusion fronts have been carried through with the aid of the above-mentioned stations.

Publications

1. H. Norinder: The wave-forms of the electric field in atmospherics recorded simultaneously by two distant stations. Arkiv för geofysik, Bd. 2, No 9, Stockholm 1954, pp. 161-195.
2. — Magnetic field variations from lightning strokes in vicinity of thunderstorms. Arkiv för geofysik, Bd. 2, No 20, Stockholm 1956, pp. 423-451.
3. O. Norinder and E. Knudsen: A new method of measuring rapid magnetic field variations from atmospheric electric discharges by using a loop system on the earth's surface. Arkiv för geofysik, Bd. 2, No 23, Stockholm 1956, pp. 481-499.
4. H. Norinder and E. Knudsen: Predischarges in relation to subsequent lightning strokes. Arkiv för geofysik, Bd. 2, H. 6, Stockholm 1957.
5. — — Atmospheric electric discharges from distant snow squalls and occlusion fronts. Arkiv för geofysik, Bd. 2, H. 6, Stockholm 1957.
6. — and B. Vollmer: Variation forms and time sequence of multiple lightning strokes. Arkiv för geofysik, Bd. 2, H. 6, Stockholm 1957.

2. *Electric charges and field conditions in thunderstorms.*

An analysis has been carried out of the charge generation in thunderstorms when ions are captured on polarized drops. In this relation the limitations of the Wilson thunderstorm theory have been discussed.

The charge generation induced by the electric field in thunderstorms has been investigated by the effect of ice-crystals impinging on the lower surfaces of falling particles of hard or soft hail. A general discussion has been presented of the generation sources of electric charges in thunderstorms.

Publications

7. D. Müller-Hillebrand: The ion capture on polarized drops. Arkiv för geofysik, Bd. 2, No 10, Stockholm 1954, pp. 197-225.
8. — Limitations of the Wilson thunderstorm theory. Arkiv för geofysik, Bd. 2, No 11, Stockholm 1954, pp. 227-244.
9. — Charge generation in thunderstorms by collision of ice crystals with graupel, falling through a vertical electric field. Tellus, Vol. 6, No 4, Stockholm 1954, pp. 367-381.
10. — Zur Frage des Ursprunges der Gewitterelektrizität. Arkiv för geofysik, Bd. 2, No 18, Stockholm 1955, pp. 395-416.

3. *Laboratory tests with long electric sparks.*

In order to investigate the mechanism of faint streamers and their relation to predischarges in lightning strokes, tests have been carried out with long electric sparks in the laboratory.

A special instrument — a portable klydonograph — for mass-investigations of the field variations caused by lightning strokes with the aid of low tension lines has been constructed. Results with this instrument have been obtained which show the importance of the occurrence of faint streamers in lightning discharges.

Publications

11. H. Norinder and O. Salka: The determination of electric discharge fields with a special klydonograph. Arkiv för fysik, Bd. 8, No 35, Stockholm 1954, pp. 355-368.
12. — — Long sparks from negative electrode with limited current in air at atmospheric pressure. Arkiv för fysik, Bd. 10, No 30, Stockholm 1956, pp. 397-423.
13. — — and M. Thorén: Åsköverspänningar i lågspänningsnät. Teknisk Tidsskrift, Vol. 86, No 36, Stockholm 1956, pp. 825-828.

Investigations of atmospheric electricity in the lowest layers of the air

Investigations in special branches of atmospheric electricity have been continued at the institute since the Rome Assembly. A part of earlier observations has been published.

Different phenomena related to the problem of electrification of snow and ice have been investigated. The diversity of the

phenomena observed has led to investigations of the elementary electric properties of ice and snow with respect to resistivity and conductivity. These problems have to be treated in detail in order to gain a secure basis for the explanation of the phenomena observed.

Investigations related to the production of ions have been continued in closed rooms by using artificial means — corona discharge and radioactive ion-generators. In connection with investigations of ions formed by corona discharge some electrical phenomena related to the corona discharge have been investigated in greater detail. Results of this work might be of importance for clarifying the mechanism of point discharge. Investigation of condensation nuclei has been started in relation to the occurrence of large ions.

Publications

14. H. Norinder, H. Israël and R. Siksna: Das luftelektrische Potentialgefälle und der Vertikalstrom in Uppsala. Arkiv för geofysik, Bd. 2, No 6, Stockholm 1954, pp. 109-138.
15. R. Siksna: Two different breakdowns between a positive electrode with small curvature and a plane. Arkiv för fysik, Bd. 9, No 6, Stockholm 1954, pp. 77-82.
16. — Some peculiarities of the current-potential characteristics of positive corona discharge. Arkiv för fysik, Bd. 9, No 7, Stockholm 1954, pp. 83-91.
17. H. Norinder and R. Siksna: Electric charges measured in the air when blowing snow. Arkiv för geofysik, Bd. 2, No 14, Stockholm 1955, pp. 343-369.
18. — — Indication of the development stages of positive corona discharge in the atmospheric air. IVA, 26, 1955, pp. 46-57.
19. R. Siksna: Photographs of the light phenomena of positive corona. Arkiv för fysik, Bd. 9, No 34, Stockholm 1955, pp. 555-560.
20. H. Norinder and R. Siksna: Atmospheric-electric elements measured at Uppsala during the solar eclipse of June 30, 1954. Arkiv för geofysik, Bd. 2, No 19, Stockholm 1955, pp. 417-421.
21. R. Siksna: Einige konstruktive Einzelheiten eines photoelektrischen Kondensationskernzählers. Geofisica pura e applicata, Vol. 31, 1955, pp. 9-20.
22. — Charged condensation nuclei formed in a room by corona discharge when alternating the polarity of the corona potential and by using alternating corona potential. Geofisica pura e applicata, Vol. 31, 1955, pp. 39-49.
23. H. Norinder and R. Siksna: Continued measurements of ions formed by corona discharge. Arkiv för fysik, Bd. 10, No 23, Stockholm 1956, pp. 341-353.
24. R. Siksna: On the condensation nuclei about the time of sunrise. Geofisica pura e applicata, in the press.
25. H. Norinder and R. Siksna: Ions formed in a room by a polonium ion-generator. Arkiv för geofysik, in the press.
26. R. Siksna: Conduction of electricity through ice and snow. I. Arkiv för fysik, in the press.
27. — Conduction of electricity through ice and snow. II. Arkiv för fysik, in the press.

28. R. Siksna and A. Metnieks: Conduction of electricity through ice and snow. III. Arkiv för fysik, in the press.
29. — Conduction of electricity through ice and snow. IV. Arkiv för fysik, in the press.

SWITZERLAND

Rapport suisse sur l'électricité de l'air (aéronomie)

Par Jean Lugeon et Paul Ackermann

1. *Sférics.*

La Suisse posséde depuis le début 1953 deux stations dotées de radiogoniographes à secteur étroit, système Lugeon-Nobile. L'une d'elles se trouve à Payerne (46°49′N, 6°57′E) et l'autre à l'Institut suisse de Météorologie à Zurich (47°23′N, 8°34′E).

Zurich travaille en plus avec un radiomaximographe et un atmoradiographe et, depuis trois ans, avec un « Atmospherics-Direction-Finder », tel celui utilisé par l'Office Météorologique de Grande-Bretagne.

Le service suisse de prévisions du temps utilise ces appareils pour localiser les orages dans un cercle de 800 km de rayon environ. Les observations sont transmises quotidiennement sur le réseau international de téléscripteurs.

Des études sur la propagation des ondes et du comportement des couches D et E de l'ionosphère se font parallèlement à l'exploitation pratique. Elles seront intensifiées pendant l'Année Géophysique, surtout à l'aide des mesures faites à la station polaire de Murchison Bay équipée avec des appareils suisses.

2. *Compteurs de décharges orageuses.*

Un nouveau compteur de décharges automatique est à l'essai dans plusieurs stations en Suisse. Ce compteur enregistre chaque décharge orageuse d'une certaine intensité dans un rayon d'environ 10 km. Comme il est prévu d'équiper tout le pays d'un réseau complet de ces compteurs, on a pris soin de trouver une solution qui garantisse un prix de fabrication acceptable.

3. *Electricité de l'air.*

Un appareil enregistreur du Prof. Israel mesure depuis deux ans le gradient de potentiel et le courant vertical à Payerne. En 1955, le Prof. Israel organisait avec l'appui de l'Institut météorologique suisse un réseau d'observations de ces deux éléments à Payerne, au Gornergrat, au Jungfraujoch et dans le Tessin.

Les Prof. Saxer et Sigrist mesurent le gradient du potentiel, la conductibilité de l'air, les petits et moyens ions et le courant vertical, avec des appareils de leur conception, à Arosa et sur le Tschuggen à 200 m. sur Arosa.

Les dernières années, le Prof. Lugeon a développé des radio-

sondes mesurant le gradient de potentiel et la conductibilité de l'air. On fera des ascensions régulières pendant l'Année Géophysique, à Payerne et à Murchison Bay.

4. *Radioactivité.*

Depuis deux ans, on mesure à Payerne la radioactivité des éléments à longue vie de l'air et des précipitations. Ces observations vont prochainement être complétées par un réseau sur tout le territoire suisse.

5. *Expédition suédo-finlando-suisse.*

La Suisse participe pendant l'Année Géophysique à une station polaire à Murchison Bay (80°03′N, 18°18′E) dans l'archipel du Svalbard. La délégation suisse s'occupera spécialement des sférics, de l'électricité et de la conductibilité de l'air. Elle aura à sa disposition les appareils suisses suivants : un radiogoniographe à secteur étroit, système Lugeon-Nobile, un atmoradiographe, un radiomaximographe, enregistrement du gradient de potentiel, courant vertical et de la conductibilité de l'air au sol, des radiosondes mesurant le gradient de potentiel et la conductibilité jusqu'à de grandes altitudes et un appareil enregistreur de la radioactivité de l'air au sol.

6. *Magnétisme terrestre.*

Les trois composantes du champ magnétique terrestre sont enregistrées à Regensberg près de Zurich.

UNION OF SOUTH AFRICA

Report on activities in the fields of geomagnetism and aeronomy, 1954-1957

I. *Report on Geomagnetism*

Observatory Work.

The routine work of the Hermanus Observatory continued without interruption. The La Cour quick-run (180 mm/hour) and Askania (20 mm/hour) magnetographs remained in continuous operation, the frequency of the regular absolute observations for base line control being maintained at six per element per month. In the case of the horizontal intensity the routine observations with the Schuster-Smith coil magnetometer were controlled by occasional observations with the Askania standard magnetometer-theodolite. Magnetic declination and dip were measured with the Askania standard magnetometer and the Askania standard earth inductor respectively. The orientations of the Askania H and D variometers were verified analytically (cf. Terr. Mag., 47, 2, p. 171).

The annual mean values of the magnetic elements indicate a further decrease in magnetic intensity and an increase in westerly declination:

Year	Magnetic Declination	Horizontal Intensity	Vertical Intensity
1954	−23° 55′.3	13345γ	−28090γ
1955	−23 58.7	13275	−28013
1956	−24 01.6	13192	−27951 (provisional)

The annual mean values of the Hermanus three-hour-range indices K for the period 1932-1953 show evidence of a 4½ to 5½-year periodicity. This effect was reported at the Geophysical Conference held in Johannesburg in July 1954 (See 1 of "References" below).

The calculation by the Chapman-Miller method of the geomagnetic lunar variations at Cape Town and Hermanus has been continued since 1954. In a recent report to the Committee on Lunar Variations it was pointed out that the preliminary results indicate not only a larger amplitude, but also a persistently bigger phase angle for years of high, as compared to years of low sunspot number.

Field Work.

In view of the full-scale secular-variation survey carried out in 1952-53 (See 2 of "References"), no first order field work has been undertaken since 1954.

The only important field assignment completed during the period 1954-57 was the measurement of magnetic declination at the principal sea-ports in the Union. Using Wild prismatic compasses calibrated at Hermanus, field officers of the Trigonometrical Survey Office observed the magnetic declination at a number of carefully selected points in and around the harbour areas of the following ports: Cape Town, Simonstown, Durban, East London, Port Elizabeth, Saldanha Bay, and Port Nolloth. True azimuths were determined trigonometrically, and wherever possible, the suitability of the site was tested by means of circum-station readings at one or more points on line to the azimuth marks. The results were corrected for diurnal change, and reduced to a convenient epoch. The investigation yielded unexpectedly consistent results for each of the harbours and provided striking confirmation of the West Coast anomaly in the region of Port Nolloth (Cf. "Magnetic Declination in South Africa, 1936", by A. D. Lewis, Department of Irrigation, Pretoria).

The Geological Survey, Pretoria, carried out further magnetic traverses between the primary field stations of the Hermanus Observatory. Wherever possible, the vertical intensity measurements are being augmented by observations of the horizontal component.

Earth Currents.

With a view to the International Geophysical Year, an extensive investigation was carried out on earth currents in the vicinity of the Hermanus Observatory. Using temporary electrodes and a recording galvanometer loaned by the Geological Survey, the variations in potential difference were recorded along a number of lines in the geographic and geomagnetic N-S and E-W directions. The results were sufficiently promising to justify the acquisition of equipment for a permanent earth-current installation.

Cosmic Rays.

A cubical meson telescope and a neutron pile monitor have been installed in a specially constructed hut at the Hermanus Observatory. Both instruments conform to the recommendations of the Cosmic Ray Group for observations during the IGY. Professor de Vos of the University of Stellenbosch, and Professor Stoker of the University of Potchefstroom personally supervised the construction and installation of the respective instruments.

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2. „The Secular Variation Programme of the Hermanus Magnetic Observatory: Progress Report, 1953". (Government Printer, Pretoria).

Other Publications

Two bi-ennial volumes of routine magnetic data (1949-50 and 1951-52) have been published since 1954. The typescript of the 1953-54 volume is now with the printers.

II. *Report on Aeronomy*

By D. J. Malan

Research work on atmospheric electricity has been confined to the study of thunderstorm electricity. Routine observations of the fine weather electric field are not undertaken in South Africa.

The mechanism of lightning discharges and the distribution of the electrical charges in thunderclouds are being investigated at the Bernard Price Institute, Johannesburg, and at the University of Natal, Durban.

By studying in detail the electrostatic field changes produced by discharges between the cloud and the ground, it was found that these flashes tap charged regions often reaching to altitudes of 8 kilometres above the plateau of Johannesburg. The above conclusion has been confirmed by 50 cm. Radar observations.

Both photographic and Radar studies have shown that the electrical activity in the cloud is continuous from the beginning till the end of a discharge, thus confirming earlier conclusions based on theoretical grounds. Observations have also shown that

a discharge is often active in the cloud for periods as long as a tenth of a second before the breakdown between the cloud base and the ground is initiated.

Electrostatic effects probably due to a space charge in the upper atmosphere above thunderclouds have been observed.

Publications 1955-1956

D. J. Malan: La distribution verticale de la charge négative orageuse. Ann. Géophys. 11, 420, 1955.

— Les décharges lumineuses dans les nuages orageux. Ann. Géophys. 11, 427, 1955.

— Visible electrical discharges inside thunderclouds. Geofis. Pura App. 34, 221, 1956.

— Relation between the number of strokes, stroke interval and the total durations of lightning discharges. Geofis. Pura App. 34, 224, 1956.

USSR

Academy of Sciences of the USSR

National Committee for Geodesy and Geophysics

National Report on Scientific Work in Geomagnetism and Aeronomy

INTRODUCTION

This report embraces the work of the main geophysical institutions and centres of the USSR in the field of geomagnetism and aeronomy, chiefly for 1950-1956.

It includes the works of the O. Yu. Schmidt Institute of Physics of the Earth of the USSR Academy of Sciences (IPE), the Institute of Atmospheric Physics of the USSR Academy of Sciences (IAP), the Research Institute of Terrestrial Magnetism, Ionosphere and Propagation of Radio-waves (NIZMIR, before 1956 — NIIZM), the Leningrad University (LU), the Arctic Institute (AI), the Geophysical Institute of the Academy of Sciences of the Georgian SSR (GIASG) and the Institute of Applied Geophysics of the USSR Academy of Sciences (IAG).

The report is based mainly on published works, a bibliography of which is given in each part of the report.

The national report has been prepared by Prof. A. G. Kalashnikov, Member of the National Committee for Geodesy and Geophysics of the USSR, Chairman of the Commission on Geomagnetism and Aeronomy.

I. GEOMAGNETISM AND GEOELECTRICITY

1. Magnetic Observatories

Before World War II the following magnetic observatories of the USSR were in operation: Nizhnedevitsk, Leningrad, Srednikan, Yakutsk, Moscow, Kazan, Sverdlovsk, Odessa, Irkutsk, Tbilisi, Vladivostok, and Tashkent.

A normal operation of the observatories in Leningrad, Odessa and Nizhnedevitsk was violated by the World War II. In place of the magnetic observatory in Pavlovsk (Slutsk), completely destroyed by the Hitler troops during their retreat from Leningrad, the construction of a new magnetic observatory in Voyeikovo ($\varphi = 59°57'$N, $\lambda = 30°42'$E) was begun in 1946. The regular operation of the observatory started in 1948. The magnetic observatory in Nizhnedevitsk was not restored. Instead, in 1946 a new magnetic observatory was built and came into operation near Moscow, at Krasnaya Pakhra ($\varphi = 55°29'$N, $\lambda = 37°19'$E). The work of the Stepanovka magnetic observatory near Odessa was resumed in 1948. The rest of the magnetic observatories (in Srednikan, Yakutsk, Sverdlovsk, Kazan, Irkutsk, Vladivostok, Tbilisi and Tashkent) functioned without interruption. The magnetic observatory near Vladivostok was transferred in 1948-1951 from Maitun ($\varphi = 43°15'$N, $\lambda = 132°20'$E) to Voroshilov ($\varphi = 43°47'$N, $\lambda = 132°02'$E) where the work was renewed from the beginning of 1952. At the magnetic observatory of Yuzhno-Sakhalinsk ($\varphi = 46°57'$N, $\lambda = 142°45'$E) operation was resumed in 1948.

Observational results obtained at the magnetic observatories during the period under review were not published in full. Among the materials published (1), (2), (3), (4) are annual mean values of magnetic elements, data on daily and annual variations and some others. L. G. Mansurova published a bibliography of observational data issued by magnetic observatories (5), and N. A. Intskirveli a description of the Tbilisi magnetic observatory (6).

In the Soviet Arctic, continuous registration of variations of the Earth's magnetic field was made by the following observatories and stations: Tikhaya Bay, Matochkin Shar, Dixon Is., Cape Chelyuskin, Tixi Bay and Wellen.

In addition investigations of terrestrial magnetism have been made in recent years in Central Arctic, where magnetic observations have been included in the programme of high-latitude expeditions and drifting stations.

As in previous years the Institute of Geophysics of the Academy of Sciences of Georgia published in 1955 "Magnetic Observations in Karsani in 1932" (7). This work contains, besides numerical data in the international form, results of the analysis of the constants of two basic series of magnetic variometers and other conditions for regular activity of the observatory.

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(Geophysical Institute of the Academy of Sciences of Georgia)

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2. *The Permanent Geomagnetic Field*

In 1940—1955 NIZMIR and its observatories fulfilled the following work.

General Magnetic Survey of the USSR.

The work on the general magnetic survey of the USSR began in 1931 and continued for the whole period under review. Before 1942 about 400 expeditions had been organized, which made determinations of the magnetic elements D, I and H in more than 20.000 points, as well as determinations of Z in over 100.000 points.

These results and observational data for 1943—1952 (over 4.000 points) were used in the compilation of normal distribution maps of geomagnetic elements on the territory of the USSR for the epoch of 1950. Maps of magnetic anomalies have been compiled for some regions of the USSR (1). Bibliographical data on determinations of geomagnetic elements all over the globe have been collected and systematized (2), and world magnetic maps for the 1955 epoch compiled (3). Commencing in 1952 preparations were made for an oceanic magnetic survey on board the non-magnetic research ship "Zarya", built specially for the USSR by Finland. In 1956 the "Zarya" made experimental investigations in the North Atlantic.

Problems of morphology of the permanent magnetic field were studied by V. P. Orlov (4) and N. P. Benkova (5).

NIZMIR continued to receive basic data for the study of secular geomagnetic variations on the territory of the USSR. In 1944—1945, 1949—1950 and 1954 expeditions visited a small revised network of magnetic repeat-stations (140 points from 1942).

Problems of the theories of the secular geomagnetic variations

and the permanent geomagnetic field are treated in papers by Yu. D. Kalinin (6—16). One of these theories (16) contains a description of the new method of forecasting secular geomagnetic variations. P. F. Kokovkin (17) thoroughly examined the problem of secular geomagnetic variations in Irkutsk, B. M. Lyakhov (18) drew attention to a regional character of changeability of secular geomagnetic variations, and V. P. Orlov (19) put forward a method of synthetic representation of secular geomagnetic variations by maps.

Great attention was paid to the study of secular changes in the geographical distribution of geomagnetic elements in the Arctic. Beside its scientific interest, the study of this phenomenon is extremely important for practical purposes, because the secular changes of the magnetic field in the Arctic are so considerable that they necessitate corrections and re-compilation every five years of the magnetic maps used for navigation.

The magnetic maps of the Central Arctic compiled for the 1955 epoch are the most reliable.

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3. Magnetic Properties of Rocks

Magnetic properties of rocks were investigated in their relation to pressure, temperature, mineralogical and chemical composition and macrostructure. Original investigations were made of susceptibility changes of igneous rocks (diabases, basalt, gabbroes, etc.) as dependent on pressure up to the order of 2.000 kg/cm^2. Regular susceptibility changes were revealed (as a rule a decrease) in the compression direction and in a perpendicular direction (1)—(5). (The work was conducted under the guidance of Prof. A. G. Kalashnikov).

In the sphere of investigations of thermomagnetic properties of rocks the basic laws of the thermomagnetization process have been discovered, which helped to clear up the relation between remanence, coercive force and thermic cycle. The laws discovered were applied to the interpretation of natural remanence of ores at the Kursk magnetic anomaly (KMA) and some other types of magnetic anomalies (6)—(9). (The work was directed by G. N. Petrova and M. A. Grabovsky).

Experimental investigations were made on the possibility of inverse magnetization of rocks as a consequence of their specific macrostructure, and phenomena of magnetic anisotropy of rocks were examined (20). A relation between susceptibility of some ore types of KMA, mineralogical composition and quantity of iron was established (21). Experimental investigations have begun to find the laws of non- homogeneous magnetization of rocks as dependent on the form and quantity of the ferromagnetic part of the rock (22)—(23). (Directed by Prof. A. G. Kalashnikov).

V. I. Pochtarev (25), (26), T. N. Roze (Simonenko) (27), (28) and M. L. Chelishvili (29) dedicated their works to the relation of geomagnetism and geology and methods of interpretation of magnetic anomalies.

The problem of inverse magnetization of rocks has been investigated in order to see whether inverse polarization of rocks may be accounted for by specific conditions prevailing during their magnetization (24).

As a result of some theoretical calculations a method was worked out simplifying computations of the magnetic field of obliquely magnetized bodies of an arbitrary form (30).

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4. *The Variations of the Geomagnetic Field*

Periodic Geomagnetic Variations

Some papers by V. I. Afanasieva (1), (2), Yu. D. Kalinin (3), S. M. Kozik (4), (5), (6), V. N. Mikhalkov (7), (8), (9), (10) and M. S. Penkevich (11), are devoted to the problems of field structures of annual, diurnal and cyclic (11-year) variations. The papers (2) and (11) deal with variations with the view of making corrections to the determination of the permanent magnetic field. A special note should be taken of a wide-scale reference-book on the variations of the geomagnetic field (12), containing summarized observational data, chiefly for 1938—1948.

Geomagnetic Activity

A number of works deal with the problems of magnetic activity. Among them are those by V. I. Afanasieva and Yu. D. Kalinin (13), V. I. Afanasieva (14), (15) who discovered non-periodic variations of magnetic activity during magnetic storms, V. I. Afanasieva and M. A. Belousova (16), M. A. Belousova (17), N. P. Benkova (18), N. P. Benkova and M. G. Borisova (19), V. M.

Mishin (20) and Z. V. Ryskina (21) discussing the use of the K-index and results obtained from it. They also include catalogues of magnetic storms compiled at the observatories in Slutsk (22), Sverdlovsk (23) and Tashkent (24), reviews of magnetic activity in 1944—1945 (25), 1946 (26), 1948—1950 (27) and 1951 (28); works on the daily variations of magnetic activity by N. P. Benkova (29), S. M. Kozik (30), on 27-day repetition of magnetic storms by N. P. Benkova (31), Yu. D. Kalinin (32), and some other works by N. P. Benkova (33), S. Sh. Dolginov (34) Yu. D. Kalinin (35), S. M. Kozik (36)—(43), G. P. Lazarenko (44), V. N. Mikhalkov (45), V. M. Mishin (46) and T. D. Filin (48). Special attention should be paid to a large work by N. P. Benkova (47), summarizing many data on the morphology of average peculiarities of magnetic storms.

Among phenomena observed in the variations of the magnetic field in high latitudes the main stress was laid on the study of daily variations of magnetic activity.

The analysis of observations of permanent polar magnetic observatories and expeditions made clear the conditions under which magnetic disturbances took place in the Soviet Arctic.

The laws were found which govern the geographical distribution of morning magnetic disturbances for the whole area of Arctic high latitudes northward from $\varphi = 60°$, and the scientists were thereby enabled to forecast in time the periods of anomalously high absorption of radio-waves which lead to interruption or weakening of radiocommunication.

Investigations of daily variations of magnetic disturbances by all data available, including observational data from Central Arctic made it possible to establish that in the region near the Pole there exists another zone of enhanced activity and regular magnetic disturbances. Its tentative location and form were indicated (49)—(54).

The GIASG made investigations of the disturbed magnetic field of the Earth by observational data from the Karsani and Dusheti magnetic observatories for the whole cycle of solar activity (1933—1945). As a result of this, a catalogue of magnetic storms was compiled and used for determining diurnal, annual and cyclic variations of their frequency. Studies were also made of peculiarities of 27-day recurrence of magnetic storms (56), (57).

During the period considered measurements of the magnetic fields of the Sun have been initiated. The works on the topic are published in 1954—1955 (58), (59).

The Sun's haloes have been studied (60) and reviews of works on the determination of the Sun's general magnetic field drawn up. (61).

Short-Period Variations of Small Amplitude in the Geomagnetic Field

Methods applied in the IPE for studying short-period variations are based on the principle of a fluxmetrical induction magnetometer (62), (63), (64).

Stations with the fluxmetrical induction magnetometer were in operation from 1945 til 1952 at Moscow, in the North Pamirs, and in the region of the North Tien-Shan. The recording of the variations of the geomagnetic field at these stations resulted in the discovery of new types of microvariations with an amplitude ranging from 0.005 to 0.1 γ and a frequency ranging from a few hertz to 1/40 hertz (64), (65), (66).

In 1955, under the IGY programme, the equipment for fluxmetrical induction stations has been improved; in 1956 new types of fluxmeters and automatic recorders were built for these stations. Observational methods have been worked out for the IGY stations.

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5. Instruments and Methods, Reference-Books and Manuals (on geomagnetic investigations)

Magnetic Instruments and Methods of Measurements

Problems of the technique of geomagnetic measurements are treated in the works by M. A. Aganin (1), N. V. Adam (2), M. G. Antsilevich (3), L. S. Banukhin (4), V. N. Bobrov (5), S. Sh. Dolginov and M. L. Ozerskaya (6), F. F. Ilgach (7), S. M. Kozik (8), (9), P. F. Kokovkin (10), S. M. and L. G. Mansurova (11), S. M. Mansurov (12), (13), L. G. Mansurova (14), V. P. Orlov (15), (16), T. N. Panov (17), M. S. Penkevich (18), (19), V. I. Pochtarev (20), Z. V. Ryskina (21), and V. F. Shelting (22), (23). L. G. Mansurova (24) published an article summarizing the results of comparing instruments of many magnetic observatories for 1946—1951.

The experimental investigations carried out by the GIASG made it possible to expand the possibilities of applying the Schmidt scales and simplify still more the observational methods (25).

The Arctic Institute has investigated the working conditions of magnetic compasses in high latitudes, and elaborated computation methods for determining deviations of the magnetic ship compass at different geographical latitudes. Besides, it was theoretically and practically proved that it was expedient to apply under Arctic conditions a special device "flindersbar" together with the ship compass.

The following instruments have been designed and built in the Institute of Physics of the Earth:

Permeameter for measuring magnetic permeability of rocks, both in the field and laboratory conditions, with a sensitivity ranging from $1 \cdot 10^{-6}$ to $1 \cdot 10^{-1}$ CGSU and with an accuracy of about 3 per cent;

Instrument for measuring remanence on the principle of a rock magnetic generator;

Universal torsional magnetometer, used for simultaneous laboratory measurement of remanence, permeability and coercive force of rocks;

Automatic magnetic field meter for recording the intensity components of the magnetic field of magnetized bodies with sensitivity from 1 MMoe to a few oersted (26)—(29).

The Leningrad University has designed the following instruments:

Magnetograph with visible registration, a mounting for a non-photographic distance registration of variations of the magnetic field (B. E. Brunelli and D. A. Nizyaev);

Stabilizer of the magnetic field, a mounting for some compensation of the magnetic field variations effected with the help of a magnetostatistical device and a photoelectrical amplifier (B. E. Brunelli and D. A. Nizyaev, Kh. D. Kanonidi);

Universal electrical magnetometer, a device for measuring the three components of the Earth's magnetic field D, H and Z, by means of their compensation in a current field. (B. E. Brunelli and D. A. Nizyaev).

Magnetic Cartography

The posthumously published work by B. P. Veinberg (30) was devoted to the methodical problems of magnetic cartography. The same questions were dealt with in the works by V. I. Afanasieva and Yu. D. Kalinin (31).

Text-Books and Manuals

B. M. Yanovsky from the Leningrad University has compiled a manual on geomagnetism with a volume of 37 quires (32). The course was drawn up in accordance with the syllabus of lectures read at the physical faculty of the Leningrad University for students in geophysics.

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6. Earth Currents

Observatories

Observations of earth currents were conducted at stations in Irkutsk, Yuzhno-Sakhalinsk, Shatsk (Ryazan Region) and Lovozero (Murmansk Region). The observations in Irkutsk were begun (in Zui, $\varphi = 52°28'$N, $\lambda = 104°02'$E) in the summer of 1943 and from the beginning of 1944 were systematically carried on with two lines each 1 km long; in Lovozero ($\varphi = 68°01'$N, $\lambda = 34°01'$E) observations were started in 1950 as in Shatsk ($\varphi = 53°59'$N, $\lambda = 41°51'$E). The observations in Yuzhno-Sakhalinsk ($\varphi = 47°00'$N, $\lambda = 142°48'$E) were renewed in 1948 and were interrupted due to disturbances in 1951. A small portion of the results obtained has been published.

Results of Observations

The observational results of some stations have been summarized by V. V. Novysh (3). In addition, the Shatsk station

made comparison of records of earth currents on long (up to 45 km.) and short lines (4). Measurements of electric currents in the Baikal Lake (5) have been made and work organized to measure sea currents by an electromagnetic method created abroad. As a result of a statistical interpretation of perennial 24-hour tellurograms and analysis of numerous experimental records obtained with a differential analyser in GIASG the principal laws of the behaviour of the electrotelluric field in the region of Dusheti (10), (15), (16), (18) have been established and studied.

A catalogue of electrotelluric storms for 1948—1954 (11) has been compiled which made it possible to establish diurnal and annual variations of these disturbances.

Survey operations on local and regional sections proved the effectiveness of using short-period (12), (25) and long-period variations of the electrotelluric field for studying some problems of structural and regional geology (26)—(30).

Short-Period Oscillations

Short-period oscillations were studied in recent years from records of earth currents in several geographical locations ranging from 34 to 142°E and from 39 to 73.2°N.

The investigations were conducted with 24-hour records of earth currents running at 20, 41, 55 and 90 mm p.h. (at different stations) as well as non-standard 24-hour records of earth currents running 1 mm p. sec.

Records of earth currents show that day in day out two oscillation types are predominant in the Earth's electromagnetic field.

The first type comprises the so-called stable oscillations lasting for a few hours without interruption with approximately steady amplitude and periods.

The second type of oscillations, called pulsation trains in works by V. A. Troitskaya, embraces groups of oscillations with a rapidly decreasing amplitude.

In the results of the analysis of records at all the above stations the following properties of both types of oscillations have been established:

Initiation of oscillations belonging to both types is very regular and occurs, as a rule, every day; the excitation and change of both types of oscillation take place physically simultaneously at all the stations considered, so that these oscillation excitements show no dependence on local time. It was discovered that the excitation of both types of oscillations depends on the relative location of the Earth's and Sun's magnetic poles.

Variations of the Electromagnetic Field

The analysis of the equations for the simplest model of the Earth, connecting elements of the diurnal variations of the

electric and magnetic fields of the Earth with parameters of its electrical profile, made it possible to find some laws with which, in the first approximation, the ratios of the amplitudes and the different phases of the variation harmonics of the electromagnetic field should fit in (27)—(31).

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II. AERONOMY

1. Atmospheric Electricity and Formation of Precipitation

Instruments and methods of measurements have been worked out to conduct practically inertialess measurements of the atmospheric electrical elements (electrical field, conductivity, ionic spectre of the air and the charge on precipitation particles) in ground conditions and in the free atmosphere. Field experiments of new investigation methods have been carried out: the method for measuring the spectre of light ions in the atmosphere (1), (2) and the method for simultaneous measurement of sizes and charges of particles and precipitation in the free atmosphere and at the Earth's surface (3), (4), (5).

Experimental data have been obtained on charges of rain drops on a plain (6), in highland conditions (7) and in the free atmosphere.

The data confirm Simpson's mirror effect, a contradiction of the electrical field variation and a summary charge for solid and liquid precipitation (7).

In contrast to some author's assumptions it was established that falling drops acquire their major charge in clouds. Experimental data and a qualitative estimate of the part played by separate mechanisms in charging rain drops showed that the process of gravitational coagulation of drops in clouds was one of the most probable mechanisms for charging rain drops (8).

A large amount of work has been effected on investigating coagulation of cloud drops and proper instruments designed; observations have been carried out on high land and theoretical investigations begun (9)—(15).

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2. *Aurorae and Airglow*

Observatories, Means of Observations

The investigation of the sky emission and aurorae during the period of the report were made from time to time at astronomical observatories (the Crimea, Alma-Ata) or by expeditions (Murmansk, Moscow Suburbs, Elbrus). In 1956, in connection with the forthcoming IGY special stations were being set up in Loparskaya (69°N, 33°E), Roshchino (60°N, 29°E) and Zvenigorod (56°N, 37°E); regular observations were organized at some astronomical observatories (the Crimea, Abastumani, Alma-Ata).

In 1949 A. I. Lebedinsky designed and put into operation a C-180° camera for photographing aurorae. With special appliances this camera could be used as a slitless spectrograph. Experimental shots have been made. After its completion the camera is to be used in the USSR for making IGY observations.

Under the agreement with the Institute of Atmospheric Physics the State Optical Institute has designed a set of fast diffraction spectrographs with dispersion of about 100 Å/mm and aperture ratio in the range of 2,700-4,000 Å - 1 : 1, 4,000-8,000 Å - 1 : 0.7 and 6,000-12,000 Å - 1 : 1.5. In the visible range and in the ultraviolet provision is made for resolution over 1 Å. The spectrographs have been tested and provide, for instance, the resolution of the yellow sodium doublet and a good reproduction of the H_a contour in aurorae and hydroxyl bands in the visible part of the sky emission.

In 1948 V. I. Krasovsky successfully used electron-optical transformers for taking spectra in the nearest infrared range. This

facilitated the investigation of airglow and aurorae in that range. Thus, it is possible to get spectra with dispersion of about 100 Å/mm and resolution above 5 Å.

Special electrophotometers have been used since 1948 by S. F. Rodionov to investigate visible and infra-red parts of the emission spectrum of airglow and aurorae. Photometry and electrophotometry of airglow were organized at the observatories in the Crimea and Alma-Ata.

To make spectroscopic investigations of the spectra of airglow and zodiacal light the usual equipment of the Crimean and Alma-Ata observatories was used as well.

A radar station of the Institute of Atmospheric Physics for investigation of aurorae in the 4 meter band has been set up in Loparskaya. It has been tested and observational data have been received.

By applying V. I. Krasovsky's electron-optical transformers new bands were discovered in 1948 in the infra-red airglow in the range of 8.500—12.000 Å. This discovery had been made before the forecast of Slifer's bands in the range 6,000—8,500 Å on the basis of Meinel's identification. The Slifer bands were proved to exist in the nearest infra-red range of the spectrum too. Electron-optical transformers became an effective means of investigating airglow and aurorae in the nearest infra-red range of the spectrum. Thus, B. A. Bagaryatsky, N. I. Fyodorova and M. I. Mordukhovich described in their works (1), (2), (3) auroral spectra in the nearest infra-red range of the spectrum. The airglow spectrum was reproduced simultaneously with the auroral spectrum.

Yu. I. Galperin (4) has measured the ratio of intensities in the yellow sodium doublet during twilight.

N. A. Kozyrev recorded the spectrum of the Venus night sky showing its high intensity; he also assumes that there exist absorption bands unknown in the Earth's and Venus's atmosphere (4382 and 2109 Å) and absent on Mars and Jupiter (18), (19), (20).

G. A. Tikhov and later V. G. Fesenkov and some of his collaborators drew attention to the intensification of emission lines in the spectrum of zodiacal light and counterglow. In these investigators' opinion the accumulation of additional data was necessary (59), (61), (62) to draw final conclusions as to the phenomena.

S. F. Rodionov and his collaborators (39)—(47) obtained data on emission intensities in the ultra-violet, visible and infra-red ranges. Especially valuable was the determination of the integral intensity of airglow in the nearest infra-red range. V. G. Fesenkov and his collaborators (60) made numerous photometrical investigations of airglow, zodiacal light and counterglow.

I. S. Shklovsky identified in 1950 (65)—(71) the new infra-red

bands discovered by V. I. Krasovsky with rotating and oscillating bands of OH molecules; he also made a theoretical calculation of the rotating and oscillating bands of hydroxyl. The known intensities of hydroxyl bands in the visible and infra-red ranges of the airglow spectrum were used to determine intensities of all other infra-red bands of hydroxyl. It was shown that the density of hydroxyl levels in the upper atmosphere increased with decrease of the oscillating quantum number.

The same author developed an ozone-hydrogen hypothesis of hydroxyl excitation. V. I. Krasovsky (30), (32), (33) put forward many objections to this hypothesis and assumed that hydroxyl excitation took place due to the reaction of atomic hydrogen with newly-formed oscillating excited molecules of oxygen in the zone of its dissociation and recombination. Further investigation of the mechanisms of excitation and upper atmosphere processes is going on.

V. I. Krasovsky (26) has analysed the possible variations of airglow intensity.

I. S. Shklovsky showed that during a twilight flash the atomic oxygen line is expected to be 8446 Å due to resonance absorption of the solar emission line L_β.

In his work Yu. I. Galperin (4) has taken into account self-absorption in lines.

S. B. Pikelner (50), (51) discussed the problem of the excitation mechanism of the red lines of oxygen as due to collision with electrons; K.K. Chuvaev and S.B. Pikelner (49) the question of the continuous spectrum as due to attachment of electrons.

V. G. Fesenkov put forward a hypothesis on the presence of a terrestrial component in the counterglow (the Earth's gas tail) and in zodiacal light (61), (62).

I. S. Shklovsky (68), (69) assumed that the excitation of hydrogen and some other emissions of aurorae occurred due to a re-charge of solar protons penetrating into the Earth's atmosphere, having estimated for the first time the concentration of protons of solar origin in the Earth's atmosphere.

A. I. Lebedinsky (36) developed the hypothesis of the gas-discharge nature of the aurorae.

V. A. Petukhov (48) suggested that corpuscular emission of the Sun was due to eruption through the Sun's atmosphere of neutrons which finally decompose into protons and electrons outside this atmosphere and give rise to aurorae on the Earth.

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3. Ionosphere

Ionospheric Stations

The beginning of regular radio observations of the ionosphere in the USSR dates back to 1936, when the Tomsk ionospheric station was organized. At present time there are 18 such stations (see the table) in the USSR making regular hourly vertical sounding of the ionosphere. At some of them (Moscow, Simferopol) observations are made each half hour. At the ionospheric stations in Alma-Ata, Ashkhabad and Irkutsk absorption measurements are also carried out (by recording amplitudes of

the first and second reflections). The absorption measurement in Moscow is made by the same method but the receiving and transmitting parts of the installation are set up at a distance of 40 km and therefore the absorption calculation, if the second reflection is absent, can be made by comparing amplitudes of the first reflection and of the ground wave. From 1956 the Moscow ionospheric station (Krasnaya Pakhra) has regularly measured ionospheric drifts by recording amplitudes of reflected radio-impulses. The receiving aerials are set up at a distance of 190 m which makes it possible to study movements of small-scale heterogeneities ($\sim$ 200 m) (45), (65), (67). Another Moscow installation (State University) is assigned for registering movements of heterogeneities $\sim$ 30 km (the aerials of this installation are set up at distances of 30—40 km). All the ionospheric stations mentioned in the table will operate during the IGY under the programme recommended by the IGY Special Committee and some of them will make additional types of observations (winds, absorption, levels of atmospheric disturbances and atmospheric whistlers).The Soviet antarctic expedition organized in 1955 for IGY purposes included an ionospheric station which from 1956 made regular observations in the Mirny settlement.

	Geographical coordinates		Geomagnetic coordinates	
Station	lat. N	long. E	lat. N	long. E
Tikhaya Bay	80°20′	52°48′	71°.5	153°.2
Dixon Is.	73 30	80 24	63 .0	161 .4
Tixi Bay	71 33	128 54	60 .6	191 .3
Murmansk	68 58	33 05	64 .1	126 .5
Providence Bay	64 23	173 18	59 .6	236 .0
Yakutsk	62 03	129 40	51 .0	193 .8
Leningrad	59 55	30 19	56 .2	117 .3
Sverdlovsk	56 44	61 04	48 .1	140 .6
Tomsk	56 30	85 02	46 .0	159 .7
Krasnaya Pakhra	55 28	37 19	50 .8	120 .5
Petropavlovsk on Kamchatka	52 59	158 39	44 .6	218 .6
Irkutsk	52 16	104 18	40 .8	174 .5
Chita	52 03	113 29	40 .6	182 .0
Rostov on the Don	47 30	41 30	42 .5	120 .9
Yuzhno-Sakhalinsk	46 55	142 44	36 .9	206 .6
Simferopol	44 50	34 04	41 .2	113 .3
Alma-Ata	43 15	76 55	33 .5	150 .0
Ashkhabad	37 56	58 22	30 .6	133 .5

Observational results of all the ionospheric stations are regularly collected and interpreted in the Research Institute of Magnetism, Ionosphere and Propagation of Radio-waves (NIZMIR) and the Arctic Research Institute (AI). Monthly summaries of the results are published in the magazine "Review of Cosmic Data" together with data on terrestrial magnetism, solar activity, earth currents, cosmic rays and radio-emission of the Sun.

Experimental data obtained by ionospheric stations and other institutions of the Soviet Union are used for scientific investigations; in addition the NIZMIR compiles short- and long-term forecasts of ionospheric conditions and usable frequencies for radiocommunication (90), (91).

At present the registration of atmospheric disturbances is carried out in several points of the Soviet Union. Ya. I. Likhter (70) has designed a device recording the amplitude spectrum of atmospheric disturbances. During the IGY the number of points recording disturbances will increase up to 12, all of them being equipped with analyzers of disturbance spectra.

Theoretical Investigations and Physics of Atmospheric Disturbances

Ya. L. Alpert (14), (16), (17) dealt with the problems of statistical structure of the ionosphere and the dispersion of radiowaves in it. He suggested methods of determining turbidity coefficients, velocity of chaotic movements, fluctuations of electronic density and size of heterogeneities, cited numerical values of quantities obtained from experiments. Theoretical investigations of magneto-hydrodynamics of ionospheric processes were considered in the works by V. L. Ginzburg (34), (35), (39), (41). Problems of ionic formation and ionization dynamics were treated by V. N. Kessenikh (63), V. M. Polyakov (78), (79) and by L. Shchepkin (88).

Morphology of Quiet Ionosphere

Ya. L. Alpert investigated the ionization distribution with height from observations of vertical soundings by solving an integral equation by the planimetry method, while B. S. Shapiro (86), assuming a parabolic distribution of ionization, calculated geometrical parameters of the layers. The height of the maximum h_{max} and semi-thickness y_m of the layer F2 were computed for a few years and different months of the year. The analysis of the diurnal and seasonal variations of h_{max} and y_m and their dependence on solar activity made it possible to develop methods of forecasting these parameters, the M 3.000 coefficients and the form of the high-frequency characteristics. The use was suggested of a method for estimating the parameters of h_{max} and y_m from tabular data of critical frequencies, minimum effective heights

and coefficients M 3.000. Some peculiarities of the observed vertical distribution of ionization are accounted for by the assumption of a mutual penetration of self-forming layers F1 and F2 of the ionosphere (87).

The geographical distribution of electronic concentration of the F2 layer is treated in the works by T. S. Kerblai (57), (58). The data of the world network of ionospheric stations for 1945-1947 were used to compile maps of critical frequencies f°F2 and to establish their dependence on the Earth's magnetic field and "local" peculiarities of the ionosphere. Maps of anomalies f°F2 (of deviations from the average distribution) have been compiled and possible physical mechanisms causing their distribution over the Globe considered. Anomalies in the F2 layer have also been treated by V. N. Kessenikh and N. D. Bulatov (60). The morphology of the F2 layer from observations of separate stations was described in the works (52), (68), (83).

Studying diurnal variations of ionization density of the F2 layer V. I. Afanasieva (18) assumed the existence of a functional relation between the layer parameters and the diurnal variations S_q of the geomagnetic field. The coefficients of correlation ϱ between the values of f°F2 and separate components of the S_q variations, have been calcutated. The value of ϱ was found to be dependent on the time of the day, year and geographical coordinates.

T. S. Kerblai (59) made clear some problems of long-term forecasting of the values of f°F2 (their independence of relative sunspot numbers at different levels of solar activity).

The morphology of the regular layer E of the ionosphere has been considered in the work by M. V. Boenkov (23). He suggested a formula for computing f°E for any geographical point, any moment of time and any level of solar activity. M. V. Boenkov stated that early morning ionization of the layer E (when ultraviolet rays did not reach the layer) was caused by long-wave red radiation penetrating into the layer due to the anomalous refraction coefficient and leading to photo-separation of electrons from negative ions.

The morphology of formations in the top part of the ionosphere is dealt with by Ya. L. Alpert (6), (7), who discovered an F2 layer of a cloudy structure, A. I. Likhachev (69) who described the layer G from observations in Tomsk and by A. N. Kazantsev and N. V. Mednikova (56), (71), (72) noticing above the layer F2 an additional layer often appearing before the start of disturbances. Features of high-latitude ionosphere are considered in the works (26), (28), (44), (53).

N. V. Mednikova (73) investigated the morphology of ionospheric disturbances in middle latitudes, in particular the problem of the criterion of ionospheric disturbance. She classified ionospheric disturbances in types. Each type of storm was given

mean characteristics: diurnal and seasonal variations of storms, geographical distribution, dependence on the period of solar activity and on time past from the beginning of the disturbance. The results obtained made it possible to draw conclusions as to the most and least favourable periods of work for radio-communication. Consideration was given to the duration of storms and their intensity in active hours, depending on the storm type, season, phase of the solar activity cycle and latitude.

Studies of disturbances in the ionosphere are also reflected in the works (19), (21), (25), (27), (29), (40), (43), (74).

Sporadic Layer E

The investigation of the layer E_s from data of the world network of ionospheric stations was conducted by R. A. Zevakina (54) who considered diurnal and seasonal variations of the frequency of a layer with different critical frequencies, geographical distribution, connection with magnetic disturbances. Two types of E_s have been discovered: of corpuscular and ultraviolet origin, differing in their morphological characteristics and the structure. The study of E_s in high latitudes was dealt with by V. M. Driatsky (50), (51).

Ionospheric Effect of Solar Eclipses

Since 1936 the ionospheric stations of the Soviet Union have conducted observations during all partial and total solar eclipses on its territory. As a rule these observations were frequent and made under a uniform programme. In his works Ya. L. Alpert (2), (3), (4), (10) has analysed observational results of several solar eclipses. The study of the ionospheric data of the 1945 eclipse led to the assumption of the presence of a corpuscular eclipse (velocities of the corpuscles being 500-600 km/sec.). N. M. Boenkova (24) has studied the ionospheric effects of the eclipses in 1952 and 1954, using data of observations of the whole network of stations. The effective coefficient of recombination α' and the ionization function for the layers E, F1 and F2 have been calculated. The ionization function has been divided into two parts: q_o — the study of a disturbed limb, q_s — radiation of the active sources. Changes of q_s were correlated with the observations of the limb by astronomical methods. Problems of ionospheric effects were also touched by the works (30), (55), (77).

The Influence of the Earth's Magnetic Field on the Propagation of Radio-waves in the Ionosphere

In his works (5), (13), (13 a) Ya. L. Alpert theoretically and practically investigated the trajectories of radio-waves taking into account the anisotropy of the ionosphere, produced under the

influence of the Earth's magnetic field. L. N. Fyodorova (85) has studied the magneto-ionic splitting of the ray from high-frequency records of the ionospheric stations and used these data to calculate the magnetic field at higher levels. It was noticed that there exists accordance of ionospheric and geomagnetic data for the region E and divergence for the region F2. Magneto-ionic splitting is also discussed in the works (34), (47), (81).

Z. Ts. Rapoport (80) examined different methods of measuring and calculating the absorption of radio-waves in the ionosphere and suggested a new method of direct recording the absorption coefficient. An operating model of an instrument has been manufactured, with which the measurement of the absorption coefficient was carried on during a year. The data obtained were interpreted and correlated with the Sun's height and indices of solar activity.

Studies of absorption are also found in the works (1), (20), (31), (36), (38), (46), (75), (76), (82), (84).

Monographs, Manuals, Reviews

Ya. L. Alpert (9), Ya. L. Alpert, V. L. Ginzburg and E. L. Fainberg (15), V. L. Ginzburg (37), M. P. Dolukhanov (48), V. N. Kessenikh (64) and A. N. Shchukin (89) have compiled monographs on problems of the ionosphere and ionospheric propagation of radio-waves. In their works Ya. L. Alpert (12) and V. N. Kessenikh (61), (62) presented reviews of the modern state and history of ionospheric investigations.

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Observations of cosmic rays were organized at four stations (in Moscow, Sverdlovsk, Irkutsk and Tbilisi) with ionization chambers of no less than 50 lit. in volume.

The observations were begun in Moscow in 1949, in Sverdlovsk and Irkutsk from 1952, in Tbilisi from 1953.

A small number of papers dealing with the problems of physics of cosmic rays were published by E. S. Glokova (1), (2), L. I. Dorman (3), (4), (5), (7), (8) and L. I. Dorman and E. L. Feinberg (6).

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U S A

United States National Report
Terrestrial Magnetism and Electricity
1954, 1955, and 1956

by

R. E. Gebhardt, Secretary
Section of Terrestrial Magnetism and Electricity
American Geophysical Union

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Chapter I

INTRODUCTION

During the triennium ending on June 30, 1957, the Section of Terrestrial Magnetism and Electricity (Section D) of the American Geophysical Union (AGU) has met each year near the first of May in Washington, D. C. The attendance at the technical sessions during these years has averaged 80 to 100 members and guests.

The field of geophysics covered by the Section is so broad and varied, and the number of workers studying the physics of the upper atmosphere has been increasing so steadily in recent years, that it is impossible for the secretary to obtain a comprehensive coverage of the progress during the past three years without the aid of experts in the various fields. This increased interest has indirectly resulted in the change in the name of the international Association to the "Association of Geomagnetism and Aeronomy". The name of Section D is also in the process of being changed and will in all probability conform to the usage of the Association.

Collaborators have kindly supplied reports or bibliographies on the several fields of interest, and these special reports comprise the chapters which follow. In editing them, every effort has been made to preserve the approach of the author, but some rearrangement and condensation have been necessary in order to carry out more fully the scheme of subdivision indicated by the chapter headings.

Chapter II

GENERAL GEOMAGNETIC MEASUREMENTS AND THEORY

by

E. B. ROBERTS

Part A: *U. S. Coast and Geodetic Survey*

(1) *Magnetic Observatories*

The Fredericksburg Magnetic Observatory (29a, 59a) was placed in full operation in the spring of 1956, and after careful intercomparison measurements the Cheltenham Observatory was dismantled in October 1956. The equipment at Fredericksburg includes special buildings for testing instruments, e. g. a building fitted with Fanselau-Braunbek coils by means of which the field can be modified to correspond with that of the region where the instrument under test is to be used; and buildings with heating and refrigerating equipment for determining temperature coefficients. There is also a fully equipped shop for making special parts and instruments.

The observatories at Tucson, Honolulu, San Juan, Sitka, College, and Barrow have continued in operation, the Barrow observatory with the aid for a time of the Geophysical Institute of the University of Alaska in collaboration with the Arctic Institute of North America.

A temporary observatory has been operated in connection with airborne operations in which this agency collaborated with the U. S. Air Force to examine the field distribution over a special test region at three altitudes (see Chapter III).

Under the IGY program, which is administered by the Coast

and Geodetic Survey for the U. S. National Committee, observatories have been established at Healy and Big Delta, Alaska; at Little America, Byrd Station, and Wilkes Base, Antarctica; and on Guam and Koror Islands in the Western Pacific. In addition, chains of unattended recording stations using the Askania variograph have been established in Alaska and in the western United States, and similar equipment is being operated at the Amundsen-Scott (South Pole) station and at Hallett Station (Cape Adare). Establishment and maintenance of the Antarctic bases have been accomplished through the successive "Deep Freeze" expeditions of the U. S. Navy and U. S. Air Force.

(2) *Ground Magnetic Surveys*

The accumulation of data from observations at magnetic stations has continued, with special emphasis on repeat stations, which provide secular-change information. During the period of this report many magnetic stations were occupied in other countries of the Western Hemisphere by the Inter-American Geodetic Survey, and the results of this work have been made available to us. A record of the station occupations is shown in the following table:

Magnetic Stations Occupied

Area	Repeat				Other	Total
	New		Old			
	Complete	D only	Complete	D only		
Alaska		4		6	60	70
Caribbean	4		10		5	19
Central America	51		3	2	4	60
Mexico	21					21
South America	78		4			82
United States	0	4	5	13	14	36
Compass roses at air bases (mostly U. S.)					167	167
Totals	154	8	22	21	250	455

(3) *Magnetic Instruments*

Rapid-run magnetographs have been placed in operation at nearly all of the regular observatories and at all the full-scale temporary observatories. They are arranged to produce a record which somewhat resembles the la Cour rapid-run magnetograms. However, the three elements are recorded on separate drums which are turned on a common shaft, and the drums advance axially by a discrete jump of 22.2 mm at the end of each revolution, so that the different recording spaces do not impose different demands on the optical system. The multiple traces are produced by mirrors rather than prisms, and the quality of the spots is fully equal to that afforded by standard-speed recording arrangements.

An interesting differential magnetograph array has been set up at College (44). A proton precession magnetometer with provision for measuring components of the field vector is under development. A GSI coil magnetometer has been acquired from Japan and is undergoing tests at Fredericksburg.

(4) *Charts*

Twenty-five magnetic charts for epoch 1955.0 have been prepared since the Rome assembly. These comprise charts of D, H, I, Z, and F for the United States (59c), the same for Alaska (59b), and three series of the same elements (somewhat more highly smoothed) which cover the polar regions and the world as a whole, these last being compiled by the Coast and Geodetic Survey and issued by the U. S. Navy Hydrographic Office (60). In addition, a North Polar chart was similarly compiled and issued to show the grid variation instead of D.

(5) *Publications and Reports*

Annual reports containing hourly values and reproductions of magnetograms have been printed or are in press for 1951 and 1952 data from Cheltenham, College, Honolulu, San Juan, Sitka, and Tucson observatories (59d).

Delays have been necessary in the compilation of the 1955 publication containing secular-change tables and magnetic chart reproductions, but it is hoped to complete this during 1958.

A number of publications and articles have been issued on various aspects of geomagnetism not specifically covered in this discussion (11, 15, 29b, 39, 49).

(6) *Magnetic field changes*

There has been a marked change in the D isoporic pattern in the southeastern United States, such that the annual change in Florida is now some 5 minutes per year westward. Although

this change appears to have set in before the end of 1951, it was not evident in the observed data soon enough to be reflected in the 1955 charts.

Part B: *Geophysical Institute, University of Alaska*
(Prepared by J. C. Cain.)

The research activities carried on during the period 1954-1957 at the Geophysical Institute or by associated personnel have included experimental studies of the aurora and airglow (see Chapter VI), ionosphere (Chapter V), geomagnetic field, and earth currents, as well as several theoretical studies. The main efforts in the field of geomagnetism are devoted to a continuation of previously reported studies of the morphology of magnetic storms and of the solar and lunar magnetic variations.

The morphology of magnetic disturbance has been studied for 346 sudden-commencement magnetic storms occurring in the interval 1902-1945. These storms were classified according to the maximum diminution of D_{st} (H) at low and moderate latitudes into the three intensity groups: weak (136), moderate (136), and great (74). The research has been completed for the weak and moderate storms and is continuing for the great storms. The study of the weak storms (57a) used the data for the three magnetic elements from 26 observatories for the four pre-storm hours and the 72 hours following the sudden commencement. The analysis included the determination of D_{st}, SD, S_q and DS. The representation of the disturbance vectors as a function of latitude zone and storm-time was by vectogram and harmonic dials. A statistical study was made of the augmentation of sudden commencements at Huancayo during the day compared with the sudden commencement at other observatories at moderate and low geomagnetic latitudes. The second phase of the research, that concerning the moderate magnetic storms, has recently been completed (57b). The details of the D_{st} and DS variations are found for the data from 19 observatories and comparisons made with the results for weak storms. During the course of these studies the subject of geomagnetic time was covered (17i), with its analytical and graphical relation to solar time determined as a function of longitude and latitude. Also, formulae and tables were prepared (17j) of the arc lengths along the lines of force of the geomagnetic (dipole) field.

A determination of the lunar magnetic tide L(H) at Greenwich, based on 62 years' hourly observations, has recently been published by Chapman (17g). The work was begun in 1925, continued intermittently and completed in 1956. The results were discussed in relation to L(E) (east declination) and also to the corresponding solar daily variations, S(H) and S(E). The investigation specifically considered the influence of season, sunspot activity, magnetic activity, and lunar distance upon the

lunar geomagnetic tide. An appendix to this publication gives the results of a previous study of L(E) at Sitka from 21 years' hourly data, 1902-1922, and also revised results of a determination of L(E) for Pavlovsk (summer months only) from 39 years' data, 1870-1908.

A determination of the solar S and lunisolar L geomagnetic variations at Sitka using about 50 years' data for all three field components H, D, and Z has been completed by Cain (13). A modified Chapman-Miller method was used to calculate the S and L harmonics with the use of IBM punched card machines and the EDSAC (Cambridge University Mathematical Laboratory). The S and L harmonics ($n = 1, 2, 3, 4$) for H, D, and Z were investigated to determine the influences of season, magnetic activity, and solar activity. These influences were determined in as great detail as the probable errors would allow and the results compared with corresponding ones for Greenwich. In order to facilitate the analysis for these various influences Bartels (8b) prepared a table assigning to each day an integer giving the season, lunar phase and distance, magnetic activity, and sunspottedness.

A paper by Chapman (17a) has been published concerning rockets and the magnetic exploration of the ionosphere. The discussion indicates five problems whose solutions could be assisted by exploring the ionosphere with rocket-borne magnetometers.

A general review has been published (17f) of the morphology of geomagnetic storms (D) and bays (B). The growth and decay of these phenomena are represented by means of overhead electric-current systems C(D) and C(B). It is pointed out that these current representations do not necessarily imply that the D and B fields are actually caused by currents circulating in a concentric spherical layer such as the ionosphere. The changes in intensity and orientation of the polar and interzonal currents are described and illustrated, with reference to "average" and to particular magnetic storms and bays.

A survey was made of geomagnetic eclipse phenomena (17e). It is concluded that any (weak) corpuscular eclipse effects are likely to be confined to the high layers of the atmosphere. Also, the effects of an eclipse on the earth's magnetic field are considered. It is shown that a substantial reduction of the electrical conductivity in a limited part of the S_q current sheet would only result in a small change of field at the earth's surface.

Theories of magnetic storms and of the closely related phenomenon, the aurora, have been re-examined and discussed by Chapman (17c). Outlines are given showing (a) the difficulty of even formulating the problem in any manageable way, and (b) the motion of solar gas on its approach toward and into the magnetic field of the earth. This discussion is based on the

assumption that the cause of the aurora is the emission from the sun of a neutral but ionized gas, probably consisting mainly of hydrogen.

Earth potential measurements have been made by Hessler (33) at several places in Alaska. Close correlation is found between the incidence of electric activity and of magnetic activity and the occurrence of visual aurora. The results suggest that the source of the earth currents is large compared to the longest electrode separation (200 miles). However, preliminary analyses show that the earth potentials cannot be entirely the result of magnetic induction from overhead ionospheric current systems but instead may arise from major separations of charge.

The matter of atmospheric tides has been extensively investigated by Chapman and Westfold (94c). They have determined the worldwide distribution of solar and lunar semi-diurnal tides in atmospheric pressure from sixty-eight stations. Both these tides are shown to decrease with increasing latitude, but not quite symmetrically relative to the equator; there is some indication that in northern latitudes the lunar tide decreases rather more rapidly than the solar. Chapman (17b) has also given a general review of tides in the atmosphere.

Part C: *U. S. Weather Bureau: Gates and Crellin Laboratories, California Institute of Technology*

(Submitted by O. R. Wulf.)

The diurnal variation of the irregular geomagnetic fluctuations in moderately low latitudes has been studied by Nicholson and Wulf (45) using the eight daily K numbers for the seven years 1940-1946 for six observatories fairly well distributed in longitude. More recently this has been extended to the nine years 1940-1948, and the five disturbed days, the ten quiet days, and the all-except-quiet days in each month have been studied separately.

In addition to the local-time variation, a universal-time variation has been found, and this exhibits a pronounced seasonal (annual) change.

It seems possible that the diurnal variation of disturbance may arise in part from geomagnetic fluctuations that have their origin, through dynamo action, in fluctuations of the air motion in the ionosphere.

Part D: *Department of Terrestrial Magnetism, Carnegie Institution of Washington*

The following statements are largely extracted from recent Annual Reports of the Department of Terrestrial Magnetism.

1. Daytime enhancement of the initial phase of magnetic

storms at Huancayo. Forbush and Vestine (27b) investigated the sudden commencements (SC's and IP's) of storms recorded at Huancayo, Peru. The results indicate that the average size of both SC's and IP's is significantly greater during daylight hours at Huancayo. It was also established that the size was dependent critically and linearly on the amplitude of the solar daily magnetic variation on the day of the storm. It is of interest to note that this result establishes the atmosphere as the major site of the electric currents yielding field changes at ground level near Huancayo.

2. S. E. Forbush (27a) investigated the variability of lower ionospheric wind speeds inferred from geomagnetic effects of solar flares. The 12-year period 1936-1947 was investigated, and 97 crochets were recorded at Huancayo in the horizontal geomagnetic component. The findings indicate that the average strength of the wind system is greater on days with large S_q. Thus a part of the variability in the amplitude of S_q is due to variations in the strength of the dynamo wind.

3. The semidiurnal tides near and within the E region of the atmosphere give rise to an air flow across the vertical component of the geomagnetic field. By dynamo action there results an electric field proportional to the product of the wind speed and the vertical geomagnetic field. Since the latter field is equal to zero at the magnetic equator, the current produced there would also be zero. The electric fields generated by winds in middle latitudes, however, are such that they drive positive electric charges equatorward and westward in the morning, and electrons equatorward in the evening. The electric field, directed from west to east along the magnetic equator, also extends to the F region.

4. In a previous study of the core motions and shift of the geographic poles, E. H. Vestine inferred that the gradual motion of the earth's eccentric dipole from south of the equator to north of the equator after about 1860 might imply a surface motion of the earth's central core about an axis in the equatorial plane. From various dynamic checks based on the westward drift it now seems likely that the core can move relative to the mantle. When account is taken of an error in the previous estimates of the gyroscopic shift of the North Pole due to supposed transverse motion of the core, the rotation appears to be about 1500 times greater than that actually observed from astronomical observations.

5. The problem of tracing the history of the earth's magnetic field at remote geologic times continues to increase in complexity. The Department has been cooperating with the U. S. Geological Survey in selecting sites and in some of the sampling. It has been found (31b) that magnetostriction can be a major

factor in interpreting measurements of residual magnetism of rock samples. Inasmuch as many rocks acquire magnetization while under direct stress and are relatively stress-free when their magnetizations are measured, these results are offered as support of an opinion that many conclusions that have been offered on the basis of rock magnetism data, relating to polar wandering, continental drift, secular variation and reversal of the earth's magnetic field, are subject to serious doubt.

Part E: *Applied Physics Laboratory, The Johns Hopkins University*

(Information supplied by R. E. Gibson.)

Methods of extrapolating and interpolating geomagnetic data have been developed which require the use of a relatively small amount of data (66).

The formulas that are used stem directly from the characteristic that both the divergence and the curl of the magnetic intensity are zero in the region external to sources of magnetism.

In extrapolation, derivatives in the vertical direction of the field components are obtained in terms of the values of the components on a small section of a spherical surface. A Taylor series is formed with these derivatives and then used to continue, either upward or downward, the respective components. The ratio of successive terms of the series approaches a theoretical limit which is applied in the determination of the number of terms required in the series.

In order to effect a magnetic interpolation that satisfies rigorous conditions of potential theory, expressions were derived which incorporated the conditions into an interpolation formula. The resultant relationships consisting of a power series modified by auxiliary equations connect surface variations of different magnetic elements. Isomagnetic maps drawn from data computed with these formulas are mutually consistent.

In progress are electromagnetic studies treating the characteristics of extraterrestrial sources of magnetic fields that may modify the geomagnetic field of internal origin.

Part F: *U. S. Air Force Cambridge Research Center*

The Air Force has a natural interest in the time variations of the earth's magnetic field because of their relation to communications conditions and navigation. To better define these relationships, the Geophysics Research Directorate sponsors both internal and contractual research in analytical instrumental, and theoretical studies.

The interest in instrumentation during the report period was centered first in a magnetograph designed to produce records suitable for automatic reduction to numerical values. Following

a suggestion by E. H. Vestine, E. J. Chernosky and W. A. Ruska designed a magnetic variograph of a new type. This type will give a variable-area photographic trace (on 70 mm film) of the magnetic-field variations. The latest model incorporates a variometer and camera in a single temperature-controlled housing to give a semiportable unit. Features of the design provide for an expanded range of five times the single trace width, simple set up and alignment, and continuous recording at trace speeds of up to eight times normal recording speeds. The faster recording speed together with the greater resolution provided by the film offers possibilities inherent in a rapid-run recorder.

With an installation of these instruments at Godhavn, Greenland, Weston, Massachusetts, and Huancayo, Peru, Chernosky expects to obtain new data on latitudinal changes in magnetic-field variations near the 70° meridian and to obtain as well a presently nonexistent frequency spectrum of magnetic variations in the extreme low frequency range.

Contract research by E. O. Schonstedt is under way for the development of a sensitive, miniaturized, single-component (Heliflux) magnetometer suitable for use in rocket vehicles. Other research to determine the feasibility of a variable-mu magnetometer is being conducted by a group under F. J. Morris.

Some experimentation was undertaken by Chernosky and Norwood to devise a method and instrumentation for measuring magnetic activity directly with the end-production of appropriate numerical indices of the activity. Efforts have been suspended pending acquisition of a suitable field site for further experimentation.

In a continued effort to formulate a simple and descriptive measurement and characterization of magnetic activity, Chernosky is studying methods of analysis of existing observatory hourly-value data. These analyses are directed toward ascertaining an equivalent frequency spectrum of the magnetic variations for existing magnetic data. One objective, but simply obtained, measure of magnetic activity is based upon differences of the hourly values. This measure appears to be a desirable alternate to the indirectly obtained amplitude or "A" figure currently of international interest and application.

Instrumentation has been designed and is now under construction for a chain of five stations which will make continuous three-component recordings of the subaudio geomagnetic fluctuations during the IGY. The stations will be at Thule, Greenland; College, Alaska; Boston, Massachusetts; Denver, Colorado; and in Puerto Rico. This program is largely supported by a National Science Foundation-IGY grant and a major portion of the work is being done by the University of Denver.

In studies of subaudio geomagnetic fluctuations, E. Maple has confirmed that these fluctuations precede large magnetic dis-

turbances. In the auroral zone where this sequence has been noted, the fluctuations are quite detectable and have received most attention in the frequency range 1 to 50 cycles per second. Investigation and evaluation of this phenomenon in relation to magnetic storms and associated disturbances are being continued. Maple is continuing with the analysis of data on the geomagnetic fluctuations in the frequency range from 0.01 to 15,000 cycles per second. Preliminary measurements in the 1 to 50 cps group have been made at College, Alaska.

An evaluation of the orientation and eccentricity of the outer magnetic field as evidenced by cosmic ray particles was attempted on Project Tan Glove. This was a cooperative Air Force-University of Chicago undertaking, under the leadership of Ludwig Katz and J. A. Simpson. The method used was to fly a neutron pile (a device which is sensitive to cosmic rays due to low-energy primary particles) back and forth across the equator at a number of different longitudes around the world. By an analysis of the pile counting rate, the geographical position of the minimum of each north-south flight will be used to define the cosmic-ray equator. The eccentricity of the related dipole field is determined by the comparison of the counting rates at different points on this equator.

Studies at the University of Toronto by Jacobs, Obayashi, and others, sponsored by the Air Force, included studies of trends and changes in the magnetic elements, the position of the north magnetic pole at altitude, the nature of sudden commencements and their associated current systems, and theories of magnetic storms.

Other studies are reflected in bibliographic entries (10, 18, 37).

Part G: *U. S. Navy Hydrographic Office*

In accordance with agreements reached by the States Members of the International Hydrographic Bureau, world isomagnetic charts of all elements are published every ten years, epochs 1945.0, 1955.0, etc.; additionally, world isogonic (variation or declination) charts are published at five-year intervals, epochs 1950.0, 1955.0, 1960.0, etc.

A new series of world charts portraying isomagnetic lines as of 1 January 1955 was compiled and published (60). World coverage for the elements declination (variation of the compass), inclination (dip), horizontal intensity, vertical intensity, and total intensity, was attained by utilizing polar azimuthal equidistant charts for the Arctic and Antarctic and a world Mercator for intermediate latitudes. Each chart, in addition to displaying the isomagnetic lines, is overprinted with current isoporic (annual change) curves. Additionally, an isogriv (grid variation) chart of the north polar region, portraying the direction of magnetic north relative to a selected rectangular grid, was also

published to facilitate grid navigation in the Arctic. Isomagnetic lines were derived from all available magnetic observations made since 1899. The data were accumulated and lines constructed by the Coast and Geodetic Survey in collaboration with the U. S. Navy Hydrographic Office.

Part H: *U. S. Naval Ordnance Laboratory*
(Submitted by J. W. Wilcox.)

Reduction of audio-frequency geomagnetic field fluctuation data (beyond that reported in 1954) further substantiated the idea that thunderstorm activity is the primary source of such fluctuations. Measurements in the 40-16000 cps frequency range, made chiefly at Pt. Barrow (Alaska), Panama City (Florida), and White Oak (Maryland) revealed the following general characteristics:

(1) Fluctuation amplitudes inversely proportional to about the 3/2 power of frequency between 100 and 1000 cps.

(2) Fluctuation spectra approximately flat above 1000 cps.

(3) Decreasing amplitude with increasing latitude throughout the audio frequency range. Vertical component decreases most rapidly.

(4) Latitude effect in reasonable agreement with theoretical computations based on broad assumptions.

(5) Good spectral linkage with reported values of VLF radio noise.

(6) Poor spectral linkage with fluctuations at 1 cps.

(7) At single stations, fluctuations at various frequencies tend to show same variations in time.

(8) No evident correlation between fluctuation intensity and the geomagnetic K index.

(9) Moderately good agreement between directional pattern of fluctuations and geographical distribution of thunderstorm activity.

(10) Good correlation between signal levels at two stations 300 miles apart and between two stations 1000 miles apart during Spring but not during Autumn.

The chief inconsistency lies in the fact that observed seasonal variations of fluctuation intensities fail to show a pattern resembling that of thunderstorm activity. There are also a few apparent discrepancies as compared with the results of other studies, although agreement is generally good.

This project has been terminated at the Naval Ordnance

Laboratory. Comprehensive results are contained in a report (64) by Wilcox and Maple.

Subaudio-frequency geomagnetic fluctuations also were studied at NOL. Recordings of fluctuations in the d.c.-to-50-cps region were taken at White Oak (Maryland) and Point Barrow (Alaska); and some Tucson (Arizona) magnetograms were examined. On the basis of rather limited data, E. Maple proposed that oscillatory "micropulsations" in the frequency region 0.1 to 1 cps originate in the F region, while those in the 0.01 to 0.1 cps region originate in the E region (normal and sporadic). Still lower oscillations (below 0.01 cps), including "giant micropulsations" observed in the auroral zone, do not seem to conform to his scheme. This was reported to the American Geophysical Union. Mr. Maple has made additional reports concerning these data since his separation from NOL.

Three specialized instruments were developed for use in the foregoing geomagnetic fluctuation studies:

(1) A very-low-frequency recording and analysing instrument employing an FM system of tape recording for signals from d.c. to 15 cps. It is designed to amplify and record signals of the order of a microvolt, representing the output of a magnetic pickup coil. Tape is subsequently played back at 30 or 60 times the original recording speed, permitting frequency analysis in the range 0.016 cps to 4.2 cps through specially developed band-pass filters. This instrument is described fully in a report by Austin (6).

(2) An audio-frequency "stochastimeter" modified from an instrument developed by Sullivan and Wells at the University of Florida. The instrument is designed to measure three quantities: probability (or percentage of time) that signal amplitude exceeds a given reference level, average number of pulses per second having amplitudes exceeding the reference level, and the average value of the noise envelope. These three instrument outputs were recorded graphically. Only a small number of signal recordings was processed by the stochastimeter prior to termination of the project, and no formal report describing the instrument has been prepared.

(3) An "intermediate"-frequency recording system for field recording of geomagnetic fluctuations in the frequency range 5 to 50 cps. Sharp rejection above 50 cps was necessary to eliminate power signals at 60 cps and harmonics thereof. A special pickup coil was designed for which sinusoidal fluxes of constant amplitude in the frequency range of interest produced a uniform output to a magnetic recorder. Fluctuations were recorded at a speed of ¼ in./sec. and played back for analysis 60 times faster through band-pass filters. This instrument was

developed by R. L. Knodle of NOL and has not been reported previously.

Part I: *U. S. Naval Research Laboratory*

In 1955, the Naval Research Laboratory contracted with Varian Associates for development of a proton-precessional magnetometer to be used in rocket exploration of the geomagnetic field. On July 5, 1956, the first rocket unit was successfully flown in an Aerobee rocket to an altitude of 163 km at White Sands Proving Ground, New Mexico. Measurements were taken twice per second throughout the flight. A second magnetometer flight was attempted at Churchill, Manitoba, in November 1956. Since the rocket failed in the launching tower, no airborne measurements were obtained. Proton-precessional magnetometers will be flown in five Aerobee-Hi rockets at Churchill during the winter 1957-1958. The objectives in the rocket measurements are:

(1) to locate and determine the distribution of ionospheric electric currents;
(2) to measure the intensity of the earth's main field accurately as a function of altitude;
(3) to correlate the magnetic field observations with atmospheric and solar phenomena.

The Group III satellite experiment of Project VANGUARD is a Naval Research Laboratory experiment in which highly accurate magnetic field measurements are to be taken both in the satellite and on the ground at the tracking-receiving stations. The development and construction of an exceptionally lightweight satellite proton precessional magnetometer is being carried out at Varian Associates under contract to NRL. For the ground-station magnetometer, NRL is developing and constructing a proton instrument to measure declination and inclination as well as the absolute total scalar field. The angle measurements are accomplished by adding homogeneous bias fields to the earth's field. Accuracies are 0.5 gamma in total field and 0.5 minute in declination and inclination. The objectives in the satellite measurements are:

(1) To determine the existence or nonexistence of extraterrestrial currents and, if existent, measure their contributions to magnetic storm disturbances as a function of latitude and time;
(2) to study ionospheric currents over a wide range of latitudes but with special emphasis on equatorial regions; and
(3) to improve our knowledge of the earth's main field by absolute measurements over a wide range of latitudes and altitudes.

The Naval Research Laboratory has developed a simple electron-beam component magnetometer. This instrument is used extensively by NRL to measure rocket aspect. In the Churchill rocket flights, the rapid a-c response of the instrument will be used to detect magnetic pulsations and the fine structure of ionospheric currents.

A magnetometer based on electron paramagnetic resonance is being developed at NRL. Similar in principle to the proton precessional magnetometer, this instrument will also measure the absolute total scalar magnetic field.

Part J: *University of Maryland*

An effort has been made to develop a model of magnetic storms which takes account of the fact that the region around the earth is not a vacuum but instead a very good electrical conductor. A magnetohydrodynamic model of magnetic storms has therefore been worked out which accounts for the first time for the reverse sudden commencement and attempts to give a theory of the sudden commencement (55b). Separately, a theory of the ring current has been worked out which leads to a stable ring current and allows for the first time a calculation of the spatial distribution of the ring current around the earth. Its connection with the aurora has been investigated and some crucial experiments have been planned for the Geophysical Year.

Chapter III
MAGNETIC AIRBORNE SURVEYS

by

WILLIAM J. DEMPSEY

Part A: *U. S. Geological Survey*

A new magnetometer, the nuclear precession magnetometer, suitable for station, airborne, and ground magnetic surveys, has been developed and placed in use in the triennium. Commercial companies have continued making exploration aeromagnetic surveys in the United States and its possessions, and abroad. The Federal Government has conducted airborne magnetometer surveys for mapping purposes and as geophysical surveys in conjunction with geologic studies.

The nuclear precession magnetometer, which was developed by Varian Associates, measures the precession rate of the nuclear magnetic spin in adjusting from an impressed field to the earth's magnetic field. This frequency measurement is dependent on the gyromagnetic ratio of the nucleus and on the earth's field. Now,

the gyromagnetic ratio of the hydrogen nucleus has been measured to an absolute value of 1 part in 40,000, and with frequency measurements easily accurate to 1 part in 1,000,000, it is possible to achieve absolute accuracies in the measurement of the earth's magnetic field of the order of one gamma. This equipment theoretically should be driftless and suitable for use as an airborne magnetic detector, for ground surveys, and for station observatory use. Hycon Aerial Surveys is using this instrument in conducting contract exploration airborne magnetic surveys. Instruments of this type will also be used by Government agencies in conjunction with mapping surveys, as a check of the absolute total field measured by the vector airborne magnetometer 2A.

Commercial companies such as Fairchild, Aero Service Corporation, and Gulf Research and Development Company continue to use the self-orienting flux-gate magnetometer for total intensity. Basic flying techniques and data-reduction procedures remain unchanged. Extremes in transient fluctuation (magnetic storms) continue to plague commercial operators as well as others. A magnetic-storm monitor has been developed by Gulf, and simultaneous tests of diurnal variation at three stations 200 miles apart have been made in Canada. Storm monitoring provides the magnetometer operator with information concerning the severity of the disturbance, but does not provide correction information.

Commercial companies have experimented with the use of smaller, slower aircraft, and routine flights as low as 300 feet above the ground have been made. The excessive costs of providing pilot guides and of data compilation militate against lower-level flights. Approximately 150,000 traverse miles of exploration surveys were made in the United States by commercial companies during the period.

The Hydrographic Office and the Naval Ordnance Laboratory of the U. S. Navy, the Coast and Geodetic Survey, and the U. S. Air Force are all continuing to participate in making and analysing the results of airborne magnetometer surveys using the vector airborne magnetometer 2A as described by Schonstedt and Irons (53). Sensitivities of this equipment are as described, but improvements have been made in compensation of the aircraft.

The U. S. Geological Survey continues to operate the modified AN/ASQ-3A magnetic airborne detector, a self orienting flux-gate magnetometer. Approximately 250,000 traverse miles were flown since the 1954 report. About half of these surveys were flown as combined airborne radioactivity and aeromagnetic surveys.

Conclusion

Except for the introduction of the nuclear precession magnetometer, there has been little change in the technique of aerial

magnetometer surveys. Results of surveys with the nuclear precession magnetometer have not been published, and comparions between surveys made with this equipment and with the fluxgate magnetometer have not been made. There is a continuing need for both exploration magnetometer surveys and mapping surveys, and it is likely that the present level of activity will be continued.

Part B: *U. S. Air Force Cambridge Research Center*

One of the problems under investigation by the Geophysics Research Directorate is the study of the *permanent geomagnetic field* and its *secular variation.* To carry out such a program, it is necessary to examine accurate, detailed, and coordinated observations near the earth. A basic requirement, therefore, is to supplement existing magnetic data; and this has been accomplished by the technique of aerial magnetic surveys.

The Instrument

The *NOL Vector Airborne Magnetometer* is an instrument which utilizes the saturable inductor principle. It measures from the aircraft: (1) the earth's total magnetic field intensity, (2) two angles which establish the direction of the earth's field with respect to a suspended orienting mechanism, and (3) an angle that specifies the attitude of the mechanism azimuthally with respect to a celestial body. With the additional knowledge of Greenwich Mean Time, the latitude and longitude of the aircraft, and astronomical information, the total vector of the earth's field can be computed.

Installation

Under ideal conditions, the magnetometer is installed in an aircraft well suited for geophysical exploration. In our case, however, an EB-29 was assigned to the project. The magnetometer console, recording equipment and associated components were installed in the rear pressurized compartment. The detector hood was installed at a point approximately 7 feet aft of the rear pressurized compartment in an unpressurized section of the aircraft.

In order to relate the measured magnetic heading to true north and obtain the declination, a Kollsman periscopic sextant was used to increase relative bearing. This has previously been modified with a synchro-transmitter attachment so that it would record continuously on an EA recorder.

Modification and Compensation

Unfortunately, when the magnetometer was installed in the aircraft, in addition to measuring the geomagnetic field, spurious

indications were recorded by the instrument. In general these indications were produced by four sources: (1) the permanent and (2) the induced magnetic fields which arise from the ferromagnetic members of the aircraft; (3) magnetic fields set up by the eddy-currents generated in the conducting sheets and structures of the aircraft by its manoeuvers; and (4) the magnetic field produced by the d-c circuits.

It was found necessary to clear the aircraft of the many sources of ferromagnetic disturbance. One of the most bothersome, since it was continually changing in flight, was the field produced by the standard Air Force control cables. To eliminate this disturbance all the control cables from the front bomb bay to the rear of the craft were replaced with a nonmagnetic type. In the unpressurized section of the aircraft, screws, clamps, latches (i. e. all hardware made of magnetic material) were replaced by nonmagnetic counterparts. In the rear pressurized compartment, seat belts, parachutes, oxygen hoses, etc., were similarly replaced.

Another major consideration was to remove the field generated by the d-c circuits of the aircraft. These effects appeared as permanent magnetism at the detector head. However, much of the current flow was at irregular intervals and in varying amounts. The simplest method of eliminating this disturbance was by twin-leading the majority of electrical units. Tests revealed that the total effect of the electrical disturbance was reduced to less than 6 gammas.

The problem of eliminating the field at the detector head produced by eddy-currents was considered to be negligible. Survey flights justified this supposition.

When the compensation was completed, it was possible to measure the total geomagnetic intensity to $\pm$ 10 gammas and declination and inclination to $\pm$ 15 minutes of arc (41).

Aeromagnetic Survey

With the aircraft compensated, an aeromagnetic survey was conducted over a portion of the Air Force Missile Test Range. In order to know the position of the aircraft accurately, Hiran was employed. The survey area was a square 100 miles on an edge, at three altitudes: 10,600 ft., 15,600 ft., and 29,600 ft.

Values of the total magnetic intensity, F, the inclination, I, and the declination, D, were obtained for discrete points along the flight lines in two sections of the area, each section being 50 miles wide by 100 miles long; the first section having a grid spacing of 10 miles, the second having a grid spacing of 5 miles.

The repeatability and overall accuracy of the measurements were checked for the first section by flying reciprocal headings and by testing the differences at each point of intersection of the N-S and E-W lines. The standard deviation from the mean

was 10. It can be stated conservatively that the magnetic data obtained in the survey, because of the aircraft compensation and the navigation system employed, are by an order of magnitude more accurate than heretofore achieved.

Presentation of Data

Once the magnetic data were collected at many discrete points, the next job was to portray the underlying continuous distribution in the form of isomagnetic charts.

The method employed in preparing charts was as follows: The total magnetic-intensity vector field of the earth satisfies two pertinent conditions: (1) the radial component of the curl vanishes and (2) the square of the magnitude of the vector is equal to the sum of the squares of the spherical components.

In a given area, each element of the vector was expanded about a point in a suitable polynomial. The conditions were used to yield relations among the polynomial coefficients. The independent set of coefficients were then determined by the method of least squares (28).

In summary, this effort has produced two contributions:

(1) A technique for accurate aeromagnetic survey

(ΔF to $\pm$ 10γ, ΔI and ΔD to $\pm$ 15′)

(2) The construction of mutually consistent magnetic charts.

Part C: *U. S. Navy Hydrographic Office*

The major program in geomagnetism sponsored by the U. S. Navy Hydrographic Office included the conduct of airborne geomagnetic surveys of ocean areas (56) and the publication of world isomagnetic charts (see Chapt. II).

The airborne geomagnetic survey of ocean areas, which got underway in 1953, continued. The purpose of this program, known as project MAGNET, is to conduct systematic geomagnetic surveys of all major ocean areas of the world and resurveys of areas as required to maintain currency of data.

The initial survey aircraft, a converted Navy P2V patrol plane, was retired from survey use and an R5D, four-engine transport plane (Commercial designation DC-4), providing additional space and range was modified and equipped and is currently in operational survey use. Improved compensation techniques have resulted in virtual elimination of effects of aircraft magnetism and navigational accuracy has been further improved through the use of doppler radar which provides for highly-accurate and continuous display of DR information to supplement celestial, loran, radar, and other fixes. An additional aircraft has been assigned to augment the R5D operations and planning for its conversion is underway. It is estimated that

the second survey aircraft will become operational about mid-1958.

The NOL vector airborne magnetometer, type 2A, which measures the direction and intensity of the earth's magnetic field, continues to be employed (53). Accuracy of the results has been increased somewhat through use of improved calibration and standardization equipment and techniques. Incorporation of automatic leveling in the periscopic sextant has resulted in improved efficiency and accuracy of celestial (azimuth) observations for the determination of declination (D). An automatic star tracker has been obtained and specifications for its modification to record necessary azimuth data, thus allowing essentially continuous recording of declination, have been prepared. Specifications for a nuclear precession airborne magnetometer were prepared and procurement is underway. This instrument will facilitate the in-the-field standardization of the VAM intensity circuit and will eventually serve as the primary instrument for recording absolute values of total magnetic field intensity.

The survey of the first major ocean area, the North Atlantic from the Arctic Circle to the equator including the Caribbean Sea, has been completed. The survey plan consisted of a series of parallel tracks, extending generally east-west and spaced approximately 200 nautical miles apart. A number of survey tracks in the North and South Pacific Oceans have also been completed. These tracks were flown in conjunction with a planned survey of Antarctic. The Antarctic flights were, however, postponed until Operation DEEP FREEZE III due to operational difficulties at the McMurdo air facility. It is now planned that the Antarctic work will be undertaken during January and February 1958. All survey flights are made at approximately 10,000 foot level. The next major survey area will be the North Pacific Ocean.

The computation and abstracting of all airborne magnetic survey data have been programmed for processing by IBM and Datatron electronic computing machines. Airborne observations, providing data on all magnetic elements, are being processed as required for use in the preparation of navigation and world isomagnetic charts (see Chap. II).

Chapter IV

ATMOSPHERIC ELECTRICITY

Though it has not been feasible to compile a summary of advances in this field, the bibliography discloses considerable activity. For work in the borderline discipline of whistling atmospherics, see Chapters V and VIII.

Chapter V
IONOSPHERIC RESEARCH

This chapter summarizes work in this field by means of excerpts chosen from the 1957 report to the International Scientific Radio Union (URSI) that was prepared by USA Commission 3 of that body. For fuller documentation and further details the original report may be consulted.

Part A: *U. S. Air Force Cambridge Research Center*

Under direction of the Ionospheric Physics Laboratory of the Geophysics Research Directorate, the installation of an airborne ionospheric recorder has been supplemented by devices able to record the amplitude of the ionospheric reflections. A magnetometer, also, has been installed for the purpose of monitoring the geomagnetic total field strength. The results of several arctic flights show how the mobility of the airborne equipment can be used to track large-scale irregularities and reveal some part of their important role in arctic radio communication (101).

A new method of measuring ionospheric drifts has been developed using the airborne equipment while the aircraft is flying on a circle.

The effects of air tides on the ionosphere has been the subject of theoretical and experimental investigations. The dynamo currents in the ionosphere have been computed using spherical harmonics and the concept of balance of power. The results compare favourably with the Bartels Sq current system and show an amplification factor of 100 for the wind at the level of the ionosphere.

Experimental data from ionospheric records taken at stations around the equator and with the airborne equipment confirm the theoretical concept and illustrate some of the details.

Rocket experiments have been carried out to determine the electron density from pulse delay data. An exact method for analysis was developed for use with high speed electronic computers. Results on the E layer show a pronounced stratification or lamination of the layer consisting of a number of horizontal strata about 6 km apart in height, each stratum being made up of irregular patches of ionization (133 a, b).

Part B: *Cornell University*

Work has been concerned with the scattering of radio waves in the ionosphere produced by irregularities of electron density.

A guiding principle in this work has been the assumption that the irregularities are due to atmospheric turbulence and that the principles of fluid mechanics that have been developed to describe turbulence in other situations are also applicable in

the ionosphere. In practice, it has been assumed that the turbulence is isotropic, since fluid mechanics is better developed for this situation than for non-isotropic turbulence. It is not, however, known to what extent turbulence in the ionosphere is non-isotropic. What we have done, therefore, is to use the theory of isotropic turbulence with a view to explaining the following phenomena:

(1) Ordinary fading of ionospheric echoes.

(2) The phenomenon of spread F.

(3) Back-scattering from field-aligned ionization in the F region.

(4) Scintillation of radio stars.

(5) Irregularly fading echoes from long-duration meteor trails.

(6) Back-scattering below the E region at 2 megacycles per second.

(7) Long-distance scatter transmission in the VHF band.

(8) Back-scattering in the VHF band from regions of auroral activity.

Part C: *Dartmouth College*

High-frequency Studies

At the Thayer School of Engineering, the vertical-incidence polarization studies described in an earlier report were continued through December 1955. The results of this experiment are essentially the same as those outlined in 1954.

An LG-17 (Canadian Marconi Company) ionosphere recorder was placed in operation in 1955. A sweep-frequency, oblique-path experiment, in which the LG-17 was to be synchronized as to timing and frequency with a similar unit operated at Saskatoon, Saskatchewan, was commenced in January 1956 but was discontinued shortly.

Instrumentation is now being developed for the operation of the sounder with two synchronized receivers placed 100 km away in orthogonal directions from the sounder. Three ionograms will be produced from the single sweep-frequency transmitter. This will permit determination of the height and the velocity vector of moving reflecting patches. The experiment will first be operated at Hanover and then at Knob Lake, which is in the auroral zone.

Whistlers and VLF Emissions

In March 1955, simultaneous records of whistlers were made at Hanover, N.H., and Washington, D.C., in collaboration with the Naval Research Laboratory (H. E. Dinger). It was found

that the dispersion of a given whistler heard at both places is the same.

In order to validate the Storey theory conclusively on the basis of predicted time delays and dispersions in whistler echo trains as received at geomagnetically conjugate points on the earth, simultaneous recordings were made at Unalaska, Alaska, and Wellington, New Zealand, in 1955 during August and September. The observations in New Zealand were made by the New Zealand Dominion Physical Laboratory (G. McK. Allcock). Spectrographic analysis of the recordings revealed complete agreement with Storey's postulates.

It is not uncommon to have a single lightning flash produce two or more separate whistlers having different dispersions. Usually the multiple whistlers are closely spaced in arrival time. Because the spacing within successive groups is constant during a given period of activity, it is concluded that this is certainly due to the existence of separate propagation paths.

In a record obtained at Unalaska on November 11, 1956, it was found that the first two whistlers were unusually widely-spaced multiples, and that the succeeding echoes could be explained by successive propagation over these two paths in various sequential combinations. One of the original pair was stronger than the other. Assuming that this path therefore had the smaller attenuation, one would expect to find preference exhibited for it in the echoes, and this was found to be the case.

After many failures, a completely successful observation was made at Hanover, correlating the visual perception of lightning with the aural perception of whistlers. Flashes were occurring three or four minutes apart and each produced a strong whistler with echoes. There were no other significant sferics audible, and no other whistlers.

Observations have been made in the Arctic near the 75th West meridian in 1956 and 1957. No whistlers have been heard above 65° geomagnetic North, but vlf emissions (dawn chorus) have been heard up to the geomagnetic pole.

With the knowledge that vlf emissions and aurora are both strongly correlated with magnetic disturbance, it is reasonable to seek a direct correspondence between vlf emissions and visible features of the aurora. This has now been found and is under further study. The correlation is with the bright patches which course rapidly up auroral rays.

At the suggestion of J. M. Watts of the National Bureau of Standards, the "tweeks" on the routine three-hourly recordings made at Hanover before and after the great solar flare of February 23, 1956, have been analyzed. The result substantiates the findings of others that the level of reflection of vlf signals in the dark hemisphere dropped to 70 km.

A multichannel audio-frequency spectrum analyzer for the rapid analysis of data has been developed. Records are produced

on continuously moving 35 mm photographic film on which the image of a row of thirty-two small cathode ray tubes is focused.

IGY-Whistlers

A meridional chain of 13 stations to observe the latitude dependence of whistlers and vlf emissions has been set up. The stations are located at:

Thule, Greenland.
Godhavn, Greenland (cooperating Danish station).
Frobisher Bay, NWT, Canada.
Knob Lake, Que., Canada.
Father Point, Que., Canada (or site nearby).
Hanover, N.H.
Washington, D.C.
Bermuda.
Gainesville, Fla.
Huancayo, Peru.
Ushuaia, Tierra del Fuego, Argentina.
Port Lockroy, Antarctica (U. K. station on Palmer Peninsula).
Ellsworth, Antarctica (U. S. station on Weddell Sea).

In addition, a station has been set up at Battle Creek, Mich. The Canadian Defence Research Board is operating stations at Ottawa and Halifax which are coordinated with these stations. All but two of these stations are in routine operation or nearly so.

Special apparatus was developed for the IGY whistler stations. It includes a local-time standard accurate to ± 0.05 sec. which places time marks directly on the tape with the records. Two-minute recordings are made hourly, commencing precisely at 35 minutes past the hour.

To provide guidance and insure standardization for all countries observing these phenomena during IGY, a manual was prepared for the URSI-AGI Committee (126a).

An agreement has recently been reached insuring that all participants in the coordinated Western Hemisphere program will use a uniform reporting sheet for the daily log of aural monitoring of tapes. This program includes eleven stations in addition to those mentioned above. The other stations are in the Western part of North America and the conjugate area in the South Pacific.

IGY — Other

All-sky cameras and visually recording magnetometers are being installed at Hanover, N.H., and Knob Lake, Que.

The Physics Department of Dartmouth is setting up automatic ionospheric absorption apparatus at Hanover and Knob Lake, using the galactic noise technique.

Part D: *New York University*

1. *Radio Scattering.* As is well known, radio waves of appropriate frequency can be scattered by turbulence-induced refractive-index fluctuations, which occur in different regions of the atmosphere ranging from the lower troposphere to the upper ionosphere. The model currently favoured to explain this "dielectric noise" is the mixing action of atmospheric turbulence acting in regions of refractive-index inhomogeneity, especially in gradients of refractivity. According to this model the regions of the atmosphere (in particular the ionosphere) that can support scatter propagation are those that have a sufficiently high level both of turbulent activity and of refractive-index inhomogeneity. Other things being equal, this favours regions of the ionosphere where the electron-density gradient is the steepest, a fact which appears to be supported by experiment. The research at New York University in radio-scattering theory has been largely concerned with the turbulent-mixing theory and its consequences for radio scattering.

2. *The Inverse Propagation Problem.* As a consequence of research in the theory of differential equations it seems possible to improve on existing methods of determining the index of refraction in the ionosphere. Our method presupposes a knowledge of the phase of the reflected wave at various frequencies at normal incidence. For nondispersive media we could alternatively use the reflection coefficient at a single frequency and various angles of incidence. At the present time the method is limited to isotropic media.

3. *The Measurement of Virtual Height.* A new definition of the virtual height of a reflected wave train is recommended. This definition is such that its accuracy increases as the width of the incident pulse increases. Moreover it is theoretically possible to obtain an estimate of the virtual height with as small an error as desired no matter what the nature of the reflecting medium.

Part E: *Pennsylvania State University*

The work of this Laboratory is concerned with the following factors:

1. *Low Frequency Vertical-incidence Measurements.* Several years of data have been obtained involving the following measurements on 75 kc/s: Equivalent height versus time, change in phase path versus time, ionospheric absorption, and sky-wave polarization.

2. *Mathematical Studies.* Various methods of solving the complete wave equations have been devised from the viewpoint of obtaining electron density height profiles in the lower E and D

regions. The methods include simple graphical procedures as well as schemes utilizing a rather large scale digital computer.

3. *Ionospheric Physics.* Studies have been completed and others are underway concerned with the physical and chemical constitution of the lower ionosphere involved in region formation in terms of the possible solar radiations effective in producing the various lower ionospheric regions.

4. *Ionospheric Properties.* Experimental and/or theoretical work related to certain ionospheric properties have been completed or are now underway as follows: Instrumentation is essentially completed for the procurement of long wave h'-f records over the range 50 kc to 800 kc. Initial measurements on 75 kc/s of phase path fluctuations utilize three spaced receivers, and their interpretation in terms of ionospheric characteristics is now underway. Short-wave vertical-incidence ionospheric absorption measurements are being procured for the IGY. An analysis of certain IGY h'-f data is being made for the IGY, utilizing a digital computer to convert such data to electron-density-height profiles with primary emphasis on the determination of temporal variations in these profiles. A rather extensive theoretical and experimental study is being made of long-wave sunrise effects and the nighttime E-layer. An experimental program utilizing amplitude fluctuations at three spaced receivers on 75 kc is underway in a study of drifts, etc., in the lower ionosphere.

5. *Rocket Measurements.* An experimental program is being initiated to determine electron density versus height profiles in the D and lower E regions of the ionosphere utilizing rocket borne equipment.

Part F: *Stanford Research Institute*

Activities include research in meteor burst propagation systems, arctic propagation and aurora.

Part G: *Stanford University*

1. *Very Low Frequency Propagation, including the "Whistler" Mode.* An extension to high frequencies of Eckersley's dispersion law led to the discovery of a new phenomenon called the "nose" whistler. This was first identified in recordings made at College, Alaska, by the Geophysical Institute.

Identification of the "nose" effect is important because it provides information on the location of the path and the variation of ionization density along the path.

In cooperation with the NBS Boulder Laboratories, a study has been made of the lightning impulses which produce whistlers. It is found that they tend to be relatively lower in the audio-frequency band than non-whistler-producing impulses.

A controlled whistler-mode experiment involving transmission between Annapolis, Maryland, and Cape Horn, South America, has been performed successfully. Pulses at 15.5 kc were transmitted from station NSS and were received via both the ground-ionosphere path and the whistler path. The results support the Storey theory and provide new data on the characteristics of whistler-mode signals.

VLF emissions, including hiss, dawn chorus, and other unusual signals, have been explained in terms of a travelling-wave amplification theory developed jointly by Gallet and Helliwell. It is hypothesized that the emissions are the result of selective travelling-wave amplification of noise energy present in the interplanetary medium. Energy for the amplification process is provided by streams of ionized particles which come from the sun and follow the lines of force of the geomagnetic field. The mechanism of amplification is similar to that of ordinary travelling-wave tubes except that the "slow wave" circuit (provided by the helix of the tube) is the ambient ionization of the exosphere in the presence of the earth's magnetic field.

2. *Fundamental Properties of Radio Reflections from Meteoric Ionization Trails.* The directional properties of radio reflections from meteoric ion trails have been studied as a function of frequency in a spaced-transmitter experiment.

The length distribution of meteoric ionization trails has been investigated.

A theory has been developed which explains the fading of long-enduring meteor trails in terms of "glints", or specular reflections from small portions of an initially-straight trail distorted by the action of upper atmospheric winds. The theory relates the aspect sensitivity, diversity effect, fading-speed change, reflected-signal spectrum, rate distribution, delay to start of fade, and "Slow fade" phenomena to the statistical properties of the wind. The results confirm Whipple's photographically found winds, and exclude the presence of smaller-scale turbulence in appreciable amplitude.

Progress has been made in the theoretical prediction of the initial size of meteoric ion trails. In general, the size is found to be larger than previously assumed. This fact may account for observations that back-scatter meteoric echoes at 100 Mc/s are less numerous than would be predicted by a first-order extension of the simple low-frequency theory.

3. *The Rate and Radiant Distributions of Meteoric Ion Trails.* Studies of the rate of occurrence and the radiant distributions of the smaller meteor trails have led to information of importance both in the design of communication circuits utilizing intermittent meteor reflections, and in the design of "ionospheric forward scatter" circuits utilizing a continuous signal.

4. *Long-distance Radio Reflections from Auroral Ionization.* Echoes from ionization associated with auroral activity in the auroral zone have been detected in the high-frequency band at the relatively low geomagnetic latitude of Stanford, and have been under study for some time.

5. *Radio Reflections from Low-latitude Field-aligned Ionization.* It has been discovered that radio echoes in the high-frequency band may be obtained from ionization aligned with the earth's magnetic field at low geomagnetic latitudes. One class of echoes apparently occurs at E-region heights, and another at F-region heights. The E-region variety appears to be associated with the formation of Es ionization, and is seen at low latitudes as well as at high. The F-region variety apparently disappears as the sounding station is moved southward from the auroral zone. Neither of these effects is correlated with visible aurora or magnetic disturbance, although the echoes display a rapid fluctuation similar to that of radio echoes from auroral ionization.

6. *Studies of Sporadic E and of Tilts in the Ionosphere by the Ground Back-scatter Technique.* Ground back-scatter mirrored in the ionosphere has been used at Stanford to study the drift of individual clouds of sporadic E ionization. An extraordinarily high percentage of these clouds are found to drift from east to west, with an apparent speed of the same order of magnitude as that characteristic of ionospheric winds.

It has been found possible to observe, with simple scatter-sounding equipment, modes of ionospheric propagation which involve two or more successive reflections from the F-region without intermediate reflection from the ground. Ionospheric tilts are required to launch such modes, and to ensure the eventual return of the energy to the ground. Tilt-supported transmission is relatively strong, owing to focusing effects in the ionosphere and to the reduction of losses at the ground and in the D layer. The available evidence suggests that tilt-supported transmission is present for an appreciable fraction of the time, depending on ionospheric conditions and the location of the transmission path.

Part H: *U. S. National Bureau of Standards*

A substantial effort at the Radio Propagation Physics Division, particularly during the past year and one half, has gone into preparations for the IGY, including preparation of manuals for ionospheric vertical soundings, ionospheric scatter, and aurora and airglow. A new ionosphere recorder, NBS Model C-4, was designed and put into production. Four units were sent to the Antarctic Continent. Personnel were trained for and sent to five ionosphere stations in Antarctica, including the South Pole

station. Preparations were made for additional ionosphere stations in South America, a world data center to contain airglow and ionospheric physics data for the western hemisphere, the organization necessary for issuing "alerts" and specifying "special world intervals" by the IGY World Warning Agency, an equatorial ionospheric forward-scatter experiment, an experiment to measure sporadic E reflection coefficients at oblique incidence in various parts of the world, and a Western Hemisphere chain of airglow photometers.

Beginning in November 1955, solar-geophysical data formerly included in the CRPL-F series "Ionospheric Data," were published separately as CRPL-F Part B entitled "Solar Geophysical Data." The scope was expanded and now includes regular reports of daily solar indices (relative sunspot numbers and 2800 Mc solar flux), solar centers of activity (calcium plage and sunspot regions, and coronal line emission indices), solar flares (optical observations, and ionospheric effects), solar radio noise observations, geomagnetic activity indices, and radio propagation quality indices.

Work on the relationship between ionospheric disturbances and solar phenomena included statistical studies of the relationship of geomagnetic disturbances to the H_α filaments and to the configurations of magnetic maps of the sun (117).

Theoretical studies of aerodynamical mechanisms producing electronic density fluctuations showed that on certain reasonable assumptions regarding the distribution of electron density and turbulence in the E region, several of the characteristics of sporadic E can be accounted for. A comprehensive theory of the oscillations of the earth's atmosphere was developed which took account of input of thermal energy at all heights and frictional losses. Applications to the dynamo theory of the diurnal geomagnetic variations were made.

The characteristics of the ionosphere at low frequencies, including polarization, were studied using a pulse sounder sweeping in frequency from 50 kc to 1100 kc. An improved sounder, with a loop antenna having an area of approximately 111,000 square meters, was recently installed near Boulder, Colorado.

Studies of the arctic ionosphere included analysis of the temporal and geographical distribution of ionospheric sounding blackouts, a determination of the latitude distribution of auroral-zone absorption using oblique-path field-strength measurements across the auroral zone, and observations of relationships between aurora and sporadic-E echoes.

A comprehensive analysis of the world-wide occurrence of sporadic E was carried out, primarily on the basis of vertical-incidence data (fEs and h'Es) but including all available information.

Investigations of VHF ionospheric ("forward") scatter were

continued with emphasis on special experiments to elucidate the physical mechanisms involved, the fading characteristics, the heights at which the scattering takes place, polarization changes and dependence upon frequency and scattering angle.

It was concluded that overlapping meteor echoes play the dominant role during the night hours, while turbulent scatter is dominant only during the six-to-eight-hour period centered on noon. Routine recording over half of one complete sunspot cycle suggests that the scattered power varies with long-term sunspot activity. Successful transmissions over a 2270 km path proved that practical communications can be achieved over circuits up to about that length when elevated antennas are used.

Study of the radio noise emitted by the planet Jupiter at 18 and 20 Mc/s showed that Jupiter possesses an ionosphere with a critical frequency of roughly 15 Mc/s which appears to change with the sunspot cycle in much the same way as the ionosphere of the earth. Statistical analysis of the occurrence of the noise yielded a precisely determined period of rotation indicating that the noises originate from a rigid core beneath the clouds.

Part I: *U. S. Naval Research Laboratory*

The Naval Research Laboratory work on ionospheric research has taken advantage of high-altitude sounding rockets. Flights have been made up to 263 km, mostly at White Sands, New Mexico. Measurements have included electron-density profiles, differention absorption, positive and negative ion composition, neutral gas composition, air pressure and density, and the intensity of various ultraviolet and soft x-ray bands. Electron density profiles have also been compared with ground measurements.

Similar measurements will be made during the International Geophysical Year, but emphasis will be placed on making the measurements in the Arctic and during unusual solar or auroral activity. The results of the recently completed pre-IGY program are now being prepared for publication.

Part J: *U. S. Navy Electronics Laboratory (San Diego)*

Very low frequency and low frequency propagation research at the U. S. Navy Electronics Laboratory has been concerned primarily with a study of amplitude variations of transmitted signals. During 1954 and 1955 NEL conducted a program of airborne measurement of VLF field intensities out to about 7000 km from various U. S. Navy transmitters. The data were compared with empirical VLF field intensity formulas and J. A. Pierce's formula was found to give the most accurate prediction.

A plot of signal amplitude as a function of distance indicated an interference pattern out to 4000 km for daytime propagation and out to 7000 km, the maximum distance at which observations

were obtained, for nighttime propagation. The interference pattern was analyzed using a ray model of propagation. From this analysis, information was obtained concerning ionospheric reflection coefficients, height of ionospheric reflection, and phase change on reflection of the wave front at the ionosphere.

Work concerning low frequency propagation includes the analysis of a 135.6 kc signal recorded at sites about 1500 km from the transmitter in the Alaskan area. From the analysis, the „R„ component of the ionospheric reflection was obtained for an oblique angle of incidence. The night-to-night variation and mean variation throughout the nighttime period was obtained. A several-week mean of the daytime reflection coefficient was obtained.

Since the summer of 1955 the Stanford University Radio Propagation Laboratory has operated at Palo Alto, California, a 43.5 Mc radio transmitter with output power of a few hundred watts broadly directed toward San Diego by a 3-element Yagi antenna. At the San Diego terminal of the 690-km path, the Navy Electronics Laboratory has monitored the RPL transmissions, using a similar 3-element Yagi antenna connected to conventional receiving and recording equipment, for studying forward scatter by meteor trails.

Part K: *University of Alaska*

Radio studies of the ionosphere were carried out at various frequencies ranging from ultrahigh to very low.

The effect of the terrestrial ionosphere upon UHF and VHF radio waves passing through it has been investigated using interferometer systems to study the signals from discrete radio sources at frequencies of 223 Mc and 456 Mc. The irregular variations in apparent intensity and in apparent source position, associated with periods of radio star scintillation, have both been investigated.

The backscatter of HF and VHF radio waves by aurora has been studied at frequencies ranging from 12 Mc to 200 Mc. The aspect sensitivity was investigated using rotating antennas at 12, 50, and 100 Mc and showed that the radar echoes were most readily obtained when the radio waves were travelling almost perpendicularly to the magnetic field lines in the aurora. The aspect sensitivity was least marked at the lowest frequency. After allowing for the aspect sensitivity of the 100 Mc radar echoes, good correlation was found between the physical positions of the visual and radar aurora, although the visual brightness of the auroral form was no indication of the strength of the radar echoes from it. The Doppler shift of auroral echoes has also been studied.

High-latitude ionospheric absorption has been studied using 30 Mc and 65 Mc extra-terrestrial radio waves. Nighttime absorp-

tion events correlate well with visual aurora, particularly with "flaming" or "pulsating" auroral forms. The absorption correlates well with periods of magnetic disturbance; for a given degree of magnetic disturbance the absorption is considerably greater during the daylight hours than during the dark hours.

In the field of HF propagation the Geophysical Institute has continued its routine vertical-incidence soundings of the ionosphere under a contract with the National Bureau of Standards. The occurrence and properties of the third magnetoionic component on these soundings are under study.

An extensive experimental investigation of radio-wave propagation via the ionosphere in and near the auroral zone, which started in June 1949, was terminated in March 1957. This investigation included oblique-incidence backscatter soundings at 12 Mc, observations of the forward scattering of these pulses, and continuous field-intensity measurements of c-w transmissions at 4, 8, and 12 Mc over 1100 and 350 km path-lengths across and along the auroral zone.

The pulse observations have shown that auroral ionization will cause aspect-sensitive backscatter from E-layer heights.

In the field of VLF ionospheric propagation, observations of whistlers and "dawn chorus" have been made since July 1955. The whistler recordings led to the discovery of the "nose whistlers." The occurrence of "dawn chorus" has been studied with regard to daily and seasonal variation.

Part L: *University of Maryland*

Much of the effort here has been devoted to making rocket research cheaper and easier. In particular it should become adaptable to university research and to routine investigations of the ionosphere. For this purpose there have been developed and fired three types of sounding rockets: (i) An aircraft-launched 2.75-inch rocket whose cost is only $50 (exclusive of aircraft); (ii) a simple ground-launched rocket costing approximately $200; and (iii) a more elaborate ground-launched rocket capable of carrying a substantial payload, costing approximately $2000. This latter rocket is being improved to enable it to reach altitudes of over 300 km. Up to the present time the work has been devoted to preparing instrumentation and ground-station equipment, and the publications have been concerned primarily with techniques rather than results.

Considerable work has been done to demonstrate the utility of satellites for geophysical research, and a major review paper has been published covering many of these geophysical applications. It appears that even a minimum satellite, carrying only a few pounds of instrumentation, can give very valuable data which will help settle many crucial problems concerning not only the ionospheric layers but also the earth's interior and the lower atmosphere, as well as the state of the outer ionosphere.

Part M: *Other Institutions*

The original report summarized in Parts A to L incorporated extensive lists of published reports and presented papers reflecting work of the twelve institutions mentioned and also of the sixteen that follow: Collins Radio Company; Department of Terrestrial Magnetism of the Carnegie Institution of Washington; Harvard University; Lincoln Laboratory of the Massachusetts Institute of Technology; Ramo-Wooldridge Corporation; Raytheon Manufacturing Company; A. D. Ring and Associates; Smyth Research Associates; Syracuse University; U. S. Signal Corps Engineering Laboratories; University of California at Los Angeles; University of Michigan; University of Puerto Rico; University of Washington; Wittenburg College; and the Wright Air Development Center.

Chapter VI

AURORAL AND NIGHT SKY STUDIES

Part A: *General*

(Prepared by C. W. Gartlein.)

Fewer papers appeared during the triennium just ended than during the preceding one, owing largely to the intensive effort devoted to planning the IGY program and to setting it in operation. The auroral group regrets the transfer of A. B. Meinel and E. H. Vestine to other fields of research. The residence of Prof. Sydney Chapman in Alaska and Colorado and his contact with members of this group have been stimulating and helpful.

All the former observation programs by Cornell University, the Geophysical Institute of the University of Alaska, the Geophysics Research Directorate of the Air Force Cambridge Research Center and Yerkes Observatory have been continued.

The activity for the IGY has brought about such a vigorous international exchange of ideas and contacts that it is not necessary to outline the U. S. work in detail. The bibliography, though it makes no claim to completeness, will suffice to indicate the scope of the work. A short topical index to the bibliography is given on page 248. The index includes references to some papers that are given in other sections of the bibliography.

(NOTE: Parts B, C and D, not originally included in this chapter, were transferred here from other chapters in the course of editing the overall report. — R.E.G.)

Part B: *Geophysical Institute, University of Alaska*

(Prepared by J. C. Cain.)

Several observational studies have been made of the aurora borealis. Ashburn has taken photometric observations of the

relative intensities of the 5577A and 3914A auroral lines (153c) and of the specific intensities of the 5577A emission (153a). In the latter study he showed that the specific intensities increase with increasing zenith distance toward the magnetic north. In a preliminary study of visual auroral observations for 1951-53 from five stations spread over Alaska, Elvey and others (169c) have shown that there is a zone at geomagnetic latitude 68° for which the incidence of auroras is independent of magnetic activity. They also find that south of 67° the incidence of auroras is markedly dependent upon magnetic activity.

One theoretical study has been made concerning the airglow. Ashburn (153b) has used Chandrasekhar's theory of radiative transfer to calculate the effect of atmospheric scattering and ground reflection upon the determination of height of the night airglow when the extinction coefficient is 0.15. It is found that atmospheric scattering is a significant factor, but that the ground reflection is not important except for high albedo (snow cover).

Several general reviews have been written concerning the airglow and aurora. Elvey and Roach (169d) have discussed the general phenomena and observations of the aurora and airglow. Elvey (169b) has considered some of the problems of auroral morphology as investigated visually and by all-sky cameras. Chapman has reviewed the occurrence of aurora in middle and low latitudes (163b) and outlined the achievements and prospects in auroral and airglow research (163a).

Several theoretical studies have been made concerning the mechanics of gases in the upper atmosphere. In a note on persistent meteor trails, Chapman (163e) suggests that the luminosity of long-lasting (one hour or more) meteor trails may be explained by a catalyst in the meteor, such as sodium, drawing energy from an available atmospheric energy store, such as dissociated oxygen, and converting it to light. A mathematical discussion is given by Chapman (163c) concerning the molecular diffusive rate of change of composition in the atmosphere. A study was also made (163f) of the solar corona and its influence on the outer ionosphere of the earth. A mathematical analysis has been made by Chapman (163d) of a monochromatically ionized layer in a non-uniformly recombinant atmosphere. The results for the model atmospheres considered are tentatively discussed with reference to the E and D ionospheric regions. The physics of fully ionized gases have been investigated theoretically by Chapman and Brittin. Chapman (163g) has derived approximate formulas for the viscosity and thermal conductivity of a completely ionized gas. Numerical illustrations are given for ionized atomic hydrogen and for completely stripped atoms of atomic number 20 and atomic weight 40. In a doctoral dissertation, Brittin has applied non-equilibrium statistical mecha-

nics to a system of charged particles interacting via the electromagnetic field. An exact form for the hydromagnetic equations is derived, and it is shown that these equations differ from those that are customarily considered to be exact.

Part C: *U. S. Air Force Cambridge Research Center*

Prior to the shipment of a high-dispersion spectrograph to New Zealand for auroral studies during IGY, attempts were being made to obtain higher resolution in the infrared region of the night-sky spectrum at middle and low latitudes. When the new improved f/0.8 spectrograph now being constructed is completed, new observations will be made to determine rotational temperature given by highly resolved OH bands in the infrared.

Development of a high-aperture sequence camera designed to take photographs at fraction-of-a-second exposures has been completed. It will be utilized when the autumnal equinoctial increase in aurora commences.

A photometer has been developed to measure the height distribution of $H\beta$ in the aurora. This instrument is presently being used at one of the Antarctic IGY stations.

Design and construction of equipment has been completed for the study of the mechanisms of auroral scatter across the auroral zone. This equipment is to be installed in the Alaskan area.

A very considerable amount of effort and time during the past two years has been spent in planning the IGY auroral program, particularly that phase involving the auroral patrol spectrograph. This spectrograph has been based on a joint study by this laboratory and the University of Chicago. This laboratory also has the responsibility for the entire Antarctic and Arctic auroral program.

Part D: *U. S. National Bureau of Standards*

Observational work on the night airglow started at Fritz Peak, near Boulder, Colorado, in January 1955, with the installation of a photometer transferred from the Cactus Peak, California, station. In October 1956 there was installed a second photometer, having a birefringent filter for the elimination of background radiation from astronomical sources. The large accumulation of data is being measured with the help of an oscillogram reader which puts the measurements on punched cards. Particular emphasis is being placed on the synoptic study of the data for a number of nights when simultaneous observations were made at Fritz Peak and at Sacramento Peak, 500 miles to the south. In preparation for the IGY, an observing station is being established at Rapid City, South Dakota, which will be operated under NBS supervision. Equipment made at Boulder has been installed

at Camden, Australia, and a cooperative research program is in progress.

Topical Index to Bibliography on Aurora and Airglow:

General: 35a, 163a, 169d, 171a, 179, 183a, 183d, 189, 190.

I. G. Y.: 162j, 163h, 171b, 172c, 174, 175, 186, 192b.

Instrumentation: 163h, 165, 167a, 167b, 171b, 176a, 177, 178b, 178c, 192b, 193a, 196.

Mathematics: 17j, 163c, 163d, 163g, 192d, 192e.

Motions: 157, 183b, 183c, 191, 197, 198.

Observation: 114, 153a, 156, 157, 162j, 163b, 168, 169a, 169b, 169c, 170d, 173, 180, 182, 183b, 183d, 191, 192a, 253.

Photometry: 153c, 177, 187a, 187b, 192b, 192c, 193c, 193d.

Radio reflection: 98b, 158, 159, 172a, 172b, 188.

Spectra: 154, 162f, 162g, 162h, 162i, 162j, 170a, 170b, 170d, 176b, 178a, 227a, 245.

Theory: 55b, 155a, 155b, 155c, 155d, 160, 161, 162a, 162b, 162c, 162d, 162e, 162j, 163e, 163f, 164, 166a, 166b, 170c, 181, 184, 185, 191, 193b, 194, 195, 199, 253.

Chapter VII

COSMIC RAYS

by

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Cosmic rays are of concern in nuclear and meson physics, in geophysics, and in astrophysics. The present review stresses certain topics bearing on the two last-named fields, such as the variations of cosmic-ray intensity in relation to electromagnetic conditions near the Earth and to processes in the solar atmosphere. Related matters to be considered will be the properties of the primary cosmic radiation, its composition and energy spectrum; the absence of low-energy primaries and its interpretation; and the kinds of fluctuation of cosmic-ray intensity that have been studied in the past three years. A general review of these topics has been completed during the past year (238a).

Part A: *Composition of Primary Radiation and its Energy Spectrum*

It is known that the cosmic rays consist of protons, alpha-particles and heavier primaries, all the way up to iron. One would like to know the exact percentage of the various charge components as a function of the energy, or, in other words, the energy spectra of the various components. In the lower-energy

region one can use the geomagnetic field as a momentum spectrometer. Therefore, by measuring the primary flux values at various latitudes down to the equator, one can determine the distribution in rigidity up to a magnetic rigidity of 1.5×10^{10} volts. At higher moments or energies, direct measurements of the energy have to be made, and this is generally possible only for heavy primaries which can be observed in photographic plates and whose interactions there can be carefully studied.

The best known spectrum is that of the alpha particles. They are easiest to measure and to interpret, since the difficulties of atmospheric absorption and identification which exist for heavy primaries do not affect them; also, they are not subject to the problems of albedo (upward moving secondary radiation) which beset measurements of the primary proton intensity. Measurements of the alpha flux at the latitudes of Minnesota and White Sands have been made by groups at Minnesota and at the University of Iowa (209, 218, 223, 225, 226). At the equator, the flux value has been measured by the Naval Research Laboratory. Taken together these determinations give an alpha spectrum having an exponent of about 1.6 and of the form

$$N(>E) = 460\ E_t^{-1.6} \text{ per } M^2\text{-sec-steradian};$$

here E_t is the total energy per nucleon.

The lowest-energy portion of the alpha spectrum has been investigated with high-altitude balloons flown in Canada by the Minnesota group, yielding evidence for a peak at an energy of around 300 Mev per nucleon, followed by a decline in the number of particles at lower energies. This is interpreted as a low-energy cutoff or a "knee" of the primary alpha particles (213).

The proton spectrum has been investigated both in high-altitude balloons and with rockets, the main problem being the elimination of the cosmic-ray albedo. Measurements have been carried out at the University of Minnesota and also at Iowa. An analysis of available data leads to a proton spectrum having an exponent of 1.15 and of the form

$$N(>E) = 4000\ E_t^{-1.15} \text{ per } M^2\text{-sec-steradian.}$$

This analysis depends crucially on the proton flux at the equator and on our accurate knowledge of the albedo contribution at the equator (209). It is hoped that this matter can be cleared up by more direct experiments.

A number of advances have been made in our knowledge of the heavy primaries. It seems fairly certain now that Li, Be, and B do exist in the primary radiation above the earth's atmosphere, i.e., are not completely due to fragmentation in the atmosphere above the balloon (220). This leads to the conclusion that the cosmic rays must have traversed a minimum density of 1 to 2 g/cm^2 in the interstellar space so that the Li, Be, and B could be

produced by fragmentation of heavier primaries. Depending on the exact numerical values of the fragmentation probabilities, it is conceivable that a large fraction, if not all, of the primary protons and alphas are also the result of fragmentation (232). In order to clear up this possibility, one needs better measurements of fragmentation probabilities plus a measurement of the Li, Be, and B flux above the atmosphere.

The energy spectra of the heavy primaries (244), the C, N, O, F, group and for $Z > 10$ has been tackled mainly by the University of Minnesota group, who have made balloon exposures of cosmic-ray emulsions at various latitudes all the way down to the equator (207). Their present findings show a very steep spectrum, 2.0 for CNOF and 2.3 for the heaviest primaries. However, it seems that the flux values at the equator are probably too low so that the heavy spectra may be about as steep as the alpha spectrum, namely an exponent of 1.5 to 1.6. Again, this situation is not completely settled as of July 1957.

Part B: *Geomagnetic Theory*

Work on the motion of cosmic rays in the earth's magnetic field has been stimulated mainly by the observations of cosmic-ray increases coupled with solar flares. These led to calculations giving the impact points for cosmic-ray trajectories starting in the vicinity of the sun. Work along these lines has been done by Jory (219b) and Lüst, University of Chicago, and experimentally the problem has been tackled by Bennett, NRL, using a device named the Störmertron. But, in addition, some classical problems have been reexamined, e.g., the question of the penumbra at intermediate latitudes was explained by Schwartz. Jory has also calculated the effects of a quadrupole component on the longitude effect of cosmic rays. Additional stimulation to the work has been offered by results derived from two sources: (i) an apparent shift in the geomagnetic equator which was noted from sea level traverses using a neutron counter (237c), and (ii) direct measurement of the cutoff energy in photographic emulsions for heavy primaries and a comparison with the cutoff energy calculated from geomagnetic theory. Both show that the geomagnetic field is twisted or distorted at large distances from the earth (237e). The cause has not been clearly established. It is possible, however, that the larger-scale inhomogeneities of the field have a greater influence on the cosmic-ray cutoff energies than has hitherto been suspected. (See also Chapter II, Part F.)

Part C: *Latitude Cutoff*

Neher has extended his work using high-altitude balloons at high latitudes and established the fact that the cutoff appears again after 1954 (230). (In 1954 the latitude cutoff had been

reduced to a much lower energy, of the order of 150 Mev for protons.) Simpson and Meyer have also found that the form of the energy-spectrum changes as a function of the solar cycle, particularly at the very lowest energies (228c). However, no precise measurement of the latitude cutoff exists as a function of time because of the difficulty of such measurements (210). It is hoped that satellite observations may provide continuous measurements of this type for the first time. The Minnesota group has obtained evidence on the low-energy portion of the alpha spectrum and of the heavy primary spectrum which indicates that peaks exist at different rigidities (213). This result is in contradiction with the measurements by Ellis et al. (210) who have shown that the energy cutoff exists at the same rigidity for all charges and could, therefore, be due to a screening by a magnetic field.

The latitude cutoff can be explained on two bases: (i) screening by a magnetic field and (ii) in some other manner. Supporting the first possibility there has been the work of Ray (236b), who considered the effects of a Störmer ring current on cosmic-ray orbits and showed that under certain conditions such a latitude cutoff could be produced. Parker (234a) has considered the effect of a turbulent magnetic screen existing in gas emitted by the sun and bound to the earth by gravitational fields. Both of these theories would give cutoffs at the same rigidity for all components of the primaries. Singer (238b) on the other hand has considered a different mechanism in which the limit is given by absorption, and in which the cutoff would be at a higher rigidity for primary alpha particles and heavier nuclei.

Part D: *Investigations of a Secondary Variation and Time Variations*

Most of the time-variations of cosmic rays are deteced in the secondary radiation, since at present the primary radiation cannot be observed continuously. This state of affairs will change after satellite observations become possible. In the meantime, however, the neutron-counting technique, which has been utilized especially by Simpson and his group, has made possible the detection of time changes of the energy components of the primary radiation. For the lowest-energy component, balloon experiments are necessary (219b). Thanks to the I.G.Y. a large increase will be possible in the number of observing stations, providing a much better opportunity for observing time variations. Also, more refined observing techniques have become possible, e. g., detectors with higher sensitivity, so that we may look forward to a better understanding of some of the phenomena after the I.G.Y. data have been collected and interpreted.

Part E: *Diurnal Variation*

The diurnal variation of the secondary component measured at sea level and on mountains by means of ionization chambers and counters is quite small (0.3 %). Diurnal variation of the neutron component is perhaps three times larger. No satisfactory explanation has yet been offered to explain the phase and magnitude of the diurnal variation and its occurrence and disappearance. It is hoped, however, that detectors with better statistics will give direct information obviating reliance on the statistical superposition of the data of many days or many stations. It is clear that the diurnal variation must be due to an anisotropy of the cosmic rays outside the earth's atmosphere (221). The diurnal-variation amplitude seems to show a 27-day recurrence. There is also a 27-day recurrence in the total cosmic-ray intensity, and this links the phenomenon quite definitely with corpuscular emission from the sun.

Part F: *27-Day Variation*

There is some question whether the 27-day variation should be regarded as an increase or a decrease of the intensity as referred to a general norm. The first alternative is advanced by Simpson (237c) but Brown (204b) prefers the second.

Part G: *Irregular Variations*

Aside from the regular variations, some of them associated with the solar cycle (212d), there are also certain occasional variations of the cosmic radiation. Most prominent are the increases which accompany some solar flares (214) and the decreases, lasting sometimes several days, which accompany some magnetic storms.

Part H: *Solar-Flare Increases*

An outstanding increase in cosmic-ray intensity was observed during the solar flare of February 23, 1956. It has been the subject of a number of papers, all pointing out the time of increase, the rapidity with which the intensity reached a value several times higher than normal and the slow fall-off to the previous value. The question of the spectrum of the additional radiation has been discussed. An explanation has been sought for the slow fall-off of the radiation, either in terms of a storage in the interplanetary system by a turbulent, reflecting screen located beyond the earth (228a), or in terms of a regular magnetic field which confines cosmic rays to a small region of the interplanetary space.

Part I: *Magnetic-Storm Decreases*

Decreases of cosmic-ray intensity (205) coupled with magnetic storms were first observed by Forbush on a world-wide basis.

The cause of the Forbush decreases has occupied much space in the literature of recent years. Morrison (229a) has proposed a model in which a turbulent magnetic field, produced in interplanetary space, keeps cosmic rays from reaching their steady-state intensity near the earth for a day or so. Parker (234a) has shown that this turbulent cloud has to be geocentric in order to act as an effective screen for cosmic rays. Singer (238b) on the other hand, has considered that magnetic screening cannot explain the features of the Forbush decrease and that an actual deceleration or loss of energy of cosmic rays must be invoked. He has worked out a model of diffusive deceleration in interplanetary space based on ideas of hydromagnetic turbulence.

This brief summary does not pretend to be a complete account of the work done in the United States during the triennium. Only those topics have been discussed which are thought to be of particular significance in connection with the cosmic-ray research of the International Geophysical Year. It is to be expected that the great increase in cosmic-ray observations produced by the many additional stations that will be located throughout the world, as well as the possibility of continuous observations of the primary radiation with earth satellites, will clear up many of the puzzling features connected with the primary spectrum and the time variations of cosmic rays.

For a general discussion of the origins of cosmic rays in the galaxy see reference 229c.

Chapter VIII

COSMIC-TERRESTRIAL RELATIONS

Concern with cosmic-terrestrial relations is implicit in many of the activities discussed in earlier chapters of this report, but it is appropriate to compile an additional list (part viii of the Bibliography) of papers that deal specifically with this field, and to note in particular the reports (277) of a special committee of the American Geophysical Union. In 1956, a valuable symposium on solar and terrestrial relationships was held at the National Academy of Sciences (280). (Several papers in the vigorous new field of radio astronomy are included in the bibliography.)

For convenient reference, there are listed here several segments of this report that deal at some length with cosmic-terrestrial relations, as well as the reference numbers of some pertinent papers:

Text

Chap. II: Parts B, F, I.
Chap. V: Parts C, G, H, I, J, K.
Chap. VI: Part B.
Chap. VII: Parts B, C, H, I.

Bibliography

Parts i-iii: Items 3, 4, 8, 10, 17c, 17d, 17e, 17f, 18, 27, 35, 47, 50, 52, 55, 57, 61.

Part v: Items 87a, 87b, 90a, 97a, 97d, 103b, 104a, 104c, 108, 114, 117, 118, 120a, 147, 149c.

Part vi: Items 155, 173, 183a, 184.

Part vii: Items 212c, 222, 228b, 229a, 236, 237a, 237b, 241.

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This bibliography is built around the reference lists that accompanied the several contributions comprising the foregoing report, with considerable added material, the whole being consolidated into a limited number of categories for convenient reference. There was some disparity among the contributed lists as to their scope and interval of coverage. It has been thought best for consistency to retain only those papers of which complete versions are generally available, and largely to exclude those that appeared prior to mid-1954. Even within these limits, complete coverage cannot be claimed, but many pertinent references coming to our attention have been included even though they are not cited in the text. The emphasis is on fundamental aspects of the field and on broad applications rather than on detailed field results or specialized engineering topics.

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Part IV

Special Reports

Committee No. 1

Committee on Observatories

Report by E. Lahaye, Chairman

Membres du Comité:

Dr. I. A. Fleming †, Président d'honneur

Prof. Dr. E. Lahaye, Président

Prof. J. Bartels	Dr. R. Glenn Madill
Dr. J. W. Beagley	Prof. E. Medi
Prof. J. Coulomb	Dr. J. H. Nelson
Dr. A. L. Cullington	Dr. S. K. Pramanik
Dr. A. A. Giesecke	Dr. L. S. Prior
Dr. P. Herrinck	Capt. E. B. Roberts
Dr. H. F. Johnston	Dr. J. Rodriguez-Navarro de Fuentes
Dr. J. D. Kalinin	Dr. J. Veldkamp
Dr. V. Laursen	Dr. E. Selzer
Dr. O. Lützow-Holm	Dr. R. F. Thyer

Le Comité des Observatoires tient tout d'abord à exprimer la douloureuse émotion que lui a causé le décès de son Président d'honneur, le Dr. I. A. Fleming. Il rend à sa mémoire un hommage de profonde reconnaissance et d'admiration pour l'œuvre si féconde réalisée par le Dr. Fleming et pour son dévouement admirable aux progrès du Géomagnétisme.

Lors de sa session tenue à Bruxelles en septembre 1955, le CSAGI avait, en suite d'une suggestion de l'AIGA, adopté la résolution suivante:

> "The CSAGI endorses the suggestion of the International Association of Geomagnetism and Aeronomy, that the Association Committee on Observatories be charged with the preparation of a list of all IGY magnetic stations with detailed information as to instrumental equipment and availability of data at each station."

Dans le but de répondre à cette résolution, le Comité a mis au point un formulaire précis et étendu, dont les textes en français et en anglais sont reproduits dans les annexes I et II. L'envoi de ces formulaires a eu lieu au début du mois d'août 1956.

Il convenait en effet que cette importante enquête ne débutât pas trop tôt, afin de pouvoir mettre à la disposition des Membres de l'AIGA les données les plus récentes sur les installations scientifiques des différents observatoires, et notamment sur les installations temporaires organisées à l'occasion de l'AGI. Les réponses se sont échelonnées depuis septembre 1956 jusque février 1957. Un rappel a été envoyé en mars 1957.

Actuellement, les observatoires indiqués dans l'annexe III ont répondu d'une manière complète au formulaire.

Le Comité considère ce résultat comme très satisfaisant. Il tient à exprimer ses plus vifs et plus sincères remerciements à tous ceux qui ont ainsi collaboré à ses efforts. Il apprécierait particulièrement toute suggestion tendant à améliorer ce formulaire.

Les réponses seront reproduites par les soins de l'Institut Royal Météorologique de Belgique, selon un procédé off-set, et telles qu'elles ont été rédigées. Cette publication, qui contiendra donc des documents rédigés en anglais, en allemand, en espagnol et en français, sera très probablement distribuée vers la fin du mois de mai 1957.

Le Comité considère qu'une démarche ultérieure devrait être la traduction de ces documents au moins en français et en anglais et leur impression définitive sous forme de feuilles perforées sous reliure mobile. Il considère en outre que cette initiative ne peut être décidée que par l'AIGA et n'est plus de la compétence du Comité des Observatoires. Il estime également qu'étant donné l'importance scientifique que présente le réseau des Observatoires magnétiques, il conviendrait que le secrétariat de l'AIGA puisse disposer d'un bureau permanent dont une des tâches serait de faire connaître régulièrement les modifications et les améliorations de ces observatoires.

Le Comité apprécie tout particulièrement les efforts considérables qu'accomplissent plusieurs pays pour établir des stations temporaires dans des régions inhospitalières et contribuer ainsi à supprimer pendant l'AGI, des lacunes importantes du réseau des observatoires magnétiques. Il souhaite vivement que les initiatives audacieuses qui se manifestent ainsi ne soient pas toutes limitées à la durée de l'AGI, et que certaines se poursuivent ultérieurement. En particulier, il considère que certaines stations de l'Antarctique devraient avoir un caractère international permanent et que certains pays devraient se relayer annuellement en ces stations afin d'y poursuivre d'une manière continue des observations dans le domaine du géomagnétisme, portant notamment sur le champ magnétique terrestre, l'ionosphère, les courants telluriques, les aurores, le ciel nocturne, etc.

Annexe I.

Formulaire adressé à tous les observatoires géomagnétiques permanents dans le but d'obtenir à l'occasion de l'Année Géophysique Internationale une description détaillée de leurs installations scientifiques ainsi que des informations étendues sur leurs activités.

I. OBSERVATOIRES MAGNETIQUES PERMANENTS

1. *Renseignements généraux.*

Nom de l'observatoire
Adresse de l'observatoire (village, province, pays)
Numéro de téléphone de l'observatoire
Institution dont il dépend
Adresse de cette Institution
Adresse où l'on peut obtenir les copies des enregistrements et des observations.

2. *Position géographique.*

2.1 Latitude (avec une précision d'au moins un dixième de degré).
2.2 Longitude Greenwich (id.).
2.3 Latitude géomagnétique.
2.4 Longitude géomagnétique
(N. B. Pour assurer l'uniformité des coordonnées géomagnétiques, il conviendrait d'utiliser les coordonnées établies par le Comité Spécial de l'Année Géophysique Internationale et qui sont basées sur les coordonnées suivantes du pôle Nord géomagnétique: 78°,5 N, 69° W).
2.5 Altitude (en mètres et en pieds).
2.6 Allure et nature du terrain au voisinage de l'observatoire.

3. *Brève note historique.*

Date de la création. Si l'observatoire actuel continue ou remplace un autre observatoire, indiquer le nom de ce dernier et sa distance approximative au nouvel observatoire. Date de la mise en station des appareils actuellement utilisés. Etc.

4. *Brève note sur les bâtiments abritant les appareils.*

Répartition des locaux; dimensions; matériaux employés pour la construction; mode de chauffage, etc.

5. *Perturbations artificielles.*

Indiquer si des lignes électriques de tramways ou des lignes de chemin de fer électriques produisent de faibles pertur-

bations; si possible, en préciser la nature. Dans ce cas, indiquer la distance approximative de la ligne la plus proche.

6. *Equipements pour l'enregistrement.*

6.1 *Variomètres.* Donner des précisions sur:

6.1.1 Leur type, la date approximative de leur construction.

6.1.2 Leur sensibilité.

6.1.3 L'orientation des aimants: par rapport au méridien magnétique (déclinaison); par rapport au plan normal du méridien magnétique (composante H); par rapport au plan horizontal (composante Z).

6.1.4 Les dispositifs utilisés pour contrôler les orientations.

6.1.5 Le contrôle et la compensation de la température.

6.1.6 Les dispositifs utilisés pour déterminer les valeurs d'échelle; la précision atteinte, le nombre de déterminations effectuées par an.

6.2 *Enregistreurs.* Donner des précisions sur:

6.2.1 Leur type, la date approximative de leur construction.

6.2.2 Leur vitesse de déroulement.

6.2.3 Le dispositif utilisé pour obtenir les marques de temps; la précision de ces marques.

N.B. Dans cette rubrique doivent également figurer les renseignements concernant les équipements pour l'enregistrement des variations rapides des éléments magnétiques.

7. *Equipements pour les mesures absolues.*

7.1 Appareils absolus utilisés. Description très succincte ou références. Précision des mesures.

7.2 Nombre de mesures absolues de chaque élément normalement effectuées en un an.

7.3 Indiquer si des comparaisons avec des instruments absolus d'autres observatoires ont été faites. Dans l'affirmative, indiquer les dates et les résultats de ces intercomparaisons et la manière dont elles ont été faites.

8. *Equipements pour les mesures en campagne.*

Type d'appareils utilisés; description très succincte ou références; précision des mesures.

9. *Autres équipements pour des mesures magnétiques non utilisés en service continu.*

   Par exemple, pour: mesure des susceptibilités de l'induction magnétique, etc.

10. *Autres installations géophysiques dépendant de l'observatoire ou situées dans son voisinage.*

    Brèves descriptions des installations de courants telluriques, de sondages ionosphériques, de rayonnement cosmique, etc.

11. *Publications des données magnétiques.*

    11.1 Titre du recueil contenant ces données, périodicité de sa publication (annuelle, semestrielle, etc.); date du dernier recueil; date des données les plus récentes publiées. Adresse où l'on peut obtenir ces publications.

    11.2 Heure utilisée. Différence entre l'heure locale et l'heure GMT.

    11.3 Eléments dont les valeurs sont publiées (D, H, Z, X, Y . . .).

    11.4 Indiquer si ces valeurs sont des valeurs horaires ou non.

    11.5 Si elles ne sont pas des valeurs horaires, indiquer comment elles sont calculées.

    11.6 Si elles sont des valeurs horaires;

    11.6.1 Sont-elles mesurées aux heures exactes.

    11.6.2 Ou sont-elles des valeurs moyennes pour un intervalle de une heure; cet intervalle de une heure finit-il à une heure exacte ou 30 minutes après une heure exacte.

    11.7 Autres valeurs publiées (sommes et moyennes journalières; sommes et moyennes horaires mensuelles; valeurs moyennes pour les cinq jours calmes et les cinq jours perturbés; maxima et minima journaliers; heures des débuts brusques; crochets; pulsations, indices; etc.).

    11.8 Indiquer si des magnétogrammes sont publiés et comment ils sont choisis.

    11.9 Indiquer si les résolutions adoptées à Rome en septembre 1954 par l'AIGA au sujet de la publication des données magnétiques, résolutions qui figurent dans le paragraphe 22 des résolutions, reproduit en annexe, seront appliquées entièrement dans les prochains recueils des données ou seulement partiellement. Dans ce cas, indiquer quelles sont les résolutions qui ne seront pas suivies.

11.10 Indiquer si certaines des données ne sont pas publiées. Dans l'affirmative, indiquer s'il est possible de les obtenir et par quels moyens.

11.11 Indiquer si l'observatoire contribue à la publication internationale des caractères magnétiques.

11.12 Indiquer si les données et les enregistrements de l'observatoire peuvent être obtenus sur micro-films; les conditions d'obtention; l'adresse où l'on peut obtenir ces micro-films.

12. *Publications autres que celles contenant les données magnétiques.*

Titres des publications contenant des études rentrant dans le cadre de l'activité de l'AIGA: géomagnétisme, courants telluriques, observations ionosphériques, etc. Adresse où l'on peut obtenir ces publications.

II. STATIONS MAGNETIQUES TEMPORAIRES ETABLIES EN VUE DE COLLABORER AUX OBSERVATIONS DE L'ANNEE GEOPHYSIQUE INTERNATIONALE

N.B. Les renseignements à fournir sont analogues à ceux indiqués dans I, mais en tenant compte du caractère temporaire des installations. Il y aura donc lieu de fournir les renseignements suivants:

1. *Renseignements généraux.*
   Fournir les renseignements comme ils sont demandés en I.1.
2. *Position géographique.*
   id. en I.2.
3. *Brève note historique.*
   Date de la mise en fonction ou de la mise en fonction probable. Durée probable des observations.
4. *Brève note sur les constructions abritant les appareils.*
   Fournir les renseignements comme ils sont demandés en I.4.
5. —
6. *Equipements pour l'enregistrement.*
   id. en I.6.
7. *Equipements pour les mesures absolues.*
   id. en I.7.
8. —
9. —

10. *Autres installations géophysiques dépendant de la station.*

Brève description des installations éventuelles pour les courants telluriques, les sondages ionosphériques, le rayonnement cosmique, etc.

Annexe

Résolutions au sujet de la publication des données magnétiques adoptées par l'AIGA à Rome en septembre 1954.

.....

22) L'AIMET 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 absolues 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 extrèmes;

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.).

Annexe II.

The annexed form of enquiry is sent to all magnetic observatories in order to collect for the IGY a complete description of the scientific equipment used and full information regarding the activities of the observatories.

I. PERMANENT MAGNETIC OBSERVATORIES.

1. *General information.*

Name of observatory
Address of observatory (village, province, country)
Telephone number of observatory
Institution to which it belongs
Address of this institution
Address at which copies of records and observations may be obtained.

2. *Geographical location.*

2.1 Latitude (with a precision of at least one tenth of a degree).

2.2 Greenwich longitude (id).

2.3 Geomagnetic latitude.

2.4 Geomagnetic longitude
(N. B. In order to ensure uniformity of geomagnetic coordinates, it is advisable to use the coordinates fixed by the CSAGI which are based upon the following coordinates of the geomagnetic North Pole: 78°,5 N, 69° W).

2.5 Altitude (in meters and in feet).

2.6 Appearance and nature of the site near the observatory.

3. *Brief historical notice.*

Date of establishment. If the present observatory replaces another observatory, give name of the former and its approximate distance from the new observatory. Date of installation of instruments in present use. Etc.

4. *Brief notice on buildings containing the instruments.*
Lay-out of the floor space; dimensions; materials used in building; type of heating; etc.

5. *Artificial perturbations.*
State whether electric tram lines or railway lines produce slight perturbations; whenever possible, specify the nature of such perturbations, and also state approximate distance of nearest line.

6. *Recording equipment.*
   6.1 *Variometers:* State particulars about
      6.1.1 Their type, approximate date of construction.
      6.1.2 Their sensitivity.
      6.1.3 Orientation of magnets:
         a) with respect to the magnetic meridian (declination);
         b) with respect to the plane perpendicular to the magnetic meridian (component H);
         c) with respect to the horizontal plane (component Z).
      6.1.4 Devices used to check orientations.
      6.1.5 Control and compensation of temperature.
      6.1.6 Devices used to measure scale values; precision reached, number of measurements per year.
   6.2 *Recorders:* State particulars about
      6.2.1 Their type; approximate date of construction.
      6.2.2 Speed of recording.
      6.2.3 Time-marking device used; precision of time-marks.
      N.B. This paragraph should also contain information about recording equipment for short-period variations of magnetic components.

7. *Equipment for absolute measurements.*
   7.1 Absolute instruments used. Very brief description or reference. Precision of measurements.
   7.2 Number of absolute measurements for each component which are normally carried out in one year.
   7.3 State whether comparisons have been made with absolute instruments of other observatories. If so, give dates and results of such inter-comparisons and manner in which they were made.

8. *Equipment for field measurements.*
   Type of instruments used; very brief description or references; precision of measurements.

9. *Other equipment for magnetic measurements not in constant use.*
   For example, for measuring magnetic susceptibility of rocks, etc.

10. *Other geophysical installations belonging to the observatory, or situated in its vicinity.*
    Short descriptions of installations for earth's currents, ionospheric soundings, cosmic radiation, etc:

11. *Publication of magnetic data.*
    - 11.1 Title of publication containing these data, periodicity of publication (annual, six-monthly, etc.); date of most recent publication stating period covered.
      Address where publications may be obtained.
    - 11.2 Time used. Difference between local and universal time.
    - 11.3 Components whose values are published (D, H, Z, X, Y...).
    - 11.4 State whether these are hourly values or not.
    - 11.5 If they are not hourly values, state how they are calculated.
    - 11.6 If they are hourly values.
      - 11.6.1 Are they measured at the whole hour.
      - 11.6.2 Or are they mean values for a period of one hour; Does this one-hour period end at the whole hour or 30 minutes after the whole hour.
    - 11.7 Other published values (daily sums and means; monthly hourly sums and hourly means; mean values for the five quiet days and the five disturbed days; daily maxima and minima; times of sudden commencements; crochets; pulsations, geomagnetic indices, etc.).
    - 11.8 State whether any magnetograms are published and how they are selected.
    - 11.9 State whether the resolutions (these resolutions are to be found in paragraph 22 of the resolutions of which a copy is given in the annex) adopted by IAGA in Rome in September 1954, concerning the publication of magnetic data, will be applied wholly in the next collection of data, or only partially. If only partially, state which resolutions will not be carried out.

11.10 State whether any data are not published. If so, state whether it is possible to obtain them and how.

11.11 State whether the observatory contributes to the international publication of magnetic indices.

11.12 State whether data and recordings of the observatory may be obtained on micro-film; what are the conditions for obtaining them; address at which to ask for these micro-films.

12. *Publications other than those containing magnetic data.*
Titles of publications containing papers relevant to IAGA activities: geomagnetism, earth's currents, ionospheric observations, etc. Address where such publications may be obtained.

II. TEMPORARY MAGNETIC STATIONS SET UP FOR THE PURPOSE OF TAKING PART IN THE OBSERVATIONS OF THE INTERNATIONAL GEOPHYSICAL YEAR.

N.B. The information to be given is similar to that set forth in I, remembering, however, the temporary nature of the installations. The following information should therefore be given:

1. *General information.*
Give information as required in I. 1.
2. *Geographical location.*
id. in I. 2.
3. *Brief historical notice.*
Date of commencement of operation or probable date of commencement. Probable duration of observations.
4. *Brief notice on building containing the instruments.*
Supply information as requested in I. 4.
5. —
6. *Recording equipment.*
id. in I. 6.
7. *Equipment for absolute measurements.*
id. in I. 7.
8. —
9. —
10. *Other geophysical installations belonging to the station.*
Short description of possible installations for earth currents, ionospheric soundings, cosmic radiation, etc.

Annex

Resolutions concerning the publication of magnetic data adopted by IAGA in Rome, September 1954.

.....

22) The IATME recommends the publication by magnetic observatories, through the media of year books or other publications, of the following data, 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 centered 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 baseline 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.

Annexe III

Australia
I. Toolangi
Macquarie Island
Mawson (Antarctica)
Port Moresby
II. Darwin
I. Watheroo
Gnangara

Belgique
I. Dourbes
Manhay
II. Base Belge Antarctique

Brazil
I. Vassouras
Tatuoca

Czechoslovakia
I. Prúhonice
Hurbanovo

Denmark
I. Rude Skov

Deutschland
(Bundes Republik)
I. Wingst
Fürstenfeldbruck
II. Göttingen

(Demokrat. Republik)
I. Niemegk
II. Warnkenhagen
Ueckermünde
Herrnhut

Egypt
I. Helwan

España
I. Ebro
San Fernando
Toledo
Almeria
Logroño
II. Tenerife

Finland
I. Nurmijärvi
Sodankylä

France
I. Chambon-la-Forêt
Nantes
Tamanrasset
Tananarive
Bangui
M'Bour

Great Britain
I. Hartland
Abinger
Argentine Island
Eskdalemuir
Lerwick
II. Halley Bay

India
I. Alibag

Indonesia
I. Kuyper
Tanggerang

Ireland
I. Valentia

Italia
I. L'Aquila
II. Asiago
Gibilmanna
Corinaldo

Japan
I. Kakioka
Memambetsu
Aso
II. Onagawa
Shimosato
Kanoya

Mexico
I. Teoloyucan
II. Tonantzintla

Nederland
I. Witteveen
II. Paramaribo
Hollandia

New Zealand
I. Amberley
Apia
II. Scott Base

Norway
I. Dombås
Tromsö

Österreich
I. Wien-Kobenzl

Philippines
I. Muntinlupa

Poland
I. Swider
Hel
Belsk

Portugal
I. Coimbra
S. Miguel (Acores)

South Africa
I. Hermanus

Sweden
I. Abisko
Kiruna
Lovö

Turquie
I. Kandilli

USSR
I. Chelyuskin
Dixon
Kazan
Irkutsk
Lvov
Moscow
Odessa
Srednikan
Sverdlovsk
Tashkent
Tbilisi
Tikhaya Bay
Tixie
Vikhodnoi
Voeikovo
Voroshilov
Wellen
Yakutsk
Yuzhno — Sakhalinsk

USA
I. Barrow
College
Fredericksburg
Honolulu
San Juan
Sitka
Tucson
II. Little America (Antarctica)
Byrd Station (Antarctica)
Knox Coast (Wilkes St.)
Big Delta (Alaska)
Mc. Kinley (Healy-Alaska)
Koror
Guam
Climax Variog. St.
Barter Island „
Anchorage „
Fort Yukon „
Northway „
Kotzebue „
Price „
Espanola „
Casper „
Burlington (Colorado) „
Carrollton „
Beloit „
South Pole (Antarc.) „
Cap Adare (Antarc.) „
Jarvis Island „
Palmyra Island „

Committee No. 2

Committee on Aurora and Airglow

Report by C. T. Elvey, Chairman

A joint meeting of the IAGA Committee on Aurora and Airglow and the IAGA/IGY Committee on Aurora was held at Toronto on September 12, 1957. Working groups had met several times previously in order to prepare material for the session. The members present at the joint meeting were: Chapman, Currie, Gartlein, Harang, Lebedinsky, Millman, and Elvey (Chairman of both Committees).

Professor Chapman pointed out that since CSAGI is a temporary organization, it is the desire of CSAGI that the Unions gradually take over the responsibility for the supervision and coordination of the IGY programs and the World Data Centers.

Although the resolutions made at the fourth meeting of CSAGI recommended that Committee 2 (Aurora and Airglow) of IAGA be the agency to select the days additional to the Special World Intervals for special studies of auroras, the Executive Committee of IAGA felt that a smaller committee should assume this responsibility and those additional administrative duties in connection with the IGY program. Hence, the Executive Committee appointed in 1957 the IAGA/IGY Committee on Aurora.

After careful consideration the Committees recommend the following courses of action:

1. That preliminary synoptic maps be made by World Data Centers from visual observations of auroras, and that these maps be distributed by the World Data Centers; that it is desirable to make a map for every hour of Universal Time; that it is suggested that Murdoch's Third Projection be used in drawing these maps, that the original plotting be carried out on a scale approximately one degree of latitude equal to four-tenths of an inch and that for trial purposes the plotting symbols used in the U.S.A. and Canada be adopted; that interchange of maps between World Data Centers can best be carried out by means of negative photographic copies on perforated 35 mm. film.

2. That although in general copies of the original visual auroral observations will not be transmitted to World Data Centers, in the case of the visual data for the Antarctic Continent it is recommended that copies of the original observations be sent to all three World Data Centers. These copies will be either in the form of microfilm of the original auroral logs or in the form of duplicate punched cards.

3. That with regard to the film from the all-sky cameras an initial inspection be made of the original film and that a record be prepared of the times of exposure, the presence or absence of aurora and the presence or absence of clouds; that copies of

this record be sent to all three World Data Centers; that after the initial inspection of the original film it will be used thereafter only for copying purposes; that the original film be stored in the country of origin; that three first copies of all films showing aurora be prepared and sent to the three World Data Centers not later than three months after receipt of the original by the National Committee concerned; that World Data Centers distribute second copies of auroral all-sky camera films to those requesting them (charging not more than the cost of reproducing and mailing the film); that each film be identified as to station, the Universal Time and Date, and the details of any photometric standardization used.

4. That the World Data Centers consider the above and that they either accept these recommendations or send corrections and comments to the IGY Coordinator within one month. It should be noted that if recommendation 3 is adopted then the selection of days as mentioned in the preliminary statement becomes unnecessary.

5. That one year from now IAGA/IGY Committee on Aurora meet to decide the details of the final synoptic auroral maps and to discuss all other items concerned with the correlation of the world-wide observational data on the aurora.

Committee No. 4

Committee on Secular Variation and Palaeomagnetism

Report by

Takesi Nagata, Chairman

In recent years, knowledge of the distribution of geomagnetic secular variation over the earth has been thought significant not only for the practical purpose of navigation or aviation but also in connection with the physical interpretation of the origin of geomagnetism. The aim of the Special Committee on Secular Variation and Palaeomagnetism, IAGA, has been, therefore, to cover the collection and synthesis of secular variation data obtained during recent years and also those for geological epochs, in order to obtain the whole historical picture of the earth's magnetic field.

The Special Committee has collected recent 10 year data of the three geomagnetic components at 61 observatories described in Table I. Most of the recent data were specially arranged by each observatory in response to the request of the Special Committee. Acknowledgement of the Special Committe, therefore, is due to these observatories for their cooperation.

The periods of recent secular variation data thus collected are not exactly the same, however the five years from 1950 to 1955 are common to all observatories.

In Figs. 1—3, distributions of average secular variation in the X, Y, and Z components during the five years 1950—55, derived from the 61 observatory data, are illustrated in unit of gammas per year. As will be seen in these figures, the general tendency of geomagnetic secular variation in this period is nearly in agreement with that for 1940—45 obtained by Vestine. More generally speaking, it may be concluded, by referring to Vestine's results for 1910—15, 1920—25, 1930—35, as well as for 1940—45, that the variation of the geomagnetic field has kept nearly the same tendency during the past 50 years.

Spherical harmonic components, obtained by analyzing the abovementioned data of 1950—55, are shown in Table II, together with those given by Vestine and others for secular variations before 1945. It does not seem that the magnitude of each harmonic reduced from the component Z satisfactorily agrees with the corresponding one reduced from X and Y, probably owing to the limited number of observatories from which these data were obtained. So far as the general tendency is concerned, however, it may be clear that the intensity of the earth's magnetic dipole was decreasing during 1950—55, in continuation of the previous tendency.

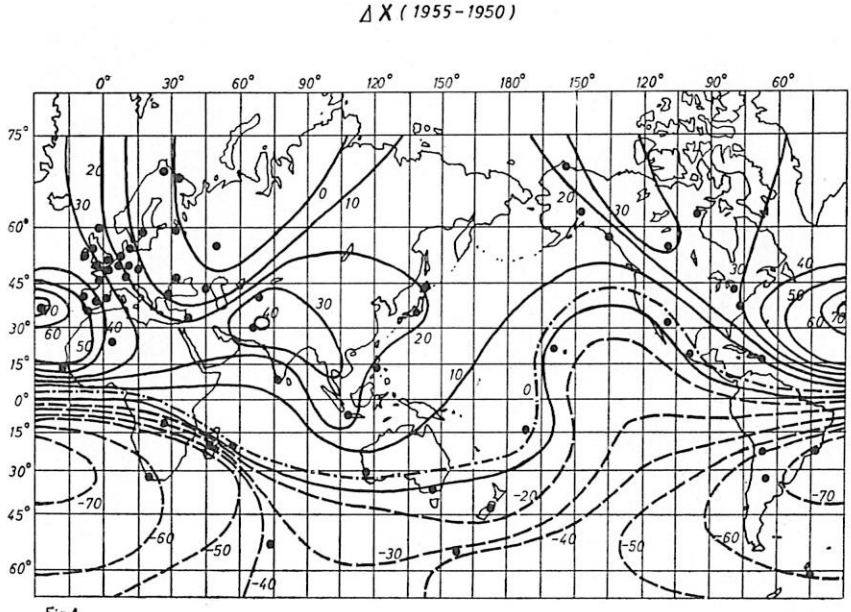

Fig.1 Unit : gammas per year

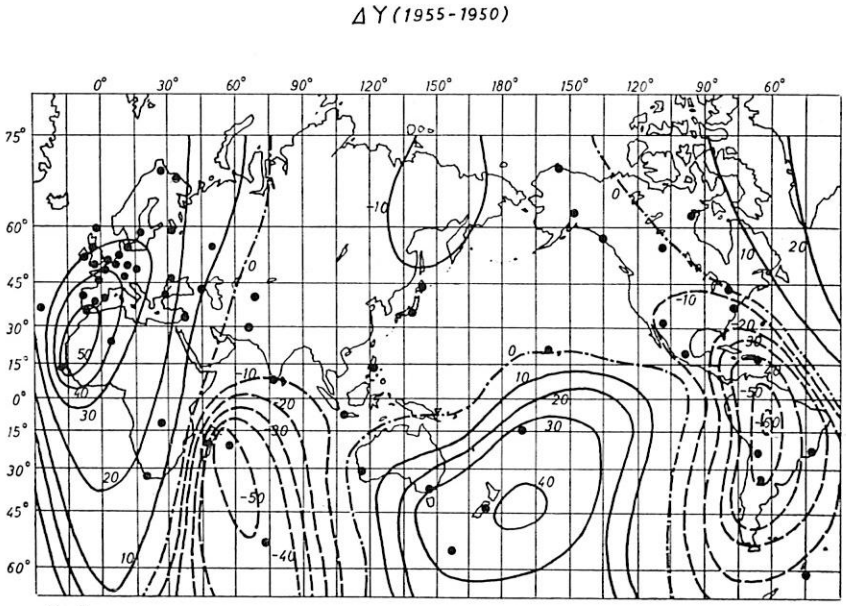

Fig. 2

Unit : gammas per year

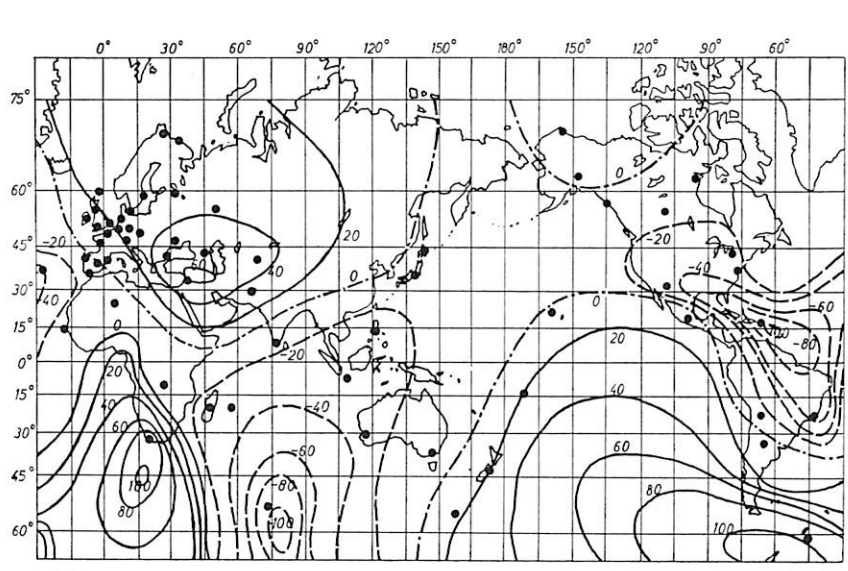

Fig.3

Unit : gammas per year

Since the time of the Rome Meeting of IUGG, studies of palaeomagnetism have been remarkably developed in connection not only with the secular variation of the geomagnetic field but also with problems of continental drift and polar wandering. Many of the results obtained during the period have already been summarized in Blackett's "Lectures on Rock Magnetism" (1956) and Runcorn's "Rock-magnetism: Geophysical Aspect" (Advance in Physics, *4*, 1955). In this general report, all published and reported results of palaeomagnetic studies during the period are very briefly summarized in Table III; only the conclusions of each researcher are tabulated.

The principles and methods of research in palaeomagnetism are fairly complicated, because, on the one hand, the origin and stability of remanent magnetisation of rocks and baked earth have not yet been completely understood, and on the other hand, continental drift and polar wandering of the earth as well as appreciable secular variation in intensity and direction of the geomagnetic field (including even the reversal of the geomagnetic field) must be simultaneously considered when remanent magnetisation of some sample of some locality is dealt with. Therefore, palaeomagnetism concerns the general history of changes in geophysical aspects of the earth.

Secular variation in direction of the geomagnetic field, deduced from palaeomagnetic studies of rocks and baked earths in *Holocene,* seems to show small fluctuations around the present geomagnetic direction, variation periods being 400—600 years and 800—1000 years for declination and dip respectively.

All data of palaeomagnetic studies of *Quaternary rocks* show that, in middle and later stages of *Pleistocene,* the geomagnetic field was not so much different from the present one, the geomagnetic north pole being within 30 degrees from the earth's north pole. It seems very likely however that the latest reversal of the geomagnetic field took place in *early Pleistocene.*

As for geological epochs before the end of *Tertiary,* considerable evidence for repeated reversals of the geomagnetic field has been found. The position of the geomagnetic pole estimated from palaeomagnetic studies of rocks in one continent is not always in agreement with that deduced from data of rocks of the same geological epoch in other continents. This discrepancy may be attributed to relative movement between the continents, namely, continental drift, since the time of formation of the rocks. For example, it may be concluded, according to Runcorn, Creer and others, that a relative movement of about 2000 miles took place between North America and Europe during the period from late Triassic to the end of Miocene.

Palaeomagnetic data from Africa, India, Tasmania and elsewhere have been discussed chiefly in relation to the continental

drift theory. It seems generally that these data support the idea that each continent separately drifted northwards.

Another idea which has been deduced from palaeomagnetic studies is a hypothesis of polar wandering of the earth.

In this hypothesis, deviations of the present earth pole from geomagnetic poles estimated from palaeomagnetic studies of old rocks in various geological epochs are interpreted as wandering of the earth's pole itself over the earth's surface, together with the geomagnetic pole. This is deduced on the assumption that the geomagnetic axis never deviates much from the earth's rotation axis.

The above-mentioned results in palaeomagnetism are always based on the assumptions that the remanent magnetism of rocks coincides with the geomagnetic direction *in situ* when those rocks were formed and that the magnetisation has been sufficiently stable since then. On the other hand, physical and chemical processes of remanent magnetisation of ferromagnetic minerals in rocks and their stability have been extensively studied, together with fundamental research on ferromagnetic minerals themselves. The physical properties of the ternary system FeO-Fe_2O_3-TiO_3 have been fairly well understood, and processes of magnetisation of fine particles of the material have been gradually elucidated. It seems however that several more years are necessary for establishing basic knowledge of magnetism and its stability in rocks, which is sufficiently reliable for palaeomagnetism.

The reporter's thanks are due to Dr. T. Rikitake who helped him in summarizing the secular variation data.

Table I. List of secular variation stations

Station	Lat.	Long.	Station	Lat.	Long.
Point Barrow	71.3°	203.2°	Witteveen	52.8°	6.7°
Tromsö	69.7	18.9	Niemegk	52.1	12.7
Abisko	68.4	18.8	Valentia	51.9	349.7
College	64.9	212.2	Abinger	51.2	359.6
Baker Lake	64.3	263.9	Manhay	50.3	5.7
Lerwick	60.1	358.8	Průhonice	50.0	14.6
Voeikovo	60.0	30.7	Fürstenfeldbruck	48.2	11.2
Lovö	59.4	17.8	Chambon-la-Forêt	48.0	2.3
Sitka	57.0	224.7	Nantes	47.3	358.4
Rude Skov	55.8	12.4	Stepanovka	46.8	30.9
Saimishche	55.8	48.9	Memambetsu	43.9	144.2
Eskdalemuir	55.3	356.8	Agincourt	43.8	280.7
Meanook	54.6	246.7	Dusheti	42.1	44.7
Wingst	53.7	9.1	Keles	41.4	69.2

Station	Lat.	Long.	Station	Lat.	Long.
Istanbul-Kandilli	41.1°	29.1°	Kodaikanal	10.2°	77.5°
Ebro	40.8	0.5	Kuyper	—6.0	106.7
Coimbra	40.2	351.6	Elisabethville	—11.7	27.5
Toledo	39.9	355.9	Apia	—13.8	188.2
Cheltenham	38.7	283.2	Tananarive	—18.9	47.5
S. Miguel	37.8	25.7	Mauritius	—20.1	57.6
San Fernando	36.5	353.8	La Quiaca	—22.1	65.4
Kakioka	36.2	140.2	Vassouras	—22.4	316.4
Ksara	33.8	35.9	Watheroo	—30.3	115.9
Tucson	32.2	249.2	Pilar	—31.7	296.1
Quetta	30.2	66.9	Hermanus	—34.4	19.2
Tamanrasset	22.8	5.5	Toolangi	—37.5	145.5
Honolulu	21.3	201.9	Amberley	—43.2	172.7
Teoloyucan	19.8	260.8	Heard Is.	—53.0	73.4
San Juan	18.4	293.9	Macquarie Is.	—54.5	159.0
Muntinlupa	14.4	121.0	Orcadas d. Sud	—60.8	315.0
M'Bour	14.4	343.0			

Table II. Spherical harmonic components of secular variations

	Dyson-Schmidt	Bartels	Carlheim-Gyllensköld	Vestine-Lange				Nagata-Rikitake	
	1922-1885	1920-1902	1920-1902	1912.5	1922.5	1932.5	1942.5	1955-1950	
								X & Y	Z
$\dot{g}_1^0$	20	42	0	25	28	23	9	8	7
$\dot{g}_1^1$	—1	—9	13	1	4	1	2	0	2
$\dot{h}_1^1$	—1	12	4	—7	—7	—5	1	4	—1
$\dot{g}_2^0$	—10	—7	0	—7	—10	—14	—18	—24	—8
$\dot{g}_2^1$	6	8	—4	—1	1	1	0	0	—2
$\dot{h}_2^1$	—14	—25	—12	—9	—14	—18	—20	—16	—15
$\dot{g}_2^2$	21	13	13	24	17	10	2	4	—3
$\dot{h}_2^2$	—18	—8	—17	—17	—17	—14	—14	—14	—11
$\dot{g}_3^0$				6	7	4	2	8	—1
$\dot{g}_3^1$				—6	—7	—7	—7	0	—4
$\dot{h}_3^1$				—6	—5	—5	—1	0	4
$\dot{g}_3^2$				—1	—2	1	3	0	2
$\dot{h}_3^2$				3	3	4	4	4	—1
$\dot{g}_3^3$				13	7	3	0	—1	—6
$\dot{h}_3^3$				—11	—11	—13	—10	—8	—2

(Unit: gammas per year)

Supplementary Note

Geomagnetic secular variation data at 8 USSR observatories are added to the data already compiled from 61 observatories. The localities of these 8 observatories are as follows.

Station	Lat.	Long.	Station	Lat.	Long.
	°	°		°	°
Srednikan	62.4	152.3	Irkutsk	52.5	104.0
Yakutsk	62.0	129.7	Yuzhno-Sakhalinsk	46.9	142.8
Sverdlovsk	56.7	61.0	Vladivostok	43.8	132.0
Moscow	55.5	37.3	Tashkent	41.4	69.2

As a result of adding these data, the distribution of secular variation in the geomagnetic field during 1950—55 is a little modified as shown in Figs. 1′—3′, and its spherical harmonic coefficients have become as follows.

	$\dot{g}^0_1$	$\dot{g}^1_1$	$\dot{h}^1_1$	$\dot{g}^0_2$	$\dot{g}^1_2$	$\dot{h}^1_2$	$\dot{g}^2_2$	$\dot{h}^2_2$	$\dot{g}^0_3$	$\dot{g}^1_3$	$\dot{h}^1_3$	$\dot{g}^2_3$	$\dot{h}^2_3$	$\dot{g}^3_3$	$\dot{h}^3_3$
From X & Y	9	0	4	-24	0	-17	4	-14	6	0	0	1	7	-1	-8
From Z	6	2	-1	-8	-1	-16	-3	-11	-2	-3	3	2	-1	-6	-4

(Unit: gammas per year)

As far as the general tendency is concerned, however, there is no fundamental difference from the general aspect of world morphology of geomagnetic secular variation described in the text.

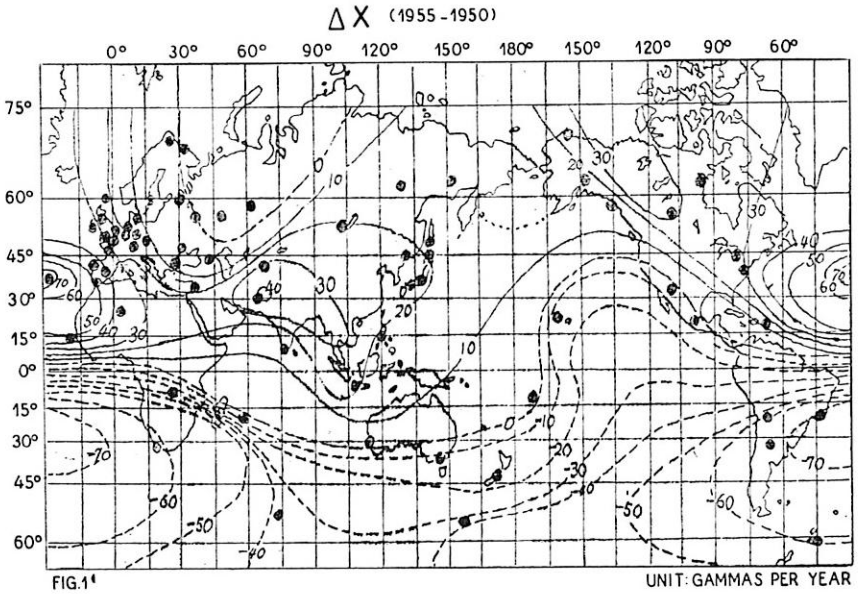

FIG.1′ UNIT: GAMMAS PER YEAR

Age	Estimated Pole-position	Sense	Locality	Rock	Authority	Remarks
Quaternary Holocene	Near present position	N	Japan	Baked earth	N. Watanabe (1957)	Secular Variation in recent 2.000 yrs. Small fluctuations with periods 400-600 yrs in D and 800-1000 yrs in I.
		N	France, Britain	Baked earth	E. Thellier (1956)	Secular variation in recent 2.000 yrs.
		N	Iceland	Basalt	J. Hospers (1955) A. Brynjolfsson (1956)	Pole positions in recent 3.000-4.000 yrs.
		N	Sweden	Varved clay	D. H. Griffiths and R. F. King (1955)	Secular variation in 1.100 B.C.-750 A.D. Experiments on sedimentation.
Pleistocene	146.8E 87.6N	N	Iceland	Basalt	J. Hospers (1955)	
	73.9E 77.3N	N	Iceland	Basalt	Th. Sigurgeirsson and T. Einarsson (1956)	
	149 E 87.8N	R				
			Iceland	Basalt	A. Brynjolfsson (1956)	Experiments on viscous magnetization.
	32 W 81 N 86 E 72 N	N, R	Japan	Lava	T. Nagata et al. (1956)	Period studied covers whole Quaternary. Field reversal in lower Pleistocene.
	100 W 72 N	N, R	France	Lava	A. Roche (1957)	Last reversal in lower Pleistocene.
Plio-Pleistocene	153.3E 77.9N	N	France	Lava	A. Roche (1951)	
Tertiary Upper Miocene		N, R	California	Sand stone	R. Doell (1956)	Idea of chemical magnetization.
Miocene-Pliocene	40 E 87 N	N, R	Washington Oregon	Basalt	C. D. Campbell and S. K. Runcorn (1956)	Repeated field reversals in Tertiary.
Miocene	5.2E 88.6N	N	Iceland	Basalt	J. Hospers (1955)	
		N, R	Iceland	Basalt	A. Brynjolfsson (1956)	
Oligocene	119 E 73 N	N	France	Intrusive	A. Roche (1950)	
Eocene	133 E 76 N	R	Ireland	Basalt	J. Hospers and H. A. K. Charlesworth (1954)	
(Tertiary)		N, R	Iceland	Basalt	Th. Sigurgeirsson and T. Einarsson (1956)	Repeated field reversals in Tertiary.
(Early Tertiary)		N, R	Tasmania	Basalt	M. Almond et al. (1956)	Northward drift of Tasmania. Dip measurement only.
Cretaceous Eocene	85 W 28 N	R	Deccan Trap	Basalt	J. A. Clegg et al. (1956)	Northward drift from 34° S and anticlockwise rotation through 25° of India.
Cretaceous	127 E 76 N		Dakota	Sand stone	S. K. Runcorn (1955)	
Jurassic		N, R	Tasmania	Dolerite	M. Almond et al. (1956)	Northward drift of Tasmania. Dip measurement only.
	23 W 50 N	N	Tasmania	Dolerite	E. Irving (1956)	
	106 W 68 N	R	South Africa	Dolerite	A. L. Hales and K. W. T. Graham (1956)	Northward drift of Tasmania and Africa.
(Lower Jurassic)	76 W 61 N	N	Rhodesia	Basalt	A. E. M. Nairn (1956)	
	149 W 79 N		Arizona		S. K. Runcorn (1955)	
Lias	61 W 81 N		New York	Sediments	S. K. Runcorn (1955)	
Triassic		N, R	Tasmania	Tuff	M. Almond et al. (1956)	Northward drift of Tasmania. Sudden field reversal with short duration.
	155 E 48 N	N, R	Britain	Red sandstone	J. Clegg et al. (1954)	
	110 E 60 N		Arizona	Sandstone	S. K. Runcorn (1955)	Polar wandering and relative movement of Britain and America.
Permian Triassic	106 E 34 N		USA	Sediments	J. W. Graham (1955)	
Permian	118 E 33 N	N	Grand Canyon (Col. River)	Sediments	R. Doell (1955) and S. K. Runcorn (1955)	Good agreement between independent measurements.
	164 E 43 N	R	Britain	Lava	K. M. Creer (1954)	Estimated latitude of Great Britain in Permian = 5°N.
			Britain	Lava Sediments	P. M. Du Bois (1956)	Separation of America from Europe since Permian = 40°-45°.
Carboniferous	124 E 39 N	N	Texas	Sediments	J. D. Martinez and L. G. Howell (1956)	Natural remanent magnetism of chemical deposits.
	142 E 42 N	R				
	120 E 49 N	N	Arizona	Sediments	S. K. Runcorn (1955)	
(Lower Carboniferous)	143 E 51 N	N	Britain	Sandstone	J. C. Belche (1955)	
	148 E 55 N	N	Britain	Igneous rock	J. C. Belche (1955)	
Devonian	20 E 45 N	R	Britain	Sandstone	K. M. Creer and P. H. S. Stubbs (1956)	Estimated latitude of Great Britain in Devonian = 8°N.
	156 E 34 N	R	Britain	Sandstone	K. M. Creer (1954)	
Silurian						
Cambrian	173 E 15 N	R	Britain	Sandstone	K. M. Creer (1954)	Estimated latitude of Great Britain in Cambrian = 22°S.
	153 W 22 S	R	Arizona	Sandstone	S. K. Runcorn (1955)	
Pre-Cambrian	42.5E 7.5N	N	Pilansberg	Dykes	D. I. Gough (1956)	Age not certain (300-400 million yrs).
Longmyndian	120 W 2 N	R	Britain	Sediments	E. Irving and K. M. Creer (1954)	
Upper Torridonian	137 W 6 S	R	Britain	Sediments	E. Irving (1954)	
Lower Torridonian	112 W 35 N	N	Britain	Sediments	E. Irving (1954)	
	147 E 25 N	N	Gr. Canyon	Sediments	R. Doell (1955) and S. K. Runcorn (1955)	Good agreement between independent measurements.

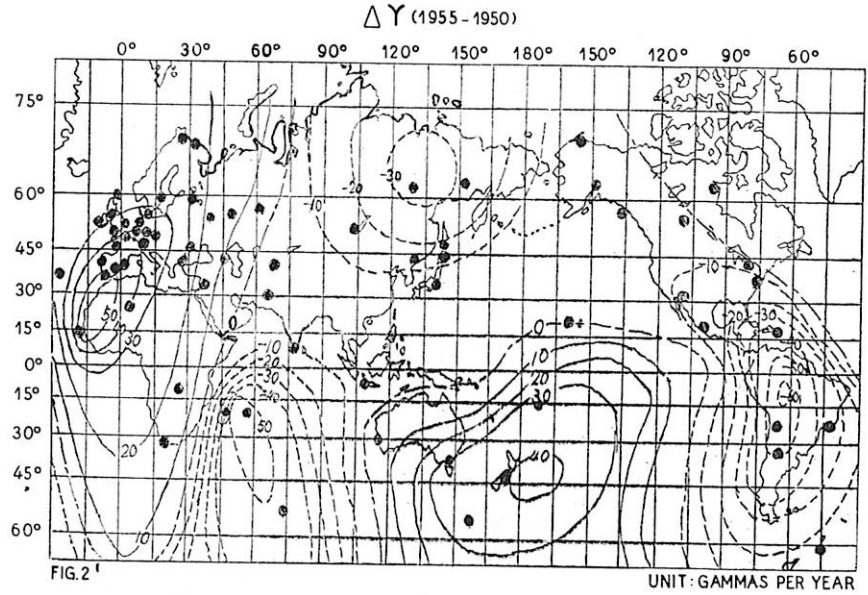

FIG. 2'

UNIT: GAMMAS PER YEAR

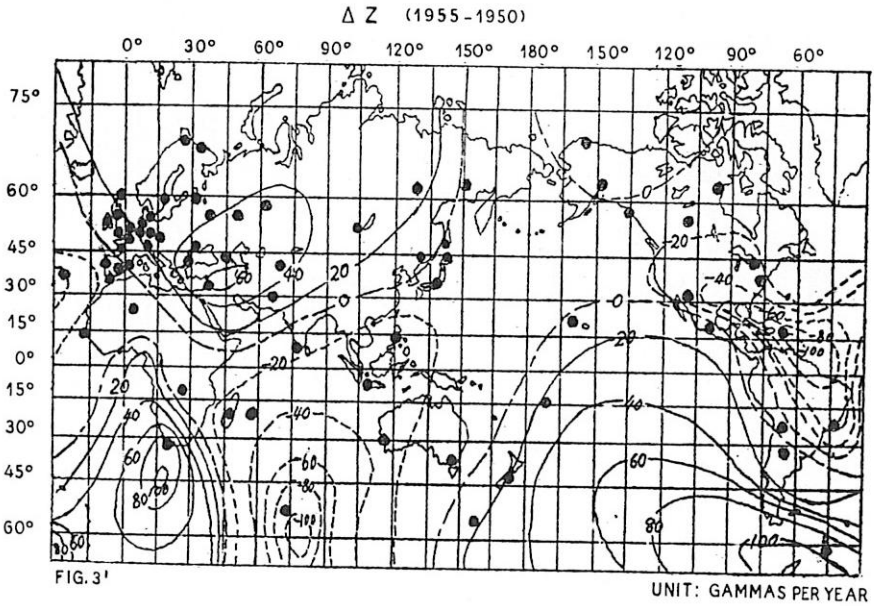

FIG. 3'

UNIT: GAMMAS PER YEAR

Committee No. 6

Committee on Lunar Variations

Report by S. Chapman, Chairman, and M. V. Wilkes, Secretary

(a) The members of this Committee, as re-constituted at Rome in 1954, were as follows:

1. J. Bartels
2. M. Bossolasco
3. J. O. Cardús
4. S. Chapman (Chairman)
5. C. H. Cummack
6. J. Egedal
7. H. F. Finch
8. R. Gallet
9. P. Herrinck
10. S. L. Malurkar
11. D. F. Martyn
12. S. Matsushita
13. S. K. Pramanik
14. P. Rougerie
15. V. Sarabhai
16. O. Schneider
17. A. Thomson
18. K. K. Tschu
19. K. Weekes
20. A. M. van Wijk
21. M. V. Wilkes (Secretary)

With great regret the Committee has learned of the death of one of its members, Dr. S. K. Pramanik, who had made valuable studies on the lunar atmospheric tide.

(b) At Rome in 1954 a grant of $1000 was placed at the disposal of the Committee (see § k).

(c) The researches coming within the scope of this Committee include lunar variations in the geomagnetic field, in earth currents, in the ionosphere (e.g., height, electron density, reflectivity, absorption, horizontal and vertical motion), cosmic rays, and meteorological elements (e.g., barometric pressure, wind, temperature). The International Union for Radio Science (URSI) is interested in the ionospheric aspects of our work, and has published a valuable report on *Tidal Phenomena in the Ionosphere* (URSI Special Report No. 2). The International Union of Pure and Applied Physics (IUPAP) is interested in the researches on lunar variations in cosmic rays. The International Association for Meteorology (IAM) was for a time co-sponsor of our researches in the domain of meteorology, and the Committee would welcome a renewal of their cooperation, so that it would again become a joint committee of the two Associations.*)

(d) Preparations for the International Geophysical Year have occupied much time of many members of the Committee, but

*) At Toronto the IAM (which at Toronto changed its name to International Association of Meteorology and Atmospheric Physics (IAMAP)) agreed to this proposal; see Notes to this report.

nevertheless several investigations of lunar variations in geophysical elements have been begun, advanced, or completed, and in some cases published. A bibliography of papers published or in course of publication is given at the end of this report. Numbered references to this bibliography are given in the following sections, with the prefix B. The bibliography is doubtless incomplete: additions that come to hand after the preparation of this draft report will be interpolated in the bibliography in alphabetical order. (Note added later: this has been done; the additions have reference letters as well as numbers).

(e) *Lunar geomagnetic tide: work completed:*

(i) A determination of the lunar magnetic tide L(H) in the horizontal magnetic force H at Greenwich, based on 62 years' hourly observations (1848-63, 1867-1913), has been published (B 3). The work, begun in 1925, was continued intermittently, and completed in 1956. Hand methods were used in the retabulations and computations. The results were discussed in relation to L(E), the lunar tide in Greenwich East declination, and also to the corresponding solar daily variations, S(H) and S(E). The investigation specially considered influences of season, sunspot activity, magnetic activity and lunar distance upon the lunar geomagnetic tide.

(ii) An appendix to the same publication (B 3) gives the results of a study (by similar methods) of L(E) at Sitka, from 21 years' hourly data, 1902-1922; and also revised results of a determination of L(E) for Pavlovsk, summer months only (May to August), from 39 years' data, 1870-1908.

(iii) J. C. Cain, with the cooperation of members 1, 4, 21 of the (1954) Committee, has made an extensive study of L and S in all three magnetic elements at Sitka, from 50 years' hourly data, 1902-1952. The Chapman-Miller method of computation was used, with IBM punched card equipment and the EDSAC machine (Cambridge). Special attention was given to the influences of season, solar and magnetic activity, and lunar distance. This work, done at the Geophysical Institute of the University of Alaska, with financial support from the Geophysical Research Directorate, Air Force Cambridge Research Center, has been issued as an Institute publication (B 2); copies of this and associated publications (B 2, 2a, 2b) can be obtained from the Institute on request.

(f) *Lunar geomagnetic tide: work in progress or awaiting publication:*

(i) Determinations have been completed (by member 4 of the Committee) for Helwan, Egypt, 1909-1934 (26 years) and for Cheltenham, Maryland, USA, 1901-1926 (26 years), for all

three elements; also for Batavia, declination only, 1867-1875, 1882-1930 (58 years). In all three cases the Chapman-Miller method was used, applied to bi-hourly values only. These determinations await publication.

(ii) Progress has been made (by member 7 of the Committee) with an investigation of the lunar geomagnetic tide at Greenwich, for all three elements, for the period subsequent to 1914, using the Chapman-Miller method.

(iii) A determination is being made (by member 9 of the Committee) of the lunar geomagnetic tide in all three elements for Elisabethville, Belgian Congo, 1938-1950, using hand methods applied to hourly values. Refinements of method are being attempted to reduce the influence of the solar daily variations and magnetic disturbance upon the computation.

(iv) The lunar geomagnetic tide, in all three elements, for Cape Town and Hermanus, South Africa, is being determined by member 20 of the Committee, using the Chapman-Miller method. Preliminary results are available from 9 years' data, 1932-1940.

(v) The lunar geomagnetic tide in all three elements for Eskdalemuir, Scotland, is being determined by member 21 of the Committee, using a modification of the Chapman-Miller method, with punched card machines and the EDSAC.

(g) *Lunar effects on the ionosphere.*

Four members of the Committee (11, 12, 14 and 15) report contributions to the study of lunar effects on the ionosphere. Three of these contributors (B 1, 5, 9) refer to the lunar tide in the F_2 layer at tropical stations (Dakar in French West Africa, Ibadan in Nigeria, and Ahmedabad, Bombay, Madras and Tiruchirapalli in India). Another paper (B 11) shows that the time of disappearance of the daytime sporadic E layer (E_s) at Huancayo, on the magnetic equator, is a function of the age of the moon; this phenomenon is discussed in connection with the remarkable lunar influences on the F_2 layer at Huancayo, and with the electric current systems associated with the solar and lunar daily geomagnetic variations. Another paper (B 13a) also deals with the lunar tide in the E_s layer at Brisbane.

New analyses of lunar tidal effects in the E and F_2 layers are presented in B 8, B 5a and B 6, B 10a, B 10b respectively; the paper B 6 also reviews the global pattern of the lunar tide in the F_2 layer, and gives a comprehensive theoretical discussion of it. The discussion takes account of the electric currents responsible for the lunar daily geomagnetic variations. It is concluded that the lunar tidal wind in or near the E layer is about 45 times greater than that observed at ground level.

(h) *Lunar tidal effects on cosmic rays.*

The bibliography includes two papers (B 10, 14) on this very interesting subject; cosmic rays appear to provide a means of investigating the lunar tide in the stratosphere. Member 10 has written a paper on the lunar tide in the Huancayo cosmic rays. This paper, read at the Gulmarg symposium on high-altitude research, awaits publication.

(i) *Lunar tidal effects in meteorological elements.*

Member 14 of the Committee has determined the lunar atmospheric tide in barometric pressure for Paris, 1920-1955 (36 years), using the Chapman-Miller method applied to hourly values. The results (B 12) are in good accord with those for other stations in northern Europe.

A determination of the lunar atmospheric tide at Copenhagen, using the Chapman-Miller method applied to hourly values of the barometric pressure, is nearing completion (by member 19).

The lunar atmospheric tide has also been discussed theoretically (B 13). Its worldwide geographical distribution has been compared (B 4) with that of the solar semidiurnal barometric variation.

(j) Methods of computing lunar tidal effects by written retabulation are described in B 7, and a method of determining the standard deviation of the found amplitudes is given.

The Chapman-Miller method (which also can be applied by written retabulation) includes the computation of probable errors.

(k) The computations involved in the determination of lunar geophysical effects are in many cases extensive and costly. Where volunteer labour is not available, the work requires financial support. It might be expected that each country should undertake and provide for such work on the data obtained within its borders; but where interest or support is lacking in the country, international assistance towards the execution of the work seems appropriate. It is hoped that further effort can be devoted to such studies before the 1960 General Assembly. To assist such researches it is requested that the grant of $1000 made available during the past triennium, for such purposes, but not used therein, may remain available, and that a new grant of like amount may be made. (See the Notes attached to this report). Dr. Egedal proposes that the Committee should establish a permanent Bureau equipped with suitable machines for the derivation of lunar geophysical effects. The Cambridge University Mathematical Laboratory, which for some years past was partly devoted to such work, under the auspices of the Committee and under the direction of the Secretary of the Committee, is unable to continue to fulfill this function. At the

Toronto General Assembly the Committee should consider what can be done in this and other ways to promote researches of the kind it is appointed to study.

(l) The Secretary of the Committee, Dr. M. V. Wilkes, regretfully reports that he must submit his resignation from the office.

(m) The continuance of the Committee is considered desirable.

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11a. Mitra, A. P., The Lunar Semidiurnal Oscillation in the Ionospheric Absorption of 150 kc/s Radio Waves. JATP, 7, 99—100, 1955.

12. Rougerie, P., La Marée Barométrique à Paris. Ann. de Géophys., 13, 203—210, 1957.

13. Sawada, R., and Haurwitz, B., The Lunar Air Tide. Ann. de Géophys., 11, 145—147, 1955.

13a. Thomas, J. A., and Svenson, A. C., Lunar Tide in Sporadic E at Brisbane. Austr. J. Phys., 8, 554—556, 1955.

14. Venkatasan, D., and Shastry, T. S. G., Effect of Lunar Atmospheric Tide on the Meson Intensity at Kodaikanal. Proc. Indian Acad. Sci., 42, 204—214, 1955.

15. Yamaguchi, Y., The Lunar Variation of the Magnetic Declination at Kakioka. Report of Ionosphere Research in Japan, X, 4, 1956. Memoirs Kakioka Magnetic Obs. 8, 13, 1957.

Notes on the Preceding Report

(i) The Chairman presented the preliminary report to IAGA on September 4th. Dr. S. Matsushita then spoke on his lunar analysis of data for the equatorial E sporadic layer (paper 11 in the above bibliography).

(ii) The Committee met on September 3rd. The following members were present: J. Bartels, J. O. Cardús, S. Chapman, H. F. Finch, S. Matsushita (and, at the Chairman's invitation, E. J. Chernosky).

(iii) Consideration was given to Dr. Egedal's proposal that a permanent bureau should be established for the investigation of lunar effects in geophysics. While all were agreed on the desirability of this proposal, the Committee saw no present opportunity to set up such a bureau. It was thought that for the present, as in the past, such investigations must be left to individual initiative.

(iv) The Committee received verbal accounts of the lunar investigations being undertaken by some of the members present. It was agreed to present the following resolution to IAGA.*)

*) This resolution was approved by IAGA in plenary session on September 13, 1957.

The IAGA expresses the hope that work on the analysis of the Abinger magnetic data, at present held in abeyance, will be continued at the earliest opportunity.

(v) The Committee recorded its thanks to the retiring Secretary, Dr. M. V. Wilkes, for his valued services given to its work for several years past, and expressed its regret that he is unable to continue to act as Secretary.

(vi) Mr. Edwin J. Chernosky was invited to be Secretary of the Committee if this was reappointed.

(vii) It was decided to appoint a sub-committee, consisting of the Chairman, the Secretary and Dr. Bartels, to consider applications for financial grants from the funds held by the Committee, towards the investigation of lunar effects in geophysical phenomena. (See paragraph k of the report above).

(viii) The members of the USSR Delegation to IAGA reported that there were no other USSR papers to be added to the bibliography in the report.

(ix) The following geophysical elements were considered to be among those for which it would be useful to study the lunar influences thereon:

(a) Winds at ground level and in the ionosphere.

(b) Barometric pressure, at many places where the world maps in paper (4) show gaps.

(c) Geomagnetic data for several stations in USSR; also at Sodankylä, Godhavn and Paris; also San Fernando and Alibag (from 1905 onwards).

(x) The IAGA, at its plenary session on September 13, 1957, reappointed the Committee with the members indicated by * in the following list. The International Association of Meteorology and Atmospheric Physics later notified the General Secretary of IAGA that it was willing to join with IAGA in making the Committee a joint one, as in earlier years. The IAMAP appointed to the Committee the member indicated in the following list by §.

* J. Bartels
* M. Bossolasco
* J. C. Cain
* J. O. Cardús
* S. Chapman (Chairman)
* E. J. Chernosky (Secretary)
* C. H. Cummack
* J. Egedal
* H. F. Finch
* R. Gallet
* P. Herrinck
* H. H. Howe
* S. L. Malurkar
* D. F. Martyn
* S. Matsushita
§ K. R. Ramanathan
* P. Rougerie
* V. Sarabhai
* O. Schneider
* J. A. Thomas
* A. Thomson
* K. K. Tschu
* K. Weekes
* A. M. van Wijk
* M. V. Wilkes

(xi) The IAGA, at its plenary session on September 13, 1957, approved the provision of $2000 for lunar investigations under the auspices of the Committee, for the triennium up to the next Assembly; thus granting the request indicated in paragraph (k) of the report.

(xii) C. H. Cummack, K. R. Ramanathan and A. Thomson have found it necessary to decline appointment to the Committee, while R. Gallet, P. Herrinck, K. K. Tschu, K. Weekes and M. V. Wilkes have not indicated their acceptance of a place on the Committee. The nomination of Mrs. N. P. Benkova has been made and has been approved by the Committee.

Addresses of Members of the Joint Committee of IAGA and IAMAP on Lunar Variations of Meteorological, Magnetic, Electric and other Geophysical Elements

1. Prof. S. Chapman, Chairman, Geophysical Institute, University of Alaska, College, Alaska, U.S.A. *and* High Altitude Observatory, Boulder, Colorado, U.S.A. (to which letters to the Chairman should be sent).
2. Prof. J. Bartels, Herzberger Landstrasse 180, (20b) Göttingen, Germany.
3. Mrs. N. P. Benkova, Scientific Research Institute of Terrestrial Magnetism, Academy of Sciences, Moscow, USSR.
4. Prof. M. Bossolasco, Istituto Geofisico e Geodetico dell'Universitá, P. O. Box 3145, Via Balbi 5, Genoa, Italy.
5. Dr. J. C. Cain, Geophysical Institute, University of Alaska, College, Alaska, U.S.A.
6. Rev. Father J. O. Cardús, S. J., Vicedirector del Observatorio del Ebro, Tortosa, Spain.
7. Mr. E. J. Chernosky, Secretary, 48 Berkley Street, Waltham 54, Massachusetts, U.S.A.
8. Mr. J. Egedal, Kongevejen 126, Birkerød, Denmark.
9. Mr. H. F. Finch, Royal Greenwich Observatory, Herstmonceux Castle, Hailsham (Sussex), United Kingdom.
10. Dr. H. H. Howe, 2419 Penn, Boulder, Colorado, U.S.A.
11. Dr. S. L. Malurkar, Director, Colaba and Alibag Observatories, Bombay 5, India.
12. Dr. D. F. Martyn, Upper Atmosphere Section, C.S.I.R.O., Camden N.S.W., Australia.
13. Dr. S. Matsushita, Geophysical Institute, Kyoto University, Kyoto, Japan; now at High Altitude Observatory, Boulder, Colorado, U.S.A.

14. Dr. P. Rougerie, Institut de Physique du Globe, 191, Rue Saint-Jacques, Paris (5e), France.
15. Dr. V. Sarabhai, Physical Research Laboratory, Navrangpura, Ahmedabad 9, India; temporarily at Physics Dept., Massachusetts Institute of Technology, Cambridge, Massachusetts, U.S.A.
16. Dr. O. Schneider, Instituto Antartico Argentino, Cerrito 1248, Buenos Aires, Argentina.
17. Dr. J. A. Thomas, Dept. of Physics, University of Queensland, St. Lucia, Brisbane, Australia.
18. Mr. A. M. van Wijk, Officer-in-Charge, Magnetic Observatory, Hermanus C.P., South Africa.

Committee No. 7

Committee on International Comparisons of Magnetic Standards

Report by V. Laursen, Chairman

As in previous years the activity of the Comparison Committee has been centred at the Danish magnetic observatory at Rude Skov, where the stock of Association magnetometers is actually stored. During the period under review the comparison programme has been considerably hampered, however, by the overwhelming amount of work which the observatory has had to take upon itself in connection with the supply of magnetic instruments to observatories and IGY-stations all over the world, and also by the fact that many observatories wanted to have their la Cour instruments repaired and calibrated at Rude Skov before the beginning of the IGY.

A comparison circulation between Rude Skov and the Argentine Observatories Pilar and La Quiaca was already reported at the Rome meeting but no results were available at that time. The completed comparison which was carried out by means of the QHM-magnetometers No. 32, 33 and 34, resulted in the following differences between the individual QHM's (representing the Rude Skov standard) and the standard value at the two Argentine observatories:

Pilar:

May 1954:	QHM 32 — Pilar	=	0.4 γ
	QHM 33 — Pilar	=	—1.1 γ
	QHM 34 — Pilar	=	—2.2 γ
		Mean	—1.0 γ

La Quiaca:

May 1954:	QHM 32 — La Quiaca	=	—41.9 γ
	QHM 33 — La Quiaca	=	—37.4 γ
	QHM 34 — La Quiaca	=	—38.2 γ
		Mean	—39.2 γ

During 1954—1955 extended comparisons were carried out by means of the QHM-magnetometers No. 90, 91 and 92 between Rude Skov, Niemegk and Fürstenfeldbruck (Germany), Pruhonice and Hurbanovo (Czechoslovakia). The following differences were found:

Niemegk:

Dec. 1954—Dec. 1955:	QHM 90 — Niemegk	=	9.2 γ
	QHM 91 — Niemegk	=	10.1 γ
	QHM 92 — Niemegk	=	9.4 γ
		Mean	9.6 γ

Fürstenfeldbruck:

April 1955:	QHM 90 — Fürstenfeldbruck	=	—8.0 γ
	QHM 91 — Fürstenfeldbruck	=	—5.9 γ
	QHM 92 — Fürstenfeldbruck	=	—7.9 γ
		Mean	—7.3 γ

Pruhonice:

Sept.—Oct. 1955:	QHM 90 — Pruhonice	=	22.7 γ
	QHM 91 — Pruhonice	=	22.1 γ
	QHM 92 — Pruhonice	=	21.1 γ
		Mean	22.0 γ

Hurbanovo:

October 1955:	QHM 90 — Hurbanovo	=	—40.0 γ
	QHM 91 — Hurbanovo	=	—38.3 γ
	QHM 92 — Hurbanovo	=	—42.7 γ
		Mean	—40.3 γ

In 1956 a comparison was carried out between Rude Skov and Cheltenham by means of QHM Nos. 32, 33 and 34. The following results were obtained:

Cheltenham:

August 1956:	QHM 32 — Cheltenham	=	0.8 γ
	QHM 33 — Cheltenham	=	—2.3 γ
	QHM 34 — Cheltenham	=	—3.4 γ
		Mean	—1.6 γ

In the below table are quoted the results of all the intercomparisons which have so far been carried out between Rude Skov and Cheltenham by means of travelling QHM's:

1948, April	(QHM 33, 51, 52)	Rude Skov — Cheltenh.	3.0γ
1949, Dec.	(QHM 90, 91, 92)	Rude Skov — Cheltenh.	—0.6γ
1949, Dec.	(QHM 29, 58)	Rude Skov — Cheltenh.	3.1γ
1951, March	(QHM 34, 50)	Rude Skov — Cheltenh.	4.6γ
1953, May—Sept.	(QHM 50, 51, 52)	Rude Skov — Cheltenh.	2.5γ
1956, Aug.	(QHM 32, 33, 34)	Rude Skov — Cheltenh.	—1.6γ

During the summer of 1957 a comparison has been carried out between Rude Skov and Wien—Kobenzl by means of QHM Nos. 228, 229, 230. The result of this comparison is not yet available.

The limited number of comparisons which it has been possible to accomplish during the period under review, have required only a part of the annual UNESCO subventions allocated for this purpose. The remaining funds have enabled the Committee to procure additional instrumental equipment, so that at this moment 10 sets of 3 QHM-magnetometers are at disposal for the extensive comparison programme which the Committee hopes to be able to carry out during the International Geophysical Year. Several observatories have already expressed their intention to participate in this programme. Others who might wish to receive a set of Association QHM's some time during the IGY are kindly requested to notify the Committee, so that a scheme may be drawn up for the most efficient utilization of the instruments available. Attention is drawn to the resolution which was passed by the IAGA (IATME) at its Rome meeting 1954 and later endorsed by the CSAGI:

> "The IATME recommends 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."

Committee No. 8

Committee on Magnetic Instruments

Report by J. H. Nelson, Chairman

Members of the Committee:

Mr. J. H. Nelson, Chairman

Dr. L. R. Alldredge	Mr. J. Olsen
Prof. G. Grenet	Mr. Pierre St. Amand
Mr. C. A. Jarman	Dr. P. H. Serson
Mr. R. Glenn Madill	Prof. E. Thellier
Dr. Alan Maxwell	Dr. I. Tsubokawa
Dr. O. Meyer	Prof. V. Vacquier

This report will be limited to brief mention of instrumental equipment or procedures that have come to the attention of the Committee.

(1) The Dominion Observatory of Canada reports that sixteen IGY stations in Canada will be equipped with 3-component visible-recording magnetographs, primarily for correlation between geomagnetism and studies in auroral and ionospheric fields. The instruments are stated to have a scale value of about 8 gammas/millimeter, a self-calibrated base-line value accurate to ± 3 %, and a base-line drift of less than 10 gammas in 10 hours. It is understood that the detector unit is of the saturable-core induction type.

(2) A magnetograph recorder using 16-mm film moving at a speed of 300 cm/day (125 mm/hour) has been tested at the Lovö observatory, with la Cour variometers. Special variometers provided with copper damping boxes and with interior mirror systems to increase their sensitivity are expected to be used with the film recorder at the Kiruna Observatory during the IGY.

(3) In West Germany, induction variometers composed of coils with 20.000 to 40.000 turns and a high-permeability core, driving galvanometers, will be used at recording speeds of 6 mm/min. for pulsation studies. Sensitivities are 0.1 to 0.01 $\gamma/\text{sec} \cdot \text{mm}$. It is understood that similar instruments are being used in Japan and USSR.

(4) At Tamanrasset electromagnetic variometers, Grenet and Castet type, have been in use since 1950. New equipment for recording horizontal intensity and declination was expected to be installed for the IGY. Recording speed will be 6 mm/min.; sensitivities will be about 0.05 $\gamma/\text{mm} \cdot \text{sec}$. for H, double that value for D. The same recording speed will be used for the vertical component, but the sensitivity will be much higher — about 0.005 $\gamma/\text{mm} \cdot \text{sec}$. The equipment uses high-permeability

cores, and can record either the field components (by using a fluxmeter) or the rates of change of the components.

(5) Experimental and development work has been done in both England and the United States on nuclear precession magnetometers for measurements of the total intensity of the earth's magnetic field. One American manufacturer has produced a commercial model that records in ink on a paper tape values of F measured every 6 seconds, with a scale value of the order of ½ γ/mm. Another model of the instrument has been built for operation in rockets and in the earth satellite, employing telemeter recording. The Coast and Geodetic Survey is currently developing a modification that is expected to provide measurements of the horizontal and vertical components of the field as well as the total intensity.

(6) In addition to the 3-component visible-recording magnetographs already mentioned, two or more types of one-component recorders have been built. They employ a beam of light reflected from a conventional suspended magnet system to a split-beam light-sensitive cell. The United States is using this type at a number of ionospheric stations ranging from Thule, Greenland, to Little America, Antarctica.

(7) The Geographical Survey Institute of Japan has built for field work a GSI Second-Order Magnetometer, the design of which is basically the same as their First-Order Magnetometer but of less weight. It uses a rotating detector coil inside a larger Helmholtz coil to determine the direction of the earth's field or the composite direction of the earth's field and that of the Helmholtz coil. A high gain electronic amplifier is used for detecting emf's generated in the rotating coil. Accuracies are said to be 0.1 minute of arc in D and I, and 1 gamma in H.

(8) A large number of countries are using the Askania Earth Variograph (portable magnetograph) during the IGY. In Germany it will furnish records for the studies of the local bay disturbances. In Peru and on the Pacific Islands of Jarvis, Palmyra, and Fanning, it will be used for the study of the equatorial electrojet. In the United States, Askania Variographs have been installed as an east-west chain to furnish records for use in studies of the correlation of upper-atmosphere phenomena and disturbances in the geomagnetic field; in Alaska they are being used in a north-south chain spanning the auroral zone. A variograph will be in operation on the Floating Ice Island station north of Point Barrow; another has been put in operation at the Amundsen-Scott Station, latitude 90° South.

(9) Oscillations of subaudio frequency (from about 0.5 to 50 cycles per second) will be recorded at several stations in the United States, using coils as sensing units and magnetic-tape

recorders at low speed (approximately one-quarter inch per second). The records will be subjected to wave spectrum analyses. One purpose of the experiment is to study the sources of such disturbances — ionospheric and meteorological.

(10) American observatories, both permanent and temporary IGY installations, will be equipped with a new rapid-run magnetograph utilizing multiple mirrors after the manner of the la Cour. However, the track width will be about 20 mm, a separate sheet of paper will be used for each of the three components, the drum will be shifted laterally at the end of each revolution, and the recording speed will be 4 mm/min permitting a resolution of periods as short as 5 seconds. Variometers will in general be slightly more sensitive than those used on standard magnetographs at the observatories.

(11) Differential magnetograph. The differential magnetograph has been installed at the College (Alaska) Magnetic Observatory. As of the date of writing this report no detailed appraisal of its performance was available. It is realized that a primary requisite of the installation was high accuracy in the orientation of all the variometers, and particular attention has been given to this problem. Early estimates of the accuracy of orientation suggests that the misalignment of magnets will not exceed 5 minutes of arc.

The demands of the International Geophysical Year have severely taxed the instrument-making capacities of a number of manufacturers. It is understood that the Danish Meteorological Institute (la Cour magnetographs, QHM's, BMZ's) and the Ruska Instrument Corporation in the United States have been unable to accept for delivery prior to the IGY all orders that were received. Askania-Werke, at the last report, were quoting on Variographs for a delivery time of one year.

Committee No. 9

Committee on Characterization of Magnetic Activity

Report by J. Bartels, Chairman

1. The present membership of the Committee is:
Dr. N. Fukushima, Tokio
Mr. H. F. Johnston, Washington, D.C.
Prof. E. Lahaye, Brussels
Dr. P. N. Mayaud, Lyon
Sir Harold Spencer Jones, London
Prof. A. P. Nikolsky, Leningrad
Prof. J. Veldkamp, De Bilt
Prof. J. Bartels, Göttingen (Chairman)

The Committee (CCMA) organizes the characterization of magnetic activity and publishes daily character figures and three-hourly indices. It carries on work which was started in 1905, along lines proposed by Adolf Schmidt; apart from an interruption 1940 to 1945, when the Department of Terrestrial Magnetism of the Carnegie Institution of Washington took care of the indices, the collection and publication has always been centered at the Royal Netherlands Meteorological Institute, De Bilt.

The present Committee was established at the Oslo, 1948, Assembly of the IUGG. At the Rome, 1954, Assembly, a further Committee (on Rapid Variations and Earth Currents) was formed under the Chairmanship of Prof. Romañá (Tortosa); it was decided that the new Committee should take over from the CCMA the subject of sudden commencements, solar flares and pulsations.

2. At the Rome, 1954, Assembly of the IUGG, a Federation of Astronomical and Geophysical Permanent Services (FAGS) was founded, as a roof organization of such enterprises as the Bureau de l'Heure, the International Seismological Summary, etc. President is Sir Harold Spencer Jones. The work of our Committee figures in that body as the "Permanent Service of Geomagnetic Indices", with Prof. J. Veldkamp as Director; a Bureau at the Royal Meteorological Institute, De Bilt; an Advisory Commission consisting of J. Bartels, chief, Prof. J. Coulomb and Dr. V. Laursen, members; and an Administrative Council formed by the members of the CCMA. The super-structure of the FAGS has mainly organizational functions in connexion with certain small funds provided to the permanent Services by the International Council of Scientific Unions (ICSU) and, thereby, by UNESCO; the actual work of the Permanent Service is, of course, identical with that of our Committee.

3. The current work runs as follows:

At De Bilt: Geomagnetic indices K and C are received monthly from about 80 observatories. The International Character Figures for each day are calculated. For each month, the 5 magnetically most disturbed days etc. are selected, on the basis of the Kp-indices.

At the Geophysical Institute, Göttingen: From K-indices supplied monthly by 12 observatories, final planetary three-hourly indices Kp are derived, as well as daily equivalent amplitudes, Ap.

4. Publications: Monthly tables for Kp-indices and for Ap as well as 27-day recurrence diagrams are distributed from Göttingen about 3 or 4 weeks after the end of each month. A few days later, De Bilt sends out tables of the daily International Character Figures, and the dates of the selected quiet and disturbed days. These monthly reports are reproduced in the series F, Part B, Solar and Geophysical Data, of the Central Radio Propagation Laboratory, Boulder, Colorado. Quarterly Reports containing the indices and preliminary data on sudden commencements, pulsations, etc., collected by the Committee on Rapid Variations and Earth Currents, are distributed by De Bilt, and published in each issue of the Journal of Geophysical Research.

The final data are published annually, in full, in the IAGA Bulletins No. 12, 12a, etc. Since the Rome Assembly, 1954, the following IAGA Bulletins "Geomagnetic Indices K and C" have appeared: No. 12h (for 1953), 12i (for 1954), and 12j (for 1955).

The following articles describing the works of the Committee have been written by J. Bartels for the International Geophysical Year Instruction Manual No. III, Geomagnetism, Part I (First edition, London 1956; final publication in Annals of the IGY, vol. IV, parts IV—VII, pp. 215—236, 1957):

> The technique of scaling indices K and Q of geomagnetic activity. — The geomagnetic measures for the time-variations of solar corpuscular radiation, described for use in correlation studies in other geophysical fields.

5. For the Geophysical Year, J. Bartels and N. Fukushima have proposed "A Q-index for the geomagnetic activity in quarter-hourly intervals", in a paper published as "Abhandlungen der Akademie der Wissenschaften in Göttingen, Mathematisch-Physikalische Klasse, Sonderheft No. 2 (1956)", which has been sent (and will, on request, be sent) to interested institutes, with a complete English translation of the text. The essential details have also been described in the above-mentioned IGY-Manual. Q-indices will be measured by polar observatories only, poleward of about 58° geomagnetic latitude, for 15-minute-intervals centered at 00, 15, 30, and 45 minutes of each Greenwich hour.

6. Further proposed changes for the IGY will be: a quicker publication of the Kp-indices (half-monthly), and an attempt to provide current data on the level of the geomagnetic horizontal intensity at the equator, as a measure of the intensity of the Equatorial Ring Current (ERC-project). The response of tropical observatories to a circular inviting their cooperation in the ERC-project has been encouraging.

7. In addition to the papers already cited, the following papers have been published by members of the Committee:

A. P. Nikolsky: Magnetic activity in Arctic. — Arktichesky Institut, Trudy, 1951.

— On the second zone of higher intensity of the magnetic activity in the circumpolar region. — Arktichesky Institut, Trudy, 1956.

— On geographical distribution of the magnetic activity in the circumpolar region. — Akademia Nauk SSSR, Doklady, 1956, t. 109, N 5.

— On the geographical distribution of the anomalous absorption of radiowaves in the ionosphere in high latitudes. Akademia Nauk SSSR, Doklady, 1957, t. 112, N 4.

— On geographical distribution of magnetic activity in Antarctic. — Akademia Nauk SSSR, Doklady, 1957, t. 112, N 5.

P. N. Mayaud: Activité magnétique dans les régions polaires. In „Terre Adélie 1951—2. Magnétisme Terrestre. Fasc. II. Expéditions Polaires Françaises. Paris 1955." A summarizing article has appeared in Annales de Géophysique, Vol. 12, p. 84 (1956).

8. For discussion by the Committee at Toronto, Dr. A. P. Nikolsky recommends "to estimate the magnetic activity on hourly amplitudes of the horizontal component at all the magnetic observatories during the IGY. For the stations below 58° geomagnetic latitude it is necessary to make such estimations, at any rate, for specially selected days with the highest magnetic activity."

Committee No. 10

Committee on Rapid Variations and Earth Currents

Report by A. Romañá, Chairman.

1. *Création et composition du Comité*

Le Comité pour l'étude des Variations Rapides et des Courants Telluriques a été créé à l'Assemblée de Rome de 1954. Déjà aux Assemblées d'Oslo et de Bruxelles on avait signalé la nécessité de préciser davantage la nature et la morphologie des variations brusques, dont on publiait les listes par les soins du Comité pour la Caractérisation des Perturbations Magnétiques, si l'on ne voulait pas courir le risque de faire des statistiques peu homogènes et par conséquent peu utilisables. Or ce Comité était déjà trop surchargé de travail pour s'imposer cette nouvelle tâche.

D'autre part beaucoup regrettaient la disparition de l'ancien Comité pour l'étude des méthodes et des instruments pour l'observation des Courants Telluriques, qui avait rendu autrefois d'excellents services. D'après quelques-uns (Mrs. Bock, De Voogt, etc.) il y a encore à présent sur les problèmes classiques des Courants Telluriques des thèses contradictoires que seule une coopération internationale permettrait de résoudre. Pour d'autres (Mrs. Cagniard, Selzer, Thellier, etc.), du point de vue même des variations rapides, leur emploi au jour le jour plus réussi pour l'enregistrement des pulsations à très courte période conseillait aussi de réprendre leur étude d'une façon coopérative.

Ce dernier aspect facilitant l'attribution des deux objectifs à un seul Comité, celui-ci fut constitué de la façon suivante:

Rév. P. A. Romañá, Président (Espagne)
Prof. R. Bock (Allemagne)
Prof. L. Cagniard (France)
Prof. V. Ferraro (Grande Bretagne)
Prof. G. Grenet (France)
Prof. Y. Kato (Japon)
Dr. L. Koenigsfeld (Belgique)
Mr. J. H. Nelson (Etats Unis)
Dr. E. Sucksdorff (Finlande)
Prof. J. Veldkamp (Pays Bas).

Le Dr. E. Sucksdorff étant malheureusement décédé le 19 Octobre 1955, l'on proposa au Président et au Secrétaire Général de l'AIGA, à l'occasion de la réunion plenière du CSAGI à Barcelone en Septembre 1956, la désignation de Mme. V. Troitskaya (U.R.S.S.) à la place de feu le Dr. Sucksdorff. La nomination fut accordé à la réunion du Comité Exécutif de l'AIGA du mois d'Octobre 1956.

2. *Etude des effets magnétiques des éclipses de soleil*

A l'occasion de l'éclipse totale de soleil du 30 Juin 1954, Mrs. J. Egedal et N. Ambolt ont étudié son influence sur la courbe de la déclinaison dans plusieurs observatoires situés au voisinage de la zone de totalité (Journal of Atmospheric and Terrestrial Physics, Vol. 7, 1955, pp. 40-48; Vol. 8, 1956, pp. 105-107; Spec. Suppl. Vol. 6, 1956, pp. 228-235). Les effets prévus par la théorie de Chapman ayant été suffisamment constatés, Mr. Egedal s'est adressé au Président de l'AIGA, Mr. Bartels, pour prier l'Association de bien voulour organiser des observations à une échelle plus étendue à l'occasion de l'éclipse totale de soleil du 20 Juin 1955. Mr. Bartels ayant confié ce soin au Comité No. 10, son Président pria tous les membres du Comité, par lettre circulaire du 17 Février 1955, de bien vouloir procurer que les expéditions organisées dans leurs propres pays pour l'observation de l'éclipse

mirent dans leur programmes des enregistrements magnétiques. La même prière a été adressée aux observatoires magnétiques se trouvant dans la zone de totalité ou dans son voisinage; car d'après Mr. Egedal pour le plein succès de l'observation il suffisait qu'à l'endroit en question 70 pour 100 du disque solaire fût éclipsé et que la variation diurne à l'heure de l'éclipse fût assez prononcée pour que l'on pût apprécier sa diminution due au phénomène. Le Père Romañá profita de l'opportunité pour demander aussi des copies de leurs anciens enregistrements aux observatoires qui s'étaient trouvés dans des circonstances pareilles pour les autres éclipses de soleil des dix dernières années, tout ce matériel devant être soumis à Mrs. Egedal et Ambolt.

Voici les réponses reçues: l'Institut de Géophysique de la Faculté des Sciences de l'Université Tôhoku, Sendai (Japon), préparait une expédition à Ceylan dans la zone de totalité: l'on projetait d'enregistrer les trois composantes magnétiques depuis le 1er Juin jusqu'au 10 Juillet avec des variomètres normaux et avec d'appareils d'induction; des observations des courants telluriques étaient aussi prévues.

Une seconde contribution japonaise, celle du Département de Géophysique de l'Université de Kyoto, devait être l'enregistrement simultané de D, H et Z à l'Observatoire Magnétique d'Aso (32°53'N, 131°01'E) et dans une station temporaire située à l'Observatoire Météorologique de Naze (28°22'N, 129°30'E) dans l'île d'Amani—Oshima, au SW de l'île de Kyushu; bien que la grandeur de l'éclipse ne devait passer de 35 pour 100 à Aso et de 50 pour 100 à Naze, l'on pouvait attendre des résultats comparatifs intéressants.

Du côté de l'Inde l'Observatoire de Kodaikanal avait aussi en projet l'enregistrement continu des éléments magnétiques à la place même de l'observatoire, où la grandeur de l'éclipse devait être de 91 pour 100, et dans un endroit de Ceylan, près de la ligne de centralité.

Finalement l'Observatoire de Muntinlupa, Rizal (Philippines), placé dans la zone de totalité, quelques jours avant l'éclipse communiqua son dessein de publier tout spécialement ses enregistrements D, H et Z entre le 10 Juin et le 1er Juillet.

Les travaux annoncés par les japonais ont été effectivement réalisés, ceux de l'Université de Kyoto aux endroits indiqués plus haut et ceux de l'Université Tôhoku de Sendai au Campus de l'Université de Ceylan (7°15'N, 80°36'E). Leurs résultats ont été publiés respectivement dans "Journal of Geomagnetism and Geoelectricity" (Vol. VII, 1955, pp. 86-90, et Vol. VIII, 1956, pp. 76-80) et dans "The Science Reports of the Tôhoku University, Fifth Series, Geophysics" (Vol. 7, Supplement, March 1956, pp. 1-41); cette dernière expédition étudia non seulement l'influence de l'éclipse sur le courant Sq de la variation diurne, mais encore sur les pulsations rapides du champ magnétique terrestre.

L'expédition de l'Observatoire de Kodaikanal s'établit à Hingurakgoda, Ceylan, et ses résultats ont été publiés dans "Kodaikanal Observatory Bulletin". Il est intéressant à signaler que l'Observatoire de Kodaikanal a réalisé aussi des observations magnétiques pendant l'éclipse annulaire du 14 Décembre 1955.

Pour ce qui regarde les données d'autres éclipses de soleil entre 1945 et 1954, les Observatoires suivants ont envoyé des copies de leurs enregistrements:

a) *Eclipse totale du 20 Mai 1947.* Observatoire de Pilar: enregistrements de D de 5h du 20 à 4h du 22; de H et Z de 4h du 20 à 5h du 21.—Observatoire de Vassouras: enregistrements de D, H et Z de 20h du 19 à 20h du 20.

b) *Eclipse totale du 1er Novembre 1948.* Observatoire de Tananarive: enregistrements de D, H et Z de 17h du 31 à 20h du 1er.

c) *Eclipse totale du 25 Février 1952.* Observatoire de Bangui: enregistrements de D, H et Z de 3h à 16h du 25.—Observatoire de Ksara: enregistrement de D, H et Z de 0h à 18h du 25.—Observatoire de Helwan: enregistrements de D, H et Z de 9h du 24 à 8h du 26.—Station temporaire d'Evinayong (Guinée Espagnole): enregistrements de D, H et Z de 23h du 24 à 15h du 25.

d) *Eclipse annulaire du 20 Août 1952.* Observatoire de Vassouras: enregistrement de D, H et Z de 12h du 19 à 12h du 21.

e) *Eclipse annulaire du 25 Décembre 1954.* Observatoire de Hermanus: enregistrements de D, H et Z de 0h à 15h du 25 et de 0h du 23 à 24h du 26.—Observatoire de Watheroo: enregistrements de D, H et Z de 0h à 24h du 25.

A ces données il faut ajouter le mémoire de Mr. Malurkar sur les effets géomagnétiques des éclipses de soleil aux Observatoires de Colaba et Alibag depuis 1894 jusqu'à 1954, écrit pour le numéro extraordinaire que l'"Indian Journal of Meteorology and Geophysics" était alors en train de préparer pour le jubilé de l'Observatoire d'Alibag et dont Mr. Malurkar eut l'obligeance de faire arriver au Comité une copie du manuscrit original bien avant sa publication dans la revue (Indian Journal of Meteorology and Geophysics, Vol. 5, Spl. No, Dec. 1954, pp. 213-222). Le Directeur de l'Observatoire de Vassouras, Mr. Lelio I. Gama, transmit aussi au Comité un exemplaire de son étude sur l'éclipse du 20 Mai 1947 paru dans "Terrestrial Magnetism and Atmospheric Electricity" (Vol. 43, 1948, pp. 405-428). Bien qu'avec un certain retard, dû à des circonstances imprévues, tout ce matériel a été mis à la disposition de Mr. Egedal pour son utilisation ultérieure. Le Comité profite volontiers de cette opportunité pour remercier de nouveau tous ces observatoires pour leur obligeante coopération.

La seule éclipse totale de 1956, celle du 8 Juin, ne se prêtait guère par sa localisation dans le Pacifique Sud et l'Océan Antarctique à l'organisation d'observations magnétiques échelon-

nées: dans le seul Observatoire pas trop èloigné de la zone de totalité, celui d'Amberley, l'éclipse commençait avant le lever du soleil, à un moment par conséquent peu favorable pour l'enregistrement d'un effet quelconque sur la variation diurne. Quant à l'éclipse totale du 23 Octobre 1957, elle pourra bénéficier de toute l'organisation de l'Année Géophysique et de la présence sur les lieux des expéditions envoyées à l'Antarctique. C'est pour cela que le Comité n'a pas cru devoir s'occuper de l'organisation d'observations magnétiques à l'occasion de ces deux éclipses.

3. *Service des variations rapides géomagnétiques et telluriques*

La résolution 42 de l'Assemblée de Rome était conçue dans ces termes: "L'Association Internationale de Magnétisme et Electricité Terrestre *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)". Par conséquent le Comité No. 10 s'est chargé de cette tâche depuis le 1er Janvier 1955. Pourtant, pour ne pas obliger les observatoires à remettre leurs données à deux adresses différentes, l'on décida que pour le moment l'Observatoire de De Bilt continuerait à rassembler tous les formulaires et que la partie relative aux commencements brusques et aux *sfe* serait retransmise tous les mois au Président du Comité No. 10.

L'étude attentive des données de 1955 confirmait la nécessité d'une plus grande uniformité dans les définitions des phénomènes etudiés et l'urgence de préciser les critéres de sélection: par exemple, pendant le même laps de temps, de deux observatoires pas trop éloignés l'un avait donné 296 *psc* tandis que l'autre n'en avait signalé que 22. A l'occasion de la réunion du CSAGI à Bruxelles en Septembre 1955, les membres du Comité qui s'y trouvaient présents avec quelques autres experts du Groupe de Travail de Géomagnétisme tracèrent une première esquisse des définitions, laquelle fut envoyée par la suite aux membres absents de même qu'à un petit nombre de spécialistes. C'est à la vue de leurs réponses que l'on a rédigé la lettre circulaire du 28 Mars 1956 que le Président du Comité a remis à tous les Observatoires collaborateurs (Annexe No. 1). On leur fasait parvenir en même temps un certain nombre d'exemplaires d'un nouveau type de formulaire destiné à remplacer l'ancien, c'est à dire, la partie réservée en bas de la page, sur les formulaires pour les indices K et les caractères C, aux commencements soudains et aux *sfe*. Dans la circulaire on priait les Observatoires de faire toutes les remarques qu'ils jugeraient opportunes pour améliorer encore les définitions avant le commencement de l'AGI. La plupart des Observatoires ont fait le meilleur accueil aux modifications introduites; seulement un tout petit nombre a donné l'impression de ne pas se rendre compte du but poursuivi et a continué à remplir les anciens formulaires sans prêter attention aux demandes

du Comité; enfin, quelques-uns ont interprété les instructions comme une duplication de travail et tout en envoyant au Comité No. 10 les nouveaux formulaires, ont remis aussi les anciens au Comité No. 9. Le Comité exprime encore une fois à tous les Observatoires collaborateurs sa plus grande reconnaissance pour leur aide et coopération et regrette qu'une mauvaise interprétation de ses instructions ait pu porter quelques-uns à un travail supplémentaire non nécessaire. Plus de trente Observatoires ont envoyé des remarques très opportunes aux différents points de la lettre circulaire; quelques-uns y ont ajouté des petits mémoires inédits ou des travaux imprimés à l'appui de leurs points de vue. A la réunion du CSAGI à Barcelone en Septembre 1956 le Président du Comité rendit compte au Groupe de Travail de Géomagnétisme de toutes ces réponses et de l'expérience d'une demie année d'emploi des nouvelles définitions. C'est alors qu'en vue de la besogne à accomplir, le Groupe de Travail a fait sienne l'idée avancée quelques mois plus tôt par le Prof. Yoshio Kato et a suggéré d'organiser une réunion exprofesso du Comité. Ce souhait du Groupe de Géomagnétisme a été approuvé par le CSAGI sous forme de recommandation (résolution III. 5 de la réunion de Barcelone).

Grâce aux bons services des membres du Bureau de l'AIGA présents à Barcelone et tout spécialement de Mrs. Bartels, Laursen et Coulomb, le Comité Exécutif de l'Association approuva le projet dans sa réunion d'Octobre 1956 et destina une somme, prélevée sur le budget des années 1954-56, pour aider à couvrir les frais de voyage et de séjour des invités; d'autre part Mr. Laclavère eut aussi l'obligeance de soumettre le cas à l'UNESCO, dont il obtint également une aide financière. L'Institut Météorologique Danois ayant invité le Comité à tenir la réunion à Copenhague, l'on fixa les dates du 9, 10 et 11 Avril 1957, comme étant les plus commodes pour la plupart des participants. Parmi les membres du Comité seuls Mrs. Ferraro et Kato ont été obligés de s'excuser; ce dernier, empêché d'entreprendre le voyage à cause d'une maladie, demanda l'autorisation d'envoyer à sa place son collaborateur le Dr. Watanabe. Par contre, quelques membres du Comité n'ayant pas eu besoin de l'aide financière mise à leur disposition par l'Association, il fut possible d'élargir un peu le nombre des invités. Voici la liste des participants à la réunion:

Rév. P. A. Romañá, Prés. du Com. No. 10 (Espagne)
Prof. J. Bartels, Prés. de l'AIGA (Allemagne)
Prof. R. Bock (Allemagne)
Prof. L. Cagniard (France)
Rév. P. J.-O. Cardús (Espagne)
Prof. J. Coulomb (France)
Dr. J. Egedal (Danemark)
Prof. N. Fukushima (Japon)

Mlle. G. Gjellestad (Norvège)
Prof. G. Grenet (France)
Prof. A. G. Kalashnikov (URSS)
Prof. L. Koenigsfeld (Belgique)
Dr. V. Laursen, Secr. de l'AIGA (Danemark)
Dr. O. Meyer (Allemagne)
Dr. J. H. Nelson (Etats Unis)
Dr. J. Olsen (Danemark)
Dr. E. Selzer (France)
Mme. V. Troitskaya (URSS)
Prof. J. Veldkamp (Pays Bas)
Dr. T. Watanabe (Japon).

Pour préparer les séances l'on avait rédigé une liste préliminaire des questions à traiter, tirées des réponses des Observatoires à la lettre circulaire du 28.3.56, de même que de la pratique de presque une année d'emploi des nouvelles définitions et des nouveaux formulaires (Annexe No. 2). Au cours des discussions on a ajouté au moment approprié d'autres questions formulées par quelques-uns des assistants dans leurs commentaires à la liste préliminaire des matières; parmi les plus élaborés il faut citer celui de Mr. Nelson au nom des membres du Département de Géomagnétisme de l'U.S.C.G.S., et celui de Mr. Y. Kato en représentation du Comité National Japonais pour les Variations Rapides et les Courants Telluriques. D'autres questions finalement sont surgies tout simplement du fond même des points discutés. Il a fallu aussi ajouter l'étude d'un certain nombre de résolutions pratiques sur les données à envoyer aux Centres Mondiaux de Rassemblement des Données pour l'AGI, à cause de la détermination prise par le Groupe de Travail des Centres Mondiaux à sa réunion d'Uccle des derniers jours de Mars de laisser la décision finale sur les données géomagnétiques à la réunion de Copenhague du Comité No. 10. Le compte rendu des séances vient de paraître dans "Chronique de l'U.G.G.I." No. 4, pages 123-140*). Ayant été décidée pour la fin de l'AGI la célébration d'un symposium sur le problème général des variations rapides, la réunion de Copenhague avait été réservée tout spécialement aux questions d'ordre pratique; seules les considérations théoriques étaient admises qui devaient servir à justifier ou éclaircir les points pratiques discutés. Du premier moment tous les sujets ont été traités de la façon la plus vivante et très à fond, presque tous les points difficiles étaient illustrés par la projection d'exemples d'enregistrements de toute sorte. Ont été aussi très utiles pour le but poursuivi quelques rapports faits par les assistants, comme par exemple celui du Prof. Kalashnikov sur les méthodes utili-

*) Voir aussi la publication définitive dans les "Annals of the IGY", vol. II B, pp. 668-709.

sées dans l'URSS pour l'observation des micropulsations à courte période (de 0.1 s à 1 m avec amplitude entre 0.1γ et 3γ) ; celui du Dr. Watanabe et du Prof. Fukushima sur les tableaux en usage à l'Observatoire d'Onagawa pour la présentation mensuelle des *pt* et des *pc*.

Il n'y a pas de doute qu'au cours des séances on est arrivé à une précision bien plus grande des phénomènes à prélever et à la suppression d'un certain nombre de causes d'ambiguité; ce n'a pas été pourtant sans un petit accroissement des types des phénomènes et des données à remettre; mais lorsqu'on examine l'affaire de plus près, l'on voit clairement que cela ne suppose pas une augmentation de travail, mais tout au contraire une simplification considérable.

Le texte anglais et français des résolutions avec les nouveaux formulaires destinés à rendre plus facile leur application à la pratique ont été remis aux Observatoires collaborateurs le 20 Juillet (Annexe 3). L'une des tâches du Comité étant de décider pendant l'Année Géophysique les phénomènes particulièrement intéressants, dont des réproductions spéciales (en plus des ordinaires) doivent être envoyées aux Centres Mondiaux de Rassemblement des Données, il est tout à fait nécessaire que l'information qu'il reçoive soit aussi complète et aussi homogène que possible. C'est pour cela qu'en remettant les nouveaux formulaires le Comité a prié instamment les Observatoires de bien vouloir s'en servir dans l'avenir et de s'abstenir d'employer les anciens, tout au moins à partir des données du mois d'Octobre 1957. Il va sans dire qu'il saura gré à tous ceux qui voudront bien s'en servir déjà plus tôt pour l'envoi des données des mois précédants.

Dans l'ordre toujours des réalisations pratiques, il faut signaler aussi l'enquête menée par le Prof. Grenet sur les caractéristiques des appareils utilisés dans les divers Observatoires, afin de parfaire son avant-projet d'étude à Tamanrasset des variations de période moyenne; de même que l'étude de Mr. Selzer sur la méthode "barre-fluxmètre" d'enregistrement des variations magnétiques rapides, destinée à paraître dans les Instructions pour l'AGI.

4. *Courants telluriques*

Tel qu'on l'a remarqué plus haut le but que l'on poursuivait en demandant la création d'un Comité des Courants Telluriques était double. D'une part Mr. Bock, après avoir étudié longtemps les enregistrements des courants telluriques sur des lignes allemandes de grande longueur, de même qu'à Tucson, Watheroo et Huancayo, il n'avait pas pu arriver à séparer, par comparaison directe des courbes, les influences locales de l'allure générale du phénomène. C'est pour cela qu'il croyait nécessaire l'existence d'un Comité qui pût obtenir de la Direction des PTT des diffé-

rents pays l'autorisation d'employer quelques lignes pour la résolution définitive de problèmes tels que l'influence sur les courants de la distance des prises de terre et de l'azimut des lignes et la possible action "de barrière" des montagnes, entre autres; il pensait en même temps que l'on pourrait aussi se servir des courants industriels pour étudier les rapports entre les champs géomagnétique et électrotellurique moyennant les perturbations produites sur les deux par un même courant perturbateur connu. Mr. De Voogt s'exprimait dans un sens pareil; pour lui la coopération internationale était nécessaire parce que la comparaison des résultats obtenus dans les différents pays est dépendante de la conductibilité des couches supérieures de l'écorce terrestre et il croyait aussi indispensable d'avoir un échange des vues sur la convenance et la possibilité d'employer des circuits de cable souterrain pour les mesures à grande distance, de même que sur la nature et la disposition des électrodes. D'autre part les résultats remarquables présentés par Mrs. Schlumberger et Kunetz et Mlle. Yvonne Beaufils sur l'enregistrement simultané des certaines pulsations à très grandes distances, confirmés plus tard par les enregistrements de Mme. Valérie Troitskaya sur le réseau d'observatoires de l'URSS, prouvaient les points de vue de Mrs. Cagniard, Selzer et Thellier sur l'importance des courants telluriques pour l'enregistrement des pulsations à courte période. De tout cela l'on déduisait la nécessité de dresser au plus tôt un catalogue des Observatoires des Courants Telluriques et de stimuler et unifier la publication de leurs résultats; et la convenance aussi de s'adresser aux Sociétés Industrielles de Prospection Electrique pour tâcher d'avoir accès à l'utilisation de leurs archives de données. Voici maintenant les réalisations pratiques.

Il faut signaler tout d'abord les pourparlers conduits au nom du Comité par Mr. Bock à partir du mois de Novembre 1954 près de la Deutsche Bundespost et de la Deutsche Forschungsgemeinschaft pour obtenir la permission d'utiliser pour l'étude des courants telluriques huit lignes télégraphiques en deux directions et quatre longueurs diverses. Grâce à l'appui du Fernmeldetechnische Zentralamt de Darmstadt il obtint l'autorisation du Ministre des Postes le mois de Mars 1955. Pourtant il n'était pas facile de trouver des lignes exemptes d'effets d'induction et ce n'a été que tout récemment que Mr. Bock a pu annoncer qu'une station disposant de sept lignes doubles de longueurs comprises entre 1 Km et 90 Km était sur le point d'entrer en fonctionnement à Apen, pres d'Oldenbourg, à 52°.3 N, 7°.9 E. Les mesures préliminaires ont donné toute satisfaction et il est possible de faire vingt-huit combinaisons des prises de terre de sorte à pouvoir travailler sur des distances et azimuts variables dans des limites très larges. La vitesse de déroulement des enregistrements varie entre 10 et 100 mm/h.; les sensibilités électriques peuvent être variées aussi au moyen de résistances adaptées aux diverses dis-

tances des électrodes; elles sont déterminées tous les jours par des tensions artificielles bien connues ajoutées aux tensions naturelles une fois par jour en sens positif et négatif. Quelques difficultés s'étant présentées dans la pratique, Mr. Bock est actuellement occupé à les résoudre.

Les réalisations de Mr. De Voogt sur les lignes télégraphiques des Pays-Bas sont aussi remarquables. Pour éviter les perturbations dues aux courants vagabonds provenant des chemins de fer électrifiés, on a substitué les prises de terre à un seul électrode par d'autres à plusieurs électrodes en "patte d'oie" situés entre 5 et 10 Km en plusieurs directions du point terminal de la ligne. Ce dispositif ayant été appliqué aux lignes télégraphiques allant de Kampen à Cuyk (N-S, 109 Km) et de Hengelo à Gouda (E-W. 132 Km) avec les appareils de mesure et de contrôle à la station de Radio-Kootwijk (52°.2 N, 5°.8 E) des PTT hollandais, permet l'enregistrement des perturbations de toute sorte (*ssc, b, p, sfe,* etc.), mais n'accuse pas de variation regulière diurne. La méthode a été aussi appliquée à l'installation de Paramaribo (5°.8 N, 55°.3 W) sur une ligne d'azimut E5° N et 2000 mètres de longueur. avec un déroulement du papier d'inscription de 150 mm/h et une sensibilité de 0.35 mv/Km par mm. Les résultats ont été très bons et la netteté de l'enregistrement des trains de pulsations et des autres perturbations est vraiment remarquable. Le même principe a dû être appliqué aussi à la station d'Hollandia (Nouvelle Guinée).

Finalement l'un des progrès les plus considérables pour l'étude des courants telluriques est le réseau d'observatoires qui sont en train d'être établis dans l'URSS sous la direction de Mme. Valérie Troitskaya. Le nombre des stations s'élève à 17, dont 5 ont été placées ou doivent l'être tout prochainement dans l'Arctique, 2 dans l'Antarctique et les 10 autres à des latitudes moyennes. Leur but primaire étant l'étude des pulsations et de la microstructure des autres variations rapides, elles sont toutes munies d'enregistreurs semirapides (90 mm/h) et ultrarapides (30 mm/min.), très appropriés à l'enregistrement des pulsations à périodes comprises entre 0.3-0.5 secondes et 1 minute; les pulsations de période plus longue sont éliminées par une capacité connectée en série aux lignes pour éliminer aussi la variation diurne. Pour l'étude de celle-ci et de l'activité tellurique aux différents endroits, quelques observatoires disposent aussi d'enregistreurs à vitesse normale (20-22 mm/h). Le fonctionnement de tous ces appareils est prévu pour les vingt-quatre heures du jour. Avec les enregistrements de ces stations et surtout avec ceux d'Alma-Ata on a pu confectionner l'album vraiment remarquable de tous les types de pulsations telluriques, que Mme. Troitskaya a offert au Comité à l'occasion de la réunion du CSAGI à Barcelone. Pour l'organisation et le fonctionnement du réseau Mme. Troitskaya a rédigé une instruction pratique très appropriée pour tous ceux

qui doivent s'occuper du fonctionnement d'un observatoire tellurique; elle contienne également des chapitres très intéressants même pour les spécialistes, tels que ceux consacrés à l'établissement et le fonctionnement des enregistreurs ultrarapides et ceux qui traitent les différents types de pulsations. Outre les *pt* et les *pc* on y signale le type dit "en perles" de périodes entre 0.3 et 2.5 sec et d'une forme très caractéristique, lequel se présente parfois dans les enregistrements de 30 mm/m. L'instruction, écrite naturellement en russe, a été traduite tout récemment à l'espagnol.

Il faut mentionner aussi la grande valeur des "Conseils pour l'Année Géophysique sur l'installation de stations d'enregistrement des variations telluriques rapides" dus au Prof. Cagniard et destinés à faire partie des Manuels de l'AGI. L'auteur, qui est aussi l'auteur du chapitre "Electricité Tellurique" du tome 47 de la nouvelle édition de "Handbuch der Physik" s'occupe surtout des dispositifs et appareils de prospection, d'une si haute valeur pour l'enregistrement des variations rapides.

L'on donne ci-contre la liste des observatoires de courants telluriques actuellement existants ou en train d'installation; les données ont été tirées de la "Description des Observatoires Géomagnétiques" publiée par le Comité des Observatoires, de la publication "Distribution géographique des stations de l'AGI" et de renseignements particuliers adressés directement au Président du Comité.

Il va sans dire que tout renseignement servant à corriger ou compléter les données précédantes sera le bienvenu. Il est facile à voir que la distribution des stations n'est pas satisfaisante: sur 60 observatoires ou stations temporaires 11 seulement se trouvent dans l'hémisphère Sud et 6 dans l'hémisphère Occidental. Même en tenant compte des stations qui ont fonctionné autrefois sur le continent américain, telles que Huancayo, Tucson, Chesterfield, etc., la disproportion entre les deux parties du globe est toujours frappante.

5. *Questions à traiter*

a - Présentation et discussion de l'atlas provisoire des différents types des variations rapides.

b - Organisation d'une collaboration plus étroite et systématique dans l'étude des courants telluriques: buts, méthodes, installations, appareils, distribution des observatoires, etc.

ANNEXE 1.

Lettre Circulaire envoyée le 28 Mars 1956 par le Rév. P. A. Romañá, Président du Comité sur les Variations Rapides et les Courants Telluriques de l'Association Internationale de Géomagnétisme et d'Aéronomie.

Monsieur et cher Collègue,

A plusieurs reprises il a été demandé à cette Commission de préciser la définition des perturbations magnétiques brusques que l'on désigne par les symboles *ssc (ssc*), psc, si, sfe...* D'autre part l'accroissement de l'activité solaire et l'approche de l'Année Géophysique Internationale rend plus pressant encore ce besoin de précision, si l'on veut éviter que les listes mensuelles deviennent trop longues et par conséquent moins utilisables.

C'est pour cela qu'à l'occasion de la réunion du CSAGI à Bruxelles en Septembre dernier quelques membres de la Commission qui s'y trouvaient présents ont préparé une première esquisse des définitions qu'ils ont soumise tout de suite à la considération des autres membres. Ceux-ci ayant envoyé leurs remarques, les définitions ont été modifiées.

J'ai donc le plaisir de vous remettre, de même qu'à tous les autres observatoires collaborateurs, le texte adopté, avec la prière de bien vouloir vous en servir pour la rédaction des listes des perturbations brusques à partir de celle du mois d'Avril 1956. On vous serait aussi très reconnaissant de bien vouloir revoir d'après ces définitions les listes des mois de Janvier—Mars pour mieux pouvoir se rendre compte des différences possibles.

La Commission vous prie aussi de lui formuler toutes les observations que l'emploi des nouvelles définitions pourrait vous suggérer, de même que toute autre remarque qui vous semblerait opportune avant le 1er Septembre 1956, dans le but de pouvoir considérer encore une fois les définitions et les rendre aussi précises et pratiques que possible avant le commencement de l'Année Géophysique Internationale.

Voici les définitions adoptées et quelques remarques sur leur emploi:

1. *ssc (et ssc*)* ... impulsion brusque suivie d'un accroissement d'activité avec caractéristiques d'orage pendant une période de perturbation suffisamment longue (sudden impulse followed by increased activity with storm characteristics for a sufficiently long period of storminess).

psc ... commencement brusque (avec ou sans pulsations) d'une baie d'amplitude suffisamment grande (d'après la latitude magnétique) pendant une période relativement calme (a sudden commencement (with or without pulsations) of a bay of suffi-

cient amplitude (the amplitude depending on magnetic latitude) during a relatively quiet interval).

si ... supprimés dorénavant. (Si par hasard on se heurtait quelquefois à un mouvement très prononcé et exceptionnel qui ne pourrait pas être classé dans les autres groupes, on pourrait le signaler par le symbole *sc*, en indiquant en même temps son amplitude).

p ... on les divise dans les deux groupes suivants:
pt .. trains de pulsations
pc .. pulsations continues

pt ... train de pulsations de durée limitée, ordinairement inférieure à une heure, souvent précédant ou accompagnant une baie (series of pulsations of limited duration, usually less than one hour, often preceding or accompanying a bay disturbance).

pc ... pulsations continues durant plusieurs heures (series of pulsations lasting for many hours).

sfe ... petite baie diurne ou crochet, d'ordinaire dans le sens de la variation diurne, que l'on suppose causée par une éruption chromosphérique (a short daytime bay or crochet, generally in the sense of the daily variation, tentatively attributed to a solar flare). Ces phénomènes ne sont que provisoirement des *sfe*, jusqu'à ce qu'ils aient été vérifiés comme tels en plusieurs observatoires ou par des données solaires ou ionosphériques (such effects are only tentative *sfe*'s until verified at several observatories or by solar or ionospheric data).

2. Pour l'application de ces définitions on tiendra compte des remarques suivantes:

a) Il est préférable de ne pas donner les mouvements brusques ayant lieu pendant une période orageuse, sauf quand il s'agit d'un *ssc* très clair.

b) Pour donner un phénomène il suffit qu'il soit clairement marqué sur une seule composante.

c) Les observatoires sont priés de faire la distinction comme auparavant entre les *ssc* et les *ssc**, et d'indiquer le sens positif ou négatif de leur mouvement principal sur les trois composantes, un 0 marquant l'absence de mouvement sur une composante quelconque. L'on prendra toujours comme sens positif pour D et Y le mouvement vers l'Est et pour H, X et Z l'augmentation de leur valeur absolue.

d) Le rapport des *pt* et des *pc* doit être fait seulement par les observatoires disposant d'appareils à enregistrement rapide d'au moins 3 mm/m et restreint à quatre heures par jour, à savoir, de 2h à 3h, de 8h à 9h, de 14h à 15h et de 20h à 21h TMG.

(Pour avoir des renseignements plus complets sur l'ensemble de la journée il est à souhaiter que quelques observatoires bien

distribués sur l'ensemble du globe veuillent bien s'offrir à reproduire tous leurs enregistrements rapides).

En ce qui concerne les *pt* on doit donner seulement le nombre des trains de pulsations observés pendant l'heure étudiée, sans mentionner l'heure de début de chacun.

Pour les *pc* on doit donner leur période moyenne et leur amplitude maximum, même si celle-ci se trouve un peu en dehors des heures choisies internationalement.

3. Pour éviter le risque d'une trop grande quantité de données pendant les années de maximum de l'activité solaire, il peut être utile de fixer pour chaque catégorie de phénomènes une amplitude au-dessous de laquelle aucun phénomène ne doit être rapporté, sauf s'il s'agit d'un cas très net et caractéristiques. Pour une première détermination de cette limite, variable nécessairement avec la latitude géomagnétique, les observatoires sont priés de bien vouloir communiquer à la Commission l'ordre de grandeur des plus petits mouvements des différentes classes qu'ils ont l'habitude de signaler dans leurs rapports mensuels.

4. Pour faciliter l'application des normes données dans cette circulaire on joint des formulaires pour l'envoi des données. Les observatoires peuvent continuer à remettre ces formulaires à l'Observatoire de De Bilt avec les listes des indices magnétiques C et K, le Dr. Veldkamp ayant l'obligeance de les faire parvenir tous les mois au Président de la Commission. Par contre toute sorte de correspondance extraordinaire sur ce sujet (demande d'éclaircissements, consultations sur les cas douteux, etc.) doit être adressée directement au Président de la Commission (Observatorio del Ebro, Apartado 9, Tortosa, Espagne).

En vous remerciant dès maintenant pour le bon accueil que vous voudrez sans doute faire à cette lettre, je vous prie, Monsieur et cher Collègue, d'agréer l'expression de mes sentiments les plus dévoués et cordiaux.

ANNEXE 2.

Liste préliminaire des questions à traiter à la réunion de Copenhague tirées des réponses des observatoires à la lettre circulaire du 28-3-56

1. **Sur les** *ssc*

(A) *Questions concernant la définition*

(a) Explication des mots "suivie d'un accroissement d'activité avec caractéristiques d'orage pendant une période de perturbation suffisamment longue". Nature et durée de cette perturbation.

(b) Cas des perturbations précédées par deux débuts brusques séparés l'un de l'autre par un intervalle de quelques heures plus ou moins calmes.

(c) Modification de la définition, proposée par RS: "*ssc* ... sudden impulse following a calm period and commencing a period of increased activity (magnetic storm)". Jusqu'à quel point est-il nécessaire que les débuts brusques se présentent pendant une période calme pour être considérés comme des *ssc?* Tendances modernes à l'étude de ceux qui se présentent pendant un orage.

(d) Définition précise des *ssc*;* nombre de composantes sur lesquelles il est nécessaire que le mouvement principal soit précédé par un petit mouvement en sens contraire.

(B) *Questions concernant les renseignements à donner*

(a) Sens du mouvement principal d'un *ssc** lorsque les deux mouvements initiaux sont à peu près de la même grandeur.

b) Proposition de Ka pour que l'on donne: (i) la minute, la seconde et le sens du premier mouvement; (ii) la magnitude totale du *ssc; (iii)* sa durée.

(c) Proposition de Ni pour que les observatoires enregistrant des dérivées donnent le changement maximum par unité de temps sur les diverses composantes.

2. Sur les *si*

(a) Faut-il maintenir la suppression des *si,* ou, vu les difficultés éprouvées par un grand nombre d'observatoires pour exprimer certains mouvements brusques, est-il préférable de les rétablir?

(b) Si oui, définition du phénomène et notation à adopter *(sc* ou *si . . .)* Données à fournir.

3. Sur les *psc*

(A) *Questions concernant la définition*

(a) Doit-on maintenir la restriction actuelle des *psc* aux phénomènes polaires se manifestant par des baies à début brusque, avec exclusion des phénomènes purement pulsationnels, ou est-il préférable de revenir à la conception assimilant les *psc* et les actuels *pt,* comme contreposés aux *pc?*

(b) Si l'on maintient la définition actuelle, est-il suffisant qu'il y ait des pulsations au commencement d'une baie pour que celle-ci puisse être considérée à début brusque? De combien de minutes peuvent ces pulsations précéder la baie pour que les deux soient censées constituer un même et seul phénomène?

c) D'autre part, pourquoi faut-il restreindre les *psc* aux baies à début brusque (ou accompagnées de pulsations) puisque même les baies à début progressif peuvent être des manifestations d'un orage polaire élémentaire? Si c'est pour des raisons d'ordre pratique, il semble qu'il ne serait pas trop onéreux de donner

toutes les baies: (i) se présentant pendant des périodes calmes, (ii) dépassant un certain ordre de grandeur minimum qui pourrait être fonction de la valeur de l'indice trihoraire K9.

Note. Voici quelques définitions proposées:

(i) Wn: *psc* . . . baies s'introduisant avec des pulsations brusques.

bay . . . toutes les autres baies; (il conviendrait pourtant de classer parmi les *psc* les doubles ondes sinusoïdales, sauf celles qui se produisent pendant les orages magnétiques).

(ii) Qu: *psc* . . . all sudden commencements (with or without pulsations) of a bay of even small amplitude (amplitude depending on magnetic latitude - 10γ for Quetta) during the night hours on a relatively quiet interval; for local daylight hours the amplitude should be sufficient (for Qu 20γ or more).

p . . . all other significant pulsatory oscillations (damped type or wave-train type) not accompanying a bay disturbance.

(B) *Questions concernant les renseignements à donner.*

(a) Heure qu'il faut donner lorsque, d'accord avec la loi de rotation du vecteur perturbation, un *psc* se présente sous la forme de deux baies commençant brusquement à des moments différents sur les courbes de D et de H.

(b) Même question concernant les baies qui sont censées être à début brusque parce que précédées ou accompagnées de pulsations: doit-on donner l'heure de commencement de la baie ou des pulsations?

(c) Proposition de Ka pour que l'on donne: (i) l'heure du commencement du *psc,* si possible à 1 sec. près; (ii) le sens du premier mouvement, la magnitude et la durée du phénomène; (iii) s'il y a des pulsations concomitantes, leur période, amplitude et durée.

(d) Pour ce qui regarde les statistiques il semble indispensable:

1. que tous les observatoires situés dans des régions peu peuplées d'observatoires donnent mensuellement les *psc;*

2. qu'on ne supprime pas sur les checking-lists les *psc* donnés par un seul de ces observatoires (par contre, l'on pourrait supprimer les *psc* signalés par moins de trois ou quatre observatoires dans les régions très peuplées comme l'Europe Centrale);

3. que l'on tâche d'éviter une dispersion trop grande (par exemple, de 13 à 1) dans le nombre de *psc* donnés pour une même période par des observatoires voisins.

4. Sur les *pt* et *pc*

(A) *Questions concernant la définition*

Tout en se déclarant d'accord en lignes générales avec la classification el les définitions proposées, plusieurs observatoires font pourtant remarquer qu'elles ne laissent pas de soulever quelques difficultés. D'autres se sont montrés moins favorables aux définitions.

(a) Et tout d'abord quelques-uns se demandent s'il est possible d'établir pour le moment s'il y a une véritable différence entre les *pt* et les *psc;* d'autres, entre les *pt* et les *pc.* Les *pt* et les *psc* semblent obéir en effet, tout au moins dans quelques observatoires, à la même loi de distribution pendant la journée, tandis que pour d'autres les *pc* et les *pt* auraient la même source. Il y a des observatoires où les pulsations durent nettement plus d'une heure et moins de deux, de sorte qu'elles ne rentrent dans aucune des catégories des *pt* ou des *pc* telles qu'on les a définies. C'est pour cela que Qu par exemple proposait de diviser les pulsations en pulsations accompagnant ou précédant une baie *(psc)* et pulsations sans baie *(p).* Voir plus haut 3. (A), Note (ii).

(b) La difficulté peut être aussi d'ordre pratique. Par exemple deux *pc* à fréquences légèrement différentes produiraient une série d'ondes d'amplitude croissante et décroissante; au minimum les ondes peuvent encore être visibles ou arriver â disparaître complètement, ce qui leur donnerait l'aspect des *pt;* la classification pourrait dépendre alors de la clarté de l'enregistrement photographique. Pour éviter cet inconvénient Le et Es proposent de diviser les pulsations en

"(i) continuous . . . lasting for one hour or more

(ii) intermittent . . . lasting less than one hour

and the range and period reported in both cases; the traces in both types should look like sine curves, although not necessarily of constant amplitude; in the case of intermittent type the time between peak amplitudes might be reported when there is marked regularity". La remarque est confirmée par Ap.

(B) *Questions concernant le choix de certaines heures*

Un nombre considérable d'observatoires s'est montré opposé à cette limitation, car d'une part elle rend impossible l'étude de la marche diurne du phénomène, et d'autre part dans plusieurs endroits le plus grand nombre des pulsations semble tomber en dehors des heures choisies. D'après quelques-uns il est possible que la tendance à la limitation ne provienne que d'une certaine confusion entre les données qui doivent être fournies régulièrement par les observatoires et les données exigées par certains services de l'AGI. Voici quelques propositions:

(a) Ni propose que l'on étende aux 24 heures de la journée

l'étude tout au moins des *pt*, dont le dépouillement n'exige pas trop de temps.

(b) Ka étend aussi la proposition aux *pc* et ajoute qu'à son avis, sans les données complètes pour les 24 heures, il est tout à fait impossible de faire des vrais progrès dans cette matière.

Note. Il peut être intéressant de rappeler la solution intermédiaire proposée par Mr. Thellier dans une lettre adressée au Président du Comité quand on était en train de préparer la lettre circulaire du 28-3-56: "Peut-être faudrait-il ici préciser un peu. Certains observatoires feront (et font déjà) des observations continues sur les 24 heures avec des vitesses de déroulement moyennes (quelques mm/min) donnant des informations détaillées sur les pulsations de périodes de quelques secondes et au dessus. Ces observatoires pourront donner tous les jours des renseignements précieux sur l'évolution des *pc* dans la journée (heure de début et fin, ordre de grandeur des amplitudes) et sur le nombre des *pt* et leur importance. Nous croyons qu'on peut solliciter et publier (sans détail) ces données. Le système des 4 heures par jour est destiné: d'une part à permettre à d'autres observatoires d'entrer dans le jeu avec économie, fournissant ainsi pour ces heures un réseau dense d'observations; et d'autre part à rendre possibles des enregistrements à très grande vitesse, coordonnés sur tout le globe, permettant de descendre plus bas dans l'échelle des périodes et en particulier permettant d'étudier les périodes, qui semblent très importantes, de l'ordre de la seconde. Ainsi le dépouillement des enregistrements des *p* conduirait à trois chapitres: 1. inventaire sommaire pour les 24 heures; 2. détail sur les 4 heures internationales fourni au moins par les appareils à déroulement moyen: 3. compléments pour ces 4 heures relatifs aux très courtes périodes (qui pourraient, bien sûr, provenir aussi bien, et peut être mieux, des enregistrements telluriques rapides)".

(C) *Questions concernant les renseignements à donner*

(a) Pour ce qui regarde les *pt:*

(i) La période moyenne et l'amplitude maximum que l'on demande pour les *pc*, sont-elles sans intérêt pour les *pt?* Quelques observatoires proposent de les donner et d'indiquer la composante.

(ii) Combien de pulsations complètes sont-elles nécessaires pour que l'on puisse parler de "train de pulsations"?

(iii) Lorsque dans un train on trouve des changements de période, doit-il être considéré comme un seul train ou comme plusieurs?

(iv) Est-il nécessaire qu'un train se trouve tout entier à l'intérieur de l'heure considérée pour être compté? Etc.

(v) Ka propose que l'on donne: (a) l'heure de présentation

du phénomène, si possible à la seconde près; (b) l'amplitude maximum des pulsations; (c) le nombre de trains dans une heure. (Un modèle de tableau simple et facile à remplir est proposé).

(b) Pour ce qui regarde les *pc:*

(i) Ka propose que l'on donne: (a) la durée de la série de pulsations avec l'heure du commencement; (b) la période moyenne, déduite du nombre de pulsations pendant 5 minutes dans la partie la plus nette de l'enregistrement; (c) l'amplitude maximum. (Comme dans le cas précédant, des modèles de tableaux sont proposés).

(ii) RS propose qu'au lieu de la période moyenne l'on donne les périodes extrêmes que l'on rencontre sur le *pc* considéré.

(iii) CF et Ni suggèrent que l'on fasse des statistiques doubles ou triples, etc., d'après les périodes les plus importantes se présentant souvent superposées et qu'il serait dommage de négliger. Wn a aussi le même point de vue.

(iv) Jusqu'à combien de minutes en dehors de l'heure étudiée peut-on prendre l'amplitude maximum?

(v) Le et Es demandent: "Should the amplitude or range be given for *pc?* your letter mentions amplitude, but the form heading is range and we have adopted the latter".

(D) *Questions concernant les enregistrements eux-mêmes.*

(a) L'on fait remarquer qu'il est très important de faire connaître le moyen d'enregistrement des pulsations: avec des variomètres très sensibles ou par des courants d'induction; car dans ce dernier cas, surtout quand il s'agit de très courtes périodes, l'on trouve de très grandes différences par rapport aux enregistrements directs avec des variomètres d'après les différentes caractéristiques des appareils employés.

(b) Il serait très intéressant de pouvoir compter sur un nombre suffisant d'observatoires bien distribués sur l'ensemble du globe qui seraient prêts à fournir des copies de leurs enregistrements rapides pour les 24 heures du jour. D'après les réponses reçues, il semble que l'on peut compter pour le moment sur les observatoires allemands et probablement aussi sur les japonais et celui de Tamanrasset.

5. **Sur les *sfe***

(A) *Questions concernant la définition.*

(a) L'on a suggéré que l'on examine de plus près les mots "d'ordinaire dans le sens de la variation diurne" et s'il y a une distinction réelle entre les *sfe* ordinaires et les renversés.

(B) *Questions concernant les renseignements à fournir.*

(a) Ni propose que l'on donne:

(i) l'heure du commencement

(ii) l'heure du maximum

(iii) l'écart maximum

sur les trois composantes; ce qui faciliterait beaucoup l'utilisation ultérieure des données à échelle universelle.

(b) Ka propose que l'on donne, en dehors de l'heure, le sens, la magnitude et la durée du premier mouvement sur les trois composantes.

6. **Sur l'ensemble des phénomènes**

(a) Quelques-uns pensent qu'il ne suffit pas qu'un phénomène soit net sur une seule composante pour qu'il doive être rapporté. Semble-t-il nécessaire d'exiger qu'il soit aussi observable en quelque sorte sur les autres composantes?

(b) La plupart des observatoires ne semblent pas favorables à l'introduction de limites inférieures de la grandeur des phénomènes à rapporter; ils aiment mieux se tenir d'ordinaire à leur netteté. L'on a posé pourtant la question suivante: Si l'on maintient le critère des limites inférieures et si l'on a à faire à un phénomène dépassant cette limite sur une seule composante (visible pourtant, mais au-dessous de la limite, sur les autres) doit-il être rapporté sur la première composante seulement ou sur toutes?

(c) Pour ce qui regarde le signe des variations, des difficultés se sont présentées à propos de l'interprétation des mots de la lettre circulaire du 28-3-56, No. 2, c): "L'on prendra toujours comme sens positif pour D et Y le mouvement vers l'Est et pour H, X et Z l'augmentation de leur valeur absolue".

Le groupe d'observatoires américains Co, Si, Ch, Tu, To et SJ fait la proposition suivante: "During IGY there will be situated along or near the magnetic equator a number of temporary observatories (some perhaps in short north-south chains) for studying the equatorial electrojet. At all such stations Z will be small; at some of them it may change sign frequently in response to transient fluctuations. It would appear highly desirable for all of them to use a common basis of reporting Z changes, not dependent on the sign that Z happens to have at particular times and places. Futhermore there will be many high-latitude stations, some at situations like Cape Adare, the Knox Coast, and Little America (in Antarctica) and Resolute Bay (in the Arctic) where D is close to or in excess of 90°. Any station in such a location that records X would encounter a similar sign difficulty. Perhaps the best solution to these problems (in regard to both X and Z) would be to stipulate that a + sign refers to an algebraic increase, with

Z regarded as negative wherever south dip prevails". A celle-ci se ramène aussi l'opinion de To, Wa et Am.

(d) L'on a proposé d'employer les courants telluriques pour l'étude des pulsations (voir ci-dessus la Note sur la proposition de Mr. Thellier). Leur grande utilité a été aussi démontrée par les enregistrements présentés à Barcelone par Mme. Troitskaya et les exemples envoyés au Comité par Mr. De Voogt. Quelques observatoires s'en servent aussi pour la confirmation des *sfe*. L'on demande de préciser la façon de les employer dans ces buts et de décider les données qui doivent être fournies par les observatoires qui les enregistrent.

(e) Plusieurs observatoires employant de plus en plus la dénomination "vortex" pour qualifier certains phénomènes, l'on propose d'étudier s'il faut entreprendre la statistique de ceux-ci comme phénomène à part. Si oui, comment doit-on les définir. Exemples.

(f) Etude de la façon de publier synthétiquement les nouvelles modalités données mensuellement (signes, amplitudes, périodes etc.).

ANNEXE 3.

Résolutions.

A. *Généralités.*

1.1 Le Comité prie les Observatoires, ayant des magnétogrammes normaux, de bien vouloir indiquer les phénomènes suivants:

ssc, ssc, si,*
b, bp, bs, bps,
pt, pg, sfe

et les Observatoires ayant des magnétogrammes rapides indiqueront ce qui suit:

pt, pc, pg

1.2 Comme on le voit on a de nouveau introduit les *si* et on a supprimé la notation *psc* qui est remplacée, comme on le verra plus loin, par la notation *bp*. Le Comité demande aux Observatoires de ne désigner aucun phénomène par la notation *sc*.

2.1 En rapportant les phénomènes tels que *ssc, si* etc. les Observatoires sont priés d'ajouter aux notations correspondantes une des trois lettres suivantes A, B, C, dont la signification est:

A = phénomène très net
B = netteté suffisante pour une identification sûre
C = douteux

2.2 Quand ils répondent aux listes de contrôle (checking lists) les Observatoires sont priés de noter leurs réponses en utilisant les lettres A, B, C ou une des suivantes:

D = le phénomène n'apparaît pas sur les enregistrements bien qu'il aurait pu y être reconnu facilement.

E = le phénomène ne peut pas être reconnu en raison de l'état d'agitation existant à ce moment.

X = il y a une lacune dans l'enregistrement correspondant.

3. Quand ils donnent le sens des variations des différents éléments le signe + devra être employé quand le vecteur représentant la variation de la composante correspondante est dirigé comme suit:

X vers le Nord
Y vers l'Est
Z et I vers le bas
D sens des aiguilles d'une montre.

Le signe — désignera les cas contraires. Comme par définition ni H ni F ne peuvent prendre des valeurs négatives une augmentation de leur intensité sera toujours donnée par le signe +.

4. Dans la représentation vectorielle éventuelle de la variation d'un phénomène en fonction du temps, les conventions de signes suivantes sont recommandées par le Comité: la composante magnétique Nord vers la droite et la composante magnétique Est vers le bas. Ceci afin que la composante Nord du courant ionosphérique supposé responsable du phénomène soit orientée vers le haut de la feuille.

5. D'une façon générale, il sera considéré comme suffisant qu'un phénomène apparaisse sur une seule composante pour qu'on le retienne. La lettre A, B, C caractérisant sa qualité, sera celle relative à la composante où il apparaît le plus clairement.

6. En examinant les définitions des phénomènes particuliers, les Observatoires sont priés de s'attacher davantage à la structure physique du phénomène plutôt qu'à la rédaction littérale forcément donnée par le Comité à la définition correspondante.

7. Le Comité No 10 doit non seulement recevoir des données et les publier, mais il doit également aider les chercheurs à rassembler les enregistrement mondiaux pour l'étude d'un phénomène particulier. Lorsqu'un observateur désirera étudier un phénomène qui lui paraîtra intéressant, il l'indiquera sur son rapport mensuel. Le Bureau du Comité, possédant l'en-

semble des rapports, pourra dire si le phénomène a été bien observé dans les autres Observatoires et s'il a ainsi des chances d'être intéressant. Dans ce cas, le Bureau, tout en priant les Observatoires participants d'envoyer des copies aux centres mondiaux, leur annoncera le travail entrepris.

8. On décide de publier un atlas avec des exemples pour les différents phénomènes; le rassemblement d'exemples réels exigeant trop de temps, on fera une première esquisse avec des phénomènes fictifs, laquelle pourrait être publiée comme Manuel pour l'AGI. L'atlas donnant des exemples réels sera publié plus tard en profitant des données de l'AGI.

9. Les enregistrements ayant été groupés d'après leur vitesse en enregistrements normaux, rapides, très rapides et ultra-rapides:

enregistrement normal	environ 20 mm/h
enregistrement rapide	entre 2 mm/m et 6 mm/m
enregistrement très rapide	entre 6 mm/m et 20 mm/m env.
enregistrement ultra-rapide	plus de 20 mm/m

le Comité propose aux Observatoires qui ne pourraient pas faire fonctionner d'une façon continue leurs enregistreurs très rapides, de faire des enregistrements tout au moins quatre heures par jour d'après le schéma suivant:

Janvier et Juillet	00-01	06-07	12-13	18-19
Février et Août	01-02	07-08	13-14	19-20
Mars et Septembre	02-03	08-09	14-15	20-21
Avril et Octobre	03-04	09-10	15-16	21-22
Mai et Novembre	04-05	10-11	16-17	22-23
Juin et Décembre	05-06	11-12	17-18	23-24

Quant aux instruments ultra-rapides, il serait bon de les faire fonctionner pendant le premier quart d'heure des heures signalées pour les enregistrements très rapides. Au cas où l'on ne pourrait pas les employer tous les jours de cette façon, il faudrait les faire fonctionner de la sorte tout au moins pendant les jours mondiaux et les intervalles mondiaux spéciaux.

B. *Phénomènes particuliers.*

(a) *Magnétogrammes normaux*

1. ssc Impulsion brusque suivie d'un accroissement d'activité durant au moins une heure; l'orage proprement dit

peut apparaître immédiatement ou seulement après quelques heures.

2. *ssc** Il est semblable à un *ssc*, précédé immédiatement sur au moins une des composantes par un ou plusieurs petits mouvements contraires. Dans le cas où les mouvements contraires seraient d'amplitudes comparables, on notera le phénomène par *ssc* et non par *ssc**.

3. Dans les cas des *ssc** on prie les Observatoires de mettre l'astérisque dans chacune des colonnes correspondant aux composantes qui présentent le ou les mouvements précurseurs.

4.1 Dans le cas où les Observatoires relèvent pendant un orage magnétique un nouveau phénomène qui leur paraît *clairement* être le début d'un nouvel orage, ils devront le noter comme un nouveau *ssc* ou *ssc** suivant le cas.

4.2 *si* Si l'on hésite à le classer en tant qu'une nouvelle tempête ou en tant qu'une autre sorte de mouvement brusque *important*, on le donnera comme un *si*.

5. Dans certains cas particuliers où l'orage semble débuter par 2 ou plusieurs mouvements brusques, on les considérera comme des *ssc* (ou *ssc**) ; ou bien on remplacera un ou plusieurs de ces *ssc* (ou *ssc**) par des *si* si l'on doute qu'un ou plusieurs des commencements soient vraiment le commencement de l'orage.

6.1 *pt* Trains de pulsations de durée individuelle ne dépassant pas en général 10 à 20 minutes mais pouvant se relayer parfois pendant un peu plus d'une heure.

6.2 On prie tous les Observatoires (même ceux qui ont seulement des magnétogrammes à vitesse normale) de donner les *pt*. On donnera l'heure du commencement du phénomène et sa durée totale.

6.3 Si dans un *pt* il y a quelque groupe très clair qu'on devrait signaler comme étant de catégorie A, on donnera aussi l'heure particulière de ce groupe.

7.1 *b* Les baies claires et isolées qui apparaissent pendant une période calme, dont le début est avec ou sans pulsations, brusques ou non, doivent être données. Dans les rapports mensuels les baies sans pulsations et sans commencement brusque seront notées par *b*, mais on les donnera seulement lorsqu'elles appartiennent à la catégorie A.

7.2 On mettra dans la colonne correspondante le signe de chaque composante.

7.3 L'heure de la baie sera celle de la composante dans laquelle la baie se présente la première.

8.1 *bp* Si une baie se présente, au moins sur une composante, avec des pulsations précédant ou suivant son début avec une faible différence de temps ne dépassant pas une dizaine de minutes, on la signalera comme *bp*. Cette catégorie sera à peu près celle des anciens *psc*.

8.2 *bs* Une baie qui commence brusquement sera signalée par *bs*.

bps Elle sera signalée par *bps* si en plus il s'agit d'une baie pulsée.

8.3 Ces baies, *bp*, *bs* et *bps* doivent être signalées même si elles appartiennent aux catégories B ou C.

(b) *Magnétogrammes rapides.*

1.1 *pt* Définition comme en B (a) 6.1

1.2 Le Comité prie les Observatoires de donner les instants du commencement de chaque groupe particulier suffisamment net.

2.1 *ptAR* S'il y a des *pt* qui sont non seulement très nets, mais dont les pulsations sont de plus très régulières, on les notera par *ptAR*.

2.2 Pour les *ptAR*, on prie les Observatories de donner, s'il est possible, en plus de l'heure du début du phénomène, la double amplitude de la plus grande des oscillations régulières, celle-ci se rapportant aux composantes elles-mêmes en gammas et non à leurs dérivées en gammas par seconde.

3.1 *pc* Pulsations présentant une certaine continuité, d'une période comprise entre 10 et 40 secondes (et exceptionnellement jusqu'à 50 sec.) et durant plusieurs heures.

3.2 Pour les *pc* on doit donner l'heure du début et de la fin des pulsations pour chaque journée de Greenwich.

3.3 S'il y a des intervalles avec des *pc* qui appartiennent à la catégorie A *(pcA)*, on donnera aussi les heures des débuts et des fins de chacun de ces intervalles.

4. Si quelques Observatoires veulent envoyer spontanément les heures du début et de la fin des intervalles particuliers avec les périodes et les amplitudes des plus grandes pulsations correspondantes, on leur sera reconnaissant, car ces données aideront beaucoup le Comité à signaler ultérieurement les intervalles de temps qui présentent un intérêt particulier et qu'il serait avantageux d'étudier plus à fond.

5. *pg* Comme il existe d'autres pulsations de périodes plus courtes ou plus longues que celles des *pc*, comme c'est le cas des pulsations géantes *(pg)*, les Observatoires voulant les signaler sont priés de le faire dans des listes séparées.

Resolutions.

A. *General Comments.*

1.1 The following phenomena are the ones that the Committee would like to have forwarded to it by all Observatories producing normal magnetograms:

ssc ssc si*

b, bp, bs, bps

pt, pg, sfe

and from Observatories producing quick-run magnetograms:

pt, pc, pg

1.2 It is noted that *si* is reinstated. The notation *psc* is discontinued and is replaced by *bp* as explained in the following text. The Committee asks that the notation *sc* be omitted in the future.

2.1 In reporting the occurrence of phenomena as *ssc, si* etc. the Observatories are asked to add one of three letters as follows:

A = very distinct
B = fair, ordinary, but unmistakable
C = doubtful

2.2 In filling in the checking lists, Observatories are asked to answer by entering A, B, C or one of the following letters:

D = decidedly not observed, although records were satisfactory

E = because of heavy disturbance the phenomenon in question cannot be discerned

X = record missing

3. In reporting the sense of the changes in the several elements, the plus (+) should be used if the pertinent part of the motion experienced by the end of the field vector is as shown below, the negative sign (—), if the contrary:

Northward	for X
Eastward	for Y
Downward	for Z and I
Clockwise	for D

Since, by definition, neither H nor F can ever have negative values, an increase of their magnitude should be given by a plus sign (+).

4. If an observer wishes to plot graphically the time changes of the magnetic field vector, the Committee recommends that the North magnetic component extend toward the right and that the East magnetic component extend toward the bottom of the diagram. Thus the ionospheric current will be correctly oriented on the sheet: a northward current toward the top of the page.

5. It is sufficient, for including a phenomenon in any list, that the phenomenon appears on only one component. The category A, B, C to be given to the phenomenon should be that of the component which shows the effect most clearly.

6. The Observatories are asked, in considering the following definitions, to use them as a general guide in looking for the various phenomena, not to take them literally in the manner of "splitting hairs".

7. Duty of Committee No 10 will be not only to receive data from Observatories and to publish them, but also to help the research workers to collect the records from other institutions in order to carry on particular studies on special phenomena. When a specialist wishes to study a particular case, which he thinks to be of special interest, he will refer to it in the monthly report to be sent to Committee No 10, and this Committee will see whether it has been well registered in a world wide scale and may have therefore a general interest. If so, Committee No 10 will ask the Observatories to send copies of the magnetograms to the World Data Centers and will announce the research planned.

8. It has been agreed to publish an atlas with examples of the different types of phenomena; as the collection of real examples will take too much time, it will be issued as a provisional atlas with artificial examples; this atlas may be published as an IGY manual. The final atlas with real examples will be prepared later using the data obtained during the IGY.

9. The magnetic and earth-current records have been grouped in the following categories:

normal	speed about 20 mm/h
quick-run	speed between 2 mm/m and 6 mm/m
very quick-run	speed between 6 mm/m and 20 mm/m
ultra-quick-run	speed more than 20 mm/m

The Committee proposes to the Observatories which will not be able to have the very quick-run records in operation the whole day to use them at least four hours per day in accordance with the following timetable:

January and July	00-01	06-07	12-13	18-19
February and August	01-02	07-08	13-14	19-20
March and September	02-03	08-09	14-15	20-21
April and October	03-04	09-10	15-16	21-22
May and November	04-05	10-11	16-17	22-23
June and December	05-06	11-12	17-18	23-24

For the ultra-quick-run records, the first quarter of hour of the times mentioned above is specially recommended. If it is still too much for some Observatories to operate the ultra-quick-run records every day in this way, all effort should be done to have them in operation at least during the World Days and Special World Intervals.

B. *Description of Phenomena.*

(a) *Ordinary magnetograms.*

1. *ssc* A sudden impulse followed by an increase in activity lasting at least one hour. The more intense activity of the storm may appear immediately or it may be delayed a few hours.

2. *ssc** This is similar to an *ssc,* except that the sudden impulse is immediately preceded, on at least one component, by one or more small reverse oscillations. In case the reverse movement has approximately the same amplitude as the principal movement, it will be reported as *ssc* (not as *ssc*)*

3. In the case of recording *ssc**, the observer is requested to put a star in the column where the algebraic sign of the principal movement is recorded, so that the star will indicate the element or elements in which such reverse movement occurred.

4.1 If the observer sees, during the course of a magnetic storm, additional *clear ssc*'s or *ssc**'s, he should report them as separate phenomena and call them *ssc* or *ssc**, as appropriate.

4.2 *si* If the observer sees an *important* sudden impulse during a storm, but doubts that it represents the beginning of a new storm, he should report it as *si.*

5. Occasionally if a magnetic storm apparently begins with two or more sudden movements, the observer should report each movement as *ssc* (or *ssc*),* unless he doubts that one or the other is actually the beginning of the storm. In the latter case the clear commencement should be reported as *ssc* (or *ssc*),* the other as *si.*

6.1 *pt* A phenomenon consisting of several series of oscillations, each series lasting generally 10 to 20 minutes, the whole phenomenon lasting for periods of not more than about one hour.

6.2 All Observatories (even those having only normal-speed recorders) are asked to report *pt.*

6.3 The time of beginning of the phenomenon and its duration should be specified. If in the phenomenon there is a series that is exceptionally clear, the time of beginning of that part should be given and it should be specified as *ptA (pt* of category A).

7.1 *b* Clear and isolated bays appearing during calm periods, with or without sharp beginnings, with or without pulsations should be reported. In the monthly reports bays without pulsations or sharp beginning should be reported as *b,* but only if they are of category A.

7.2 When the observer lists a bay, he should give the algebraic sign of its movement in the column corresponding to the proper magnetic element.

7.3 The time of the beginning should be taken from the element on which the bay first appears.

8.1 *bp* If a bay appears with pulsations preceding or following the beginning of the bay by not more than about 10 minutes, the bay should be reported as *bp.* This type of phenomenon is essentially the same as the old *psc.*

8.2 *bs* A bay with a sharp beginning should be given as *bs.*

bps A bay with pulsations and a sharp beginning should be given as *bps.*

8.3 *bp, bs* and *bps* of categories A, B and C should be reported.

(b) *Rapid-run Magnetograms*

1.1 *pt* Definition as above B (a) 6.1.

1.2 It is requested that the time of beginning of each clear series of oscillations be given.

2.1 *ptAR* If one or more series of oscillations is unusually clear and regular, it should be specified by *ptAR.*

2.2 For the *ptAR's* the observers are requested to give, if possible, the time of beginning, the period, and the double amplitude of the largest regular oscillation. Amplitudes shall refer to magnetic elements in gammas, not to the derivative in gammas per second.

3.1 *pc* Pulsations having a considerable element of continuity, having periods between 10 and 40 seconds (and exceptionally to 50 seconds) lasting a number of hours.

3.2 For *pc* the time of beginning and of ending of the pulsations should be given for each Greenwich day.

3.3 If there are intervals during the *pc* when the pulsations can be classified in category A *(pcA)*, the time of beginning and ending of these special intervals should be given.

4. If some Observatories wish to send voluntarily the times of beginnings and endings of particular intervals, with periods and amplitudes of the largest oscillations, the Committee will be guided by them in selecting the times of particular interest for further study.

5. *pg* Since there exist pulsations having periods longer or shorter than those of *pc*, such as giant pulsations *(pg)*, Observatories wishing to report them should do so on separate lists.

Notes.

L'atlas provisoire dont on parle dans la résolution A.8 a été publié dans les "Annals of the IGY", vol. II B, pp. 694-709.

Les Observatoires qui d'après la résolution B.(b) 5. voudront bien donner des renseignements sur des pulsations de périodes différentes de celles choisies pour les *pc*, sont priés de le faire en employant des formulaires du même type, mais en indiquant dans la colonne des Notes les périodes des pulsations rapportées.

The provisional atlas mentioned in the resolution A. 8 has been published in the "Annals of the IGY", vol. II B, pp. 694-709.

The Observatories which in accordance with resolution B.(b) 5. wish to report pulsations having periods different from those selected for *pc*, are asked to do so using forms of the same type, but indicating in the column for Notes the periods of the reported pulsations.

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, or to brief author's extracts in those cases where they have been supplied and citations are not available.

Origin of the secular variation

by D. W. Allen and E. C. Bullard

Department of Geodesy and Geophysics, University of Cambridge

The secular variation is known to have its origin within the earth. Its short time scale makes it likely that the cause lies in the fluid core rather than in the solid mantle or in the crust.

Motions of the material of the core in the main field will produce induced currents and changes in the field. It is widely believed that the secular variation is produced in this way, but detailed calculations have always given either too small or too slow a change. It seems sufficiently large changes can be produced in a short enough time by supposing the large toroidal field, which is believed to exist within the core, to be brought to the surface of the core by rising convective motions. Detailed calculations have been made in a few simple cases.

Ideas concerning the causes of the secular variation of the geomagnetic field

by G. Barta

Budapest

When projecting orthogonally the vectors representing the secular variation to a plane tangent to the globe about Pakistan one can state that the vectors around the center of the picture are pointing characteristically to each other, while being directed outwards at the marginal sections. Taking into account this and the respective sideviews we can conclude that in a depth of about 3000 km a circular current is flowing around Pakistan with a radius of about 3000 km; the direction of the current is clockwise when seen from Pakistan, and its intensity is estimated at

10^7—10^8 Ampères. The shifting of the eccentric magnetic center with a velocity of about 10 km pro year can be due to a movement of the Earth's core. This causes an increase of pressure and a divergence of matter around the point below Pakistan and the variation of the site and intensity of this vortex in time may be responsible for the secular variation. The movement of the Earth's core may be oscillatory with a period of 400—500 years.

The helicoidal march with a 50 year-period, observable in the secular variation can be produced by a precession-like movement of the axis of this vortex. Thus, the 50 year-period manifesting itself both in the revolving speed of the Earth and in the secular variation of the Earth's magnetism may be attributed to a movement in the Earth's core. The supposed rearrangement of masses must result in a variation of the gravitational field too. The variations of gravitational levels can be followed even in the past by using the level data of tide-gauge stations, and an eventually existing period of 50 years can be detected there. It is probable, that also the main period of 500 years of the magnetic secular variation could be detected in these latter phenomena.

Sodium twilight experiments and wind measurements

by J. F. Bedinger

Geophysics Research Directorate,
Air Force Cambridge Research Center, Bedford, Mass.

The complete text is published under the title "Study of sodium vapor ejected into the upper atmosphere" (by J. F. Bedinger, E. R. Manring and S. N. Ghosh) in J. Geophys. Res., v. 63, pp. 19—29, 1958; a summary has been published in IAGA Bull. 16b, pp. 278—279, 1959.

Current systems of magnetic storms

by N. P. Benkova

USSR

By world-wide observations at magnetic observatories in 1932—1933 the regular parts of the field of world magnetic storms (D_{st}- and S_D-variations) and that of polar storms have been considered; the potentials of the external and internal parts of these fields computed; the parameters of the equatorial current ring ($J = 7 \times 10^5 A$ and $a = 3.8R \pm 0.8R$) responsible for the D_{st}-variations calculated.

By means of the method of surface integrals, an ionosphere current system causing S_D-variations has been computed. The form of the S_D-system proved to be similar in general outlines but different in detail from the current system derived by Chapman and Vestine by qualitative methods.

A current system of polar storms has been built.

The D_{st}- and S_D-variations of the F-region in the ionosphere and the connection of disturbed variations of the magnetic field and the ionosphere have been examined; current systems of several individual storms are described.

An analytical conception of the external (E) and internal (I) parts of the field of storms made it possible to determine the conductivity ($\varkappa$) of different parts of the Earth. To carry out this task the data on D_{st}-variations and polar storms should be involved together with data on S_q-variations.

The following results have been obtained. For the first harmonic of D_{st}-variations the ratio I/E was found to be about 0.40 which, from the Lamb-Price formulae, gives the following value of the core conductivity $\varkappa = 4.4 \times 10^{-12}$ CGSM and its radius $\varrho = 0.94R$. Taking into account the influence of the surface conducting layers and assuming that $\varkappa$ of the core increases with depth according to the law:

$$\varkappa = \varkappa_0 \, (r/\varrho)^{-s},$$

we have $s = 26$, $\varrho = 0.91R$ and $\varkappa_0 = 4 \times 10^{-13}$ CGSM.

The curve of dependence of $\varkappa$ on depth, calculated for these values of the parameters reveals a drastic increase of $\varkappa$ at a depth of 900—1200 km where Gutenberg and Repetti discovered ruptures in the change of P wave velocity.

The calculation of the core conductivity by the ratio of the external and internal parts of the polar storm field led for different terms of the potential series to values of $\varkappa$ lying in the range of 10^{-12} to 10^{-14} CGSM which is concordant with the data obtained from the analysis of D_{st}-variations.

The Störmertron

by W. H. Bennett

U.S. Naval Research Laboratory, Washington, D.C.

The complete text is published in Ann. Géophys., 14, pp. 206—207, 1958; (IAGA Bull. 16b, pp. 346—347, 1959).

Twilight sodium effects

by J. E. Blamont

Ecole Normale Supérieure, Paris

The complete text is published under the title "The sodium twilight airglow 1955—1957, I" (by J. E. Blamont, T. M. Donahue and V. R. Stull) in Ann. Géophys., 14, pp. 253—281, 1958; (IAGA Bull. 16b, pp. 226—254, 1959), and "The sodium twilight airglow 1955—1957, II" (by J. E. Blamont, T. M. Donahue and W. Weber) in Ann. Géophys., 14, pp. 282—304, 1958; (IAGA Bull. 16b, pp. 255—277, 1959).

Ozone and water vapour in the upper atmosphere

by A. W. Brewer

Clarendon Laboratory, Oxford

Observations show that the distribution of water vapour in the stratosphere is remarkably unvarying, and at 48.000 ft. the frost-point is always very close to 190° A. On the other hand the evidence from total ozone and Umkehr measurements is that the ozone concentration of the lower stratosphere is very variable. An electro-chemically operated ozone concentration sonde of suitable size and simplicity for use on a fairly wide scale has now been made. Preliminary flights made between April and July, 1957, suggest an annual variation and show considerable structure which varies from day to day. It is hoped that the ozone concentration sonde will be a valuable tool for stratospheric studies.

Investigations of the nature of earth regional currents and their relation to geology from observations in Georgia.

by A. V. Bukhnikashvili and V. V. Kebuladze

USSR

Earth regional electric (telluric) currents have attracted investigators for a long time. But the nature of these currents and their relation to geological and geophysical phenomena have not yet been studied sufficiently. Of considerable interest is the relation between the nature of earth currents and the geomagnetic field, atmospheric electricity, meteorological processes, seismic phenomena, etc.

Recent works of different investigators show the possibility of using earth currents for studying the structure of the upper part of the Earth's crust though there is not enough experience in this field.

Despite such a great scientific and practical importance of studying earth currents, continuous observations of the latter are rather irregular and made at only a few stations arbitrarily distributed on the Earth's surface.

In our opinion, proper measures should be taken towards a rational distribution of observation points on earth currents and co-ordination of such observations in different localities which is especially important during the IGY.

As the result of a statistical treatment of diurnal records of earth current variations made at the Dushet telluric station ($\varphi = 42°05'$ N, $\lambda = 44°42'$ E) since 1947, a number of laws governing the behaviour of earth currents have been revealed and studied. It was discovered that the observed values of differences between the potentials of an electrotelluric field are

mostly conditioned by local processes and electrode effects, the dominating role in the formation of these differences belonging to meteorological factors, and physical and chemical processes in points where electrodes were earthed. In connection with this, the report considers the problem of the existence of a constant component of the electrotelluric field and the possibility of revealing it. It is being proved that the variable part of the electrotelluric field is mostly conditioned by regional factors but it is somewhat influenced by local factors too. Considering local factors the author deals with the Sun's diurnal, seasonal, annual and secular variations as well as with the arrival times of these variations.

Considered apart are electrotelluric storms and disturbances, their frequency and amplitudes, diurnal and annual variations of these disturbances.

A complete parallelism is stated to exist between the variation of the horizontal component of the geomagnetic field intensity and the latitudinal component of the electrotelluric field observed not only during electromagnetic storms and disturbances but also on magnetically quiet days. The report considers the problem of the dependence of the variable part of the electrotelluric field on the induction of the Earth's magnetic field. Our observational data are compared with those of some other stations located at various latitudes and longitudes.

The author takes a view of the results obtained in using the earth currents for studying geological structures. In 1949 measurements were made by utilizing only short-period variations and with small spacings of the receiving lines to study the local structures. In 1954—1956 investigations were conducted along a few routes 200 km long with the Dushet station as a base point; short-period variations and pulsations were used in addition to the amplitudes of long-period variations and electrotelluric disturbances. The electrotelluric survey of Eastern Georgia has confirmed the efficiency of using the methods of measuring earth currents especially in the determination of the surface depth of a crystalline foundation. It has been discovered that the structure and behaviour of these currents depend on geological conditions of the upper part of the Earth's crust at the observation point.

Interpretation of the twilight airglow

by J. W. Chamberlain

Yerkes Observatory, University of Chicago

The complete text is published under the title "Interpretation of twilight spectra" in Ann. Géophys., 14, pp. 196—203, 1958; (IAGA Bull. 16b, pp. 325—332, 1959).

A physical interpretation of the central quadrupole

by A. Chargoy

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Instituto Nacional de la Investigación Cientifica

The central quadrupole, as described by Umow, is studied. An analysis with this model is made using data from 1835 to 1945. It is shown that two eccentric electric rings in a plane are equivalent to this quadrupole, and that if the intensities of the currents on these rings are varying, one with respect to the other, then one observes from the earth's surface a quadrupole and a dipole, the latter varying its sense and intensity.

Determination of atmospheric densities from absorption of solar radiation

by T. A. Chubb

U.S. Naval Research Laboratory, Washington, D.C.

The complete text is published under the title "The use of radiation absorption and luminescence in upper air density measurements" (by T. A. Chubb, E. T. Byram, H. Friedman and J. E. Kupperian, Jr.) in Ann. Géophys., 14, pp. 109—116, 1958; (IAGA Bull. 16b, pp. 52—59, 1959).

Distribution normale du champ géomagnétique en Roumanie pour l'époque 1955.0

par L. Constantinescu

Observatoire Géophysique de Surlari

La communication a pour objet la présentation du problème de la distribution normale du champ géomagnétique en Roumanie et en particulier de la solution qui lui a été donnée actuellement, dans le cadre du Comité Géologique de ce pays (ancien Institut Géologique de la Roumanie).

A la base du travail se trouvent les données d'observation obtenues dans un système cohérent de 21 stations magnétiques, uniformément réparties sur tout le territoire roumain — dont 10 stations de répétition, destinées à permettre de suivre les particularités de l'évolution de la variation séculaire, et 10 stations intermédiaires —, système s'appuyant sur l'Observatoire Géophysique de Surlari qui, tout en en constituant la 21-ième station, lui fournit les valeurs absolues de référence de même que les informations nécessaires aux réductions. Les valeurs des éléments géomagnétiques (D, H, I) ont été mesurées à l'aide d'un appareillage unitaire (théodolite magnétique et inducteur terrestre), contrôlé périodiquement à l'Observatoire de Surlari.

Les données d'observation, soumises aux procédés habituels de réduction et de transformation, ont conduit aux formules de distribution normale des éléments géomagnétiques pour l'époque 1955.0, formules constituant les principaux résultats du travail. En même temps, celui-ci met en évidence les informations supplémentaires qui peuvent en être déduites, comme les valeurs des gradients horizontaux N et E des éléments géomagnétiques, et fournit des renseignements sur la variation séculaire de ces éléments en Roumanie, à l'heure actuelle.

Mettant, ainsi, à la disposition des cercles de spécialité les principales informations concernant la distribution géographique du champ géomagnétique en Roumanie qui présentent un interêt à l'échelle internationale, la communication tend à combler une lacune, masquée jusqu'à présent seulement par des interpolations sur les cartes géomagnétiques mondiales.

The procedure of magnetic cleaning

by K. M. Creer

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The stability of the remanent magnetisation of sedimentary and igneous rocks is discussed. Physical tests for stability are described, and the results of experiments to measure or remove the soft, unstable components of magnetisation of some Triassic sedimentary rocks from England and Triassic lavas from Uruguay are given as illustrations.

Discussion by Prof. E. Thellier:

Prof. Thellier appelle l'attention sur le fait que l'aimantation visqueuse est d'autant plus dure magnétiquement que le temps d'action du champ qui l'a créée est plus long. Par example, pour détruire complètement l'aimantation créée par un champ de 10 Oe agissant brièvement, il faut un champ alternatif d'intensité efficace de 10 Oe environ; mais pour un temps d'action d'une heure il faut 100 Oe, pour 4 mois 250 Oe .... Ceci étant indépendant de la nature de la roche (Mlle Rimbert). Dans la recherche de directions d'aimantation le "lavage" alternatif reste intéressant parce qu'il enlève la partie principale de l'aimantation visqueuse, mais la partie la plus dure peut rester, avec l'ATR, et donner une erreur systématique.

Dans sa réponse Dr. Creer parle de saturation de l'aimantation visqueuse. Prof. Thellier fait observer que la viscosité ne risque pas de donner des aimantations infinies à cause de sa loi logarithmique. Considérons l'augmentation de la rémanence de viscosité entre une action d'une minute et une action d'un jour; on aura la même augmentation en passant de 1 jour à 1440 jours, soit 4 ans environ; la même encore de 4 ans à 6000

ans environ, puis à 10 millions d'années .... Ainsi pour une durée supérieure à l'âge de la Terre l'aimantation visqueuse serait seulement augmentée de 4 fois ce qu'elle est entre 1 minute et 1 jour.

Diffusion coefficient in the F-layer

by A. Dalgarno

Geophysics Research Directorate, ARDC, Bedford, Mass.

The complete text of the communication presented is published under the title "The altitudes and excitation mechanisms of the night airglow" in Ann. Géophys., 14, pp. 241—252, 1958; (IAGA Bull. 16b, pp. 372—383, 1959).

Palaeomagnetism of the Deccan Traps

by E. R. Deutsch

Department of Physics, Imp. Coll. of Science and Technology, London

and P. W. Sahasrabudhe and C. Radakrishnamurty

Tata Institute of Fundamental Research, Bombay

The complete text has been published in Ann. Géophys., 15, pp. 39—59, 1959; (IAGA Bull. 16a, pp. 39—59, 1959).

A convective system in the mantle between the NW of Africa and the Azores

by A. de Mendonça Dias

Serviço Meteorológico Nacional, Lisbon

An anomaly which was analysed in the vertical component of the earth's magnetic field, was successively recorded at S. Fernando (Cadiz), Coimbra and S. Miguel (Azores Islands) with its beginning in 1894 at S. Fernando.

On the other hand a systematic migration of epicenters from SE to NW, was recorded during the seismic crisis which at S. Miguel had its beginning in 1932.

For the explanation of the phenomena are admitted: (a) Conducting materials which are moving in the mantle from SE to NW, electric currents flowing through them being responsible for the recorded anomalous magnetic field. (b) Tangential stresses, related to the movement of the same materials under the crust, which would explain the occurrence of the earthquakes and the epicenters' migration itself.

This appears to be in accordance with a convective system in the mantle with an upward current under Africa and a horizontal branch from that continent to the Azores.

The hypothesis of convergence under the archipelago with another current from NW, both subsiding there, is also sub-

mitted and may be related to the origin of the Mid-Atlantic Ridge.

Drifting sporadic E-clouds

by W. Dieminger

Max-Planck-Institut für Aeronomie

The complete text has been published under the title "Clouds in the sporadic E-layer" in Ann. Géophys., 15, pp. 23—30, 1959; (IAGA Bull. 16b, pp. 121—128, 1959).

Ionosphere in the region near the pole

by V. M. Driatsky

Arctic Scientific Research Institute of the Chief Administration of the Northern Sea Route, USSR.

The complete text has been published under the title "Ionospheric conditions in the circumpolar region" (by V. M. Driatsky and A. S. Besprozvannaya in Ann. Géophys., 14, pp. 438—455, 1958; (IAGA Bull. 16b, pp. 103—120, 1959).

Palaeomagnetism and geological correlation

by P. M. Du Bois

Geophysics Division, Geological Survey of Canada

The complete text has been published in Ann. Géophys., 14, pp. 509—514, 1958; (IAGA Bull. 16a, pp. 33—38, 1959).

Routine measurements of the vertical distribution of atmospheric ozone by the Umkehr method and their evaluation with the help of a high speed electronic computer

by H. U. Dütsch

Zürich

About five hundred single Umkehr curves on wave-length pair "C" of the Dobson instrument have been made at Arosa since December 1955. For getting a consistent set of vertical ozone distributions from this large amount of material an evaluation method suitable for a fixed programme on a high speed electronic computer has been developed.

For this purpose the non-linear problem of computing the distribution of the atmospheric ozone into nine layers has been linearized with the help of tables which give the influence of ozone changes in a single layer on the Umkehr curve. These tables and a theoretical Umkehr curve belonging to a standard ozone distribution were calculated by an electronic computer.

The error arising from the linearization is decreased by means of a correcting method using second order terms which is

applied by successive approximation. The remaining errors are not much larger than the standard errors of the observations.

Solar activity

by John W. Evans

Sacramento Peak Observatory, Sunspot, New Mexico

The complete text has been published in IAGA Bull. 16b, pp. 152—156, 1959.

Potentialberechnungen und geomagnetisches Normalfeld

von G. Fanselau

Geomagnetisches Institut, Potsdam

Am Geomagnetischen Institut Potsdam wurde eine Potentialberechnung bis zur 16. Ordnung durchgeführt, um einmal den Einfluss der höheren Reihenglieder abzuschätzen und einen Vergleich mit ähnlichen Reihenentwicklungen von Prey (1) zur Verfügung zu haben.

Ferner wurde ein Normalfeld, basierend auf Potentialberechnungen, vorgeschlagen, das gegenüber den üblichen Normalfeldern mehrere bedeutende Vorteile aufweist. Bei Verwendung zeitabhängiger Parameter (2) lassen sich diese Potentialfelder für verschiedene Epochen ableiten. Hierzu müssen mindestens alle fünf Jahre Potentialberechnungen durchgeführt werden, die das Geomagnetische Institut Potsdam zu berechnen bereit wäre.

Literatur:

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Abhandl. d. Königl. Gesellschaft d. Wissenschaft. zu Göttingen, Math.-Phys. Klasse, Neue Folge, Bd. XI, 1, Berlin 1922.

(2) Peter Mauersberger: Betrachtungen über die zeitliche Änderung der Parameter des geomagnetischen Feldes auf Grund der vorliegenden Potentialentwicklungen.
Geophys. Institut Potsdam, Abhandl. Nr. 5, Berlin 1952.

Aircraft observations of convective cloud electrification

by D. R. Fitzgerald and H. R. Byers

University of Chicago

A horizontal component of the potential gradient in and around developing trade-wind and extratropical cumulus clouds has been measured with induction field meters mounted in the wingtips of an airplane. These data in conjunction with radarscope photographs of the cloud precipitation development indicate the following.

1. Case studies selected from a survey of 691 probes of trade-

wind cumulus whose tops were in the 5000—9000 ft. range showed that the main draft columns were regions of excess negative charge accumulation. Maximum fields and maximum liquid water contents were encountered at the same flight levels on occasions when two airplanes made simultaneous cloud penetrations. All but one of the trade-wind clouds produced weak fields of order 1 to 10 volts/cm. The exception had convective turrets extending to sub-zero temperature levels. A field greater than 88 volts/cm was observed in this cloud with indication of a large positive charge excess on the very heavy rain falling from these turrets.

2. The development of the electric field in moderate sized cumulus congestus clouds has been examined from a sample af 389 cloud passes in the mid-western United States made at altitudes of 17.000 to 20.000 ft. A number of these clouds exhibited strong field build-ups coincident with or somewhat before the observation of solid precipitation in the form of snow pellets or graupel, snow grain, or heavy snow, at flight level. On the assumption that the unbalanced charge producing the observed field resides largely off the side of the airplane where the largest radar echo volume is observed, we find that a strong positive charge is on recently formed solid precipitation. Regions of high liquid water content in mixed-phase clouds appear to be regions of excess negative charge accumulation in agreement with the results for all-water trade-wind clouds. Magnitudes of the fields encountered in clouds known to contain solid precipitation were from 10 to 100 times the usual fields measured in all-water clouds.

On vertical ozone profiles in the troposphere

by F. N. Frenkiel

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It has been shown that ozone is produced by a photochemical reaction involving nitrogen dioxide at concentrations of the order of parts per million[1, 2]. Certain hydrocarbons and other organic compounds increase the ozone forming capacity of nitrogen dioxide. Geophysically significant quantities of ozone are obtained by this mechanism from natural and artificial sources of nitrogen dioxide[3]. Some of this ozone is decomposed when touching the ground, but a large part disperses upwards through the troposphere. Much larger quantities of ozone are produced in the stratosphere [4, 5], and a part of this ozone may be diffused downward through the tropopause.

The major part of ozone found above the tropopause originates in the stratosphere itself through photo-dissociation of O_2. However, below the tropopause there are at least three significant ozone producing mechanisms: (1) Tropospheric ozone produced

through photolysis of NO_2, (2) Stratospheric ozone formed above the tropopause and diffused downwards, (3) Ozone formed in the troposphere through photo-dissociation of O_2. It seems that the first of these mechanisms is mainly responsible for the ozone content in the tropopause.

A study of the vertical distribution of ozone in the troposphere is based on estimates of the quantities of ozone produced in the lower tropopause and on the character of atmospheric motions which disperse it through the troposphere. On the basis of some available data it has been estimated that artificial sources of NO_2 are responsible for the formation of 3×10^{10} ozone-molecules/cm^2·sec in the belt between parallels 30° N and 60° N. Large quantities of NO_2 are also produced by natural sources, such as forest fires, volcanoes, lightnings and biological processes.

Mathematical models of the atmosphere are considered with appropriate vertical mean wind velocity components and turbulent diffusion characteristics. A time-history of tropospheric ozone profiles is then determined assuming various changes in atmospheric conditions, particularly those corresponding to day- and night-time. As a result hourly variations of ozone profiles are obtained. The analysis is further extended to seasonal and latitudinal effects on the theoretical profiles of ozone concentration in the troposphere. The comparison between the theoretical and experimental measurements seem to give further support to the view that the intermixing between the troposphere and stratosphere is quite limited. It also appears to provide a direct explanation for the diverse inconsistencies in the measurements of ozone in the troposphere under different meteorological conditions.

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X-ray emission from the active sun

by H. Friedman

U.S. Naval Research Laboratory, Washington, D.C.

The complete text has been published under the title "X-ray and ultraviolet emission of solar flares (IGY project 10.3) (by H. Friedman, T. A. Chubb, J. E. Kupperian, Jr., R. W. Kreplin and J. C. Lindsay) in Ann. Géophys., 14, pp. 232—235, 1958; (IAGA Bull. 16b, pp. 161—164, 1959).

Zum Problem der inversen Gesteinsmagnetisierung

von F. Frölich

Potsdam

The researches so far undertaken on lavas and sediments have led to no final palaeomagnetic conclusions.

From this, and from lengthy experiments in which specimens of rock have been heated to the Curie point and then cooled, it seems that the interpretation of inverse magnetisation will require a thorough investigation of the lattice arrangement and of the state of stress of the specimen.

The shapes of certain auroral forms

by C. W. Gartlein

Department of Physics, Cornell University, Ithaca, New York

The complete text has been published under the title "Visual observation of the aurora" in Ann. Géophys., 15, pp. 31—38, 1959; (IAGA Bull. 16b, pp. 178—185, 1959).

Note sur les enregistrements des variations rapides à Tamanrasset

par G. Grenet

Institut de Météorologie et de Physique du Globe de l'Algérie

A Tamanrasset on utilise depuis 1950 des variomètres électromagnétiques type Grenet et Castet. De nouveaux appareils vont être installés pour l'AGI pour la composante horizontale et la déclinaison. La vitesse d'enregistrement sera 6 mm/minute, la sensibilité au moins 0,05 γ/mm $\times$ sec pour H, probablement le double pour la déclinaison. Pour la composante verticale nous utiliserons la même vitesse d'enregistrement, mais comme organe sensible une boucle horizontale, la sensibilité sera environ 0,005 γ/mm $\times$ sec. Nos projets comprennent aussi l'emploi de barres en acier de haute perméabilité, utilisées soit pour enregistrer les composantes du champ (utilisation en flux-mètre) soit pour l'enregistrement des dérivées.

Remarques sur les amplitudes de certaines perturbations magnétiques pulsatoires

par G. Grenet et R. Will

Institut de Météorologie et de Physique du Globe de l'Algérie

La répartition statistique de certaines perturbations magnétiques à caractère d'oscillations amorties montre que la réduction du nombre de perturbations dans la journée peut s'expliquer par un effet d'absorption. Le fait qu'il n'y a pas d'amplitude privilégiée montre que le seuil à partir duquel les oscillations

se déclenchent est lié à l'importance de la cause perturbatrice (probablement l'importance du nuage ionisé provenant du soleil).

See also: Ann. Géophys., 14, pp. 530—532, 1958.

Méthode pour éliminer l'influence non-contrôlable due à l'inertie de l'égalisateur de potentiel dans les mesures du champ électrique terrestre

par A. Grigoriu
Bucharest

L'équation de l'appareil de mesure peut être réduite à la forme:

$V_a = V_m + G\varepsilon_0\varphi$, où V_a et V_m sont respectivement les potentiels vrai et mesuré, G une fonction mesurable, $\varepsilon = \varepsilon_0\varphi = C_r$ l'inertie due à la résistance variable r dans la pellicule d'air adjacente à l'égalisateur, et φ un facteur variable qui dépend de la ventilation.

En utilisant simultanément deux appareils à inerties spécifiques ε_0 inégales, le facteur non-contrôlable s'élimine de l'expression de V_a.

On précise aussi une méthode pour la mesure de l'inertie spécifique ε_0 des appareils.

Deux phases dans l'évaporation ionique des gouttes d'eau

par A. Grigoriu, G. Giurgea et H. Ivanovici
Bucharest

Les Auteurs signalent que chaque goutte d'eau peut passer par deux phases d'évaporation ionique.

Premièrement la goutte d'eau pure évapore des ions négatifs (Lenard) et se charge positivement jusqu'à un potentiel maximum fonction de la température (Frenkel).

Si l'évaporation continue (deuxième phase) la goutte commence à libérer sa charge maximum (ions positifs).

Pour les gouttes d'eau marine le signe des ions est renversé (Lenard).

On explique la charge négative (accumulée par condensation et coalescence) ou positive (générée par évaporation excessive) de la pluie et les phénomènes signalés par Schlarb (laboratoire) et Herovanu (observations côtières).

L'origine de la composante universelle (Mauchly) du champ électrique terrestre par ciel clair

par A. Grigoriu
Bucharest

L'Auteur reprend la théorie de Frenkel et constate que chaque dipôle nuageux détermine à distance, par influence,

une répartition jamais nulle des charges négatives sur toute la sphère terrestre.

La composante universelle est due à la somme des charges locales induites par l'ensemble terrestre des dipôles (nuages convectifs).

Le minimum terrestre de la convection (océans et continents, 4h GMT) entraîne donc aussi celui de la composante universelle. Mais le maximum des dipôles et de la composante universelle (18h GMT) survient deux heures après celui de la convection (retard nécessaire à la séparation gravitationelle des charges dans les nuages).

L'origine de l'électrification négative permanente de la surface du globe

par A. Grigoriu

Bucharest

Dans un lieu quelconque la densité électrique superficielle par ciel clair doit être séparée en deux composantes:

— la composante universelle variable (Mauchly), représentant la somme des charges induites à distance par l'ensemble des dipôles nuageux répandus sur la globe;

— la composante permanente, qui ne varie pas ou presque pas.

Dans la conception de l'Auteur cette dernière composante est due à l'électrification négative des océans (et positive de l'air) pendant l'évaporation des ions positifs (Lenard). Cette charge négative se répand sur tout le globe et ses petites variations ne dépendent que de la circulation atmosphérique générale.

The non-equilibrium electrification of raindrops by the association of charged cloud droplets.

by Ross Gunn

U.S. Weather Bureau, Washington, D.C.

A 1955 article entitled "Raindrop electrification by the association of randomly charged cloud droplets" (J. Meteor. *12*, 562—568) considered the equilibrium charges transferred to falling rain as a result of the drops' growth from electrified cloud droplets.

Whenever the number of collisions experienced by raindrops growing by coalescence with electrified cloud droplets is limited either by a finite distance of fall or by the drop size, then the accumulated electrical charge may be notably less than the equilibrium value. It is shown that under these non-equilibrium conditions the accumulated drop charges, averaged without regard to sign, are proportional to the charge on the parent cloud droplets and the square root of the number of charge transferring collisions; whereas the accumulated *net* charges

are directly proportional to the number of collisions. When the parent cloud droplets are weakly electrified there are usually too few collisions to accumulate random equilibrium charges on typical rain. On the other hand, equilibrium may be established on raindrops formed from randomly charged cloud droplets which are, themselves, highly electrified by atmospheric electric fields. Whenever the population density of the positively and negatively charged parent cloud droplets are notably different, drop charges as large as those usually observed may be established even when the number of collisions is limited. The analysis suggests that the non-equilibrium regime is more important in the electrification of typical rain than is the description of equilibrium worked out in the above-referenced article.

Variations in atmospheric ozone with meteorological conditions at Quetta

by A. Halim

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A Dobson ozone spectrophotometer has been in regular use at the Geophysical Observatory, Quetta, since August 1952. A maximum ozone amount in spring and a minimum in autumn, with secondaries in early February and late November respectively, have been observed each year. A diurnal variation with a generally higher value (10—15 %) during the night and a minimum value (0.5—2 %) near local noon is well pronounced.

During winter, an approaching western disturbance affected a decrease in ozone amount followed by a significant increase when the cold front had just passed over Quetta, the centre of maximum ozone amount lying within 50 miles in the wake of the depression. No such relationship was observed during the monsoons.

Geomagnetic dynamos

by A. Herzenberg

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The complete text is published in Ann. Géophys., 14, pp. 522—525, 1958; (IAGA Bull. 16a, pp. 85—88, 1959).

Recent work at the University of Saskatchewan on auroral and night sky spectra

by D. M. Hunten

University of Saskatchewan, Saskatoon

The complete text has been published in Ann. Géophys., 14, pp. 167—174, 1958; (IAGA Bull. 16b, pp. 186—193, 1959).

Airglow observations

by M. Huruhata
Tokyo Astronomical Observatory

The complete text has been published under the title "Airglow observation on board the 'Soya' expedition ship to Antarctic" (by M. Huruhata and J. Nakamura) in Ann. Géophys., 14, pp. 175—178, 1958; (IAGA Bull. 16b, pp. 222—225, 1959).

The IGY satellite tracking program as a source of upper atmospheric data

by J. Allen Hynek and F. L. Whipple
Smithsonian Astrophysical Observatory

The complete text has been published under the title "The IGY optical satellite tracking program as a source of geodetic information" in Ann. Géophys., 14, pp. 326—328, 1958; (IAGA Bull. 16b, pp. 395—397, 1959).

Movement of the pole relative to Australia since the Proterozoic

by E. Irving and R. Green
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The average pole positions computed from the Australian palaeomagnetic data are these:

Upper Proterozoic	— Mauritius
Cambrian	— South Africa
Silurian and Devonian	— South Atlantic
Carboniferous and Permian	— Morocco
Jurassic	— North Atlantic
Eocene	— West Greenland
Quaternary	— present geographic pole

The last result provides the first confirmation from the Southern Hemisphere of the average dipolar nature of the geomagnetic field during this period. In earlier time the pole path is 160° in longitude away from the pole paths determined from Europe and North America, and indicates that prior to the Quaternary the field lost its overall dipolar character or that Australia has drifted relative to these continents.

Sea magnetic survey on board the non-magnetic ship "Zarya"

by M. M. Ivanov
USSR

For the most part, the magnetic survey of oceans was conducted on board the ships "Galilei" and "Carnegie" during 1905—1929. Magnetic observations were made in three oceans and served as the basis for compiling magnetic charts of the oceans.

After 1929 there were no magnetic observations in the oceans. Therefore, data on changes in the Earth's magnetic field were taken from observations at magnetic observatories and repeated coastal observations. The distribution of secular changes on a vast water space of the oceans, as marked on the existing charts of isopores, is chiefly assumptive.

Observations on board the yachts "Galilei" and "Carnegie" were made in separate points with an interval of about 100 miles. Therefore, these surveys could not reflect regional magnetic anomalies likely to be in the oceans relating to peculiarities of the structure or relief of the bottom.

The above mentioned facts stimulated many magnetologists to raise the question on the necessity of a repeated magnetic survey of oceans.

After World War II the question was thoroughly discussed by Soviet scientists and it was decided to build for this purpose a new non-magnetic ship-laboratory.

This ship, the non-magnetic schooner "Zarya", was built and equipped with the necessary navigation and measuring magnetic instruments.

The "Zarya" is a sailing motor schooner of about 600 tons displacement. The ship's length along its waterline is 37.5 m, its width about 9 m. The ship is equipped with a 300 h.p. propeller and a gaff sailing structure. The average speed under the propeller is 8—9 knots. The water and fuel reserves are sufficient approximately for a month of an autonomous ship navigation. The ship crew is 34 men including 25 crew and 9 scientific personnel.

The navigation equipment of the ship is as follows:

a) two gyrocompasses,
b) radiolocator,
c) radio direction finder,
d) echo sounder,
e) hydrodynamical and boarding logs.

There are instruments for magnetic measurements:

a) for measuring declination: a distance compass for constant recording of the magnetic course and a difference between the "gyrocourse" and the "magnetic course", a 127 mm compass with an optical direction finder.

b) for measuring the horizontal component: two double magnetic compasses as control instruments.

c) for measuring horizontal and vertical components: a two-component magnetodynamical magnetometer. The orientation of indicators of H and Z in horizontal and vertical planes takes place with the help of a gyrohorizon. The orientation of the indicator of H in the magnetic meridian is made by means of the third indicator automatically orientated perpendicularly to the magnetic meridian.

d) A magnetodynamical *T* magnetometer with a self-orientating indicator.

During the IGY, the magnetic equipment of the ship will be complete.

The above-mentioned equipment makes possible a continuous recording of changes of the three magnetic elements and the magnetic course during the ship's movement which throws more light upon the magnetic field in the investigation region, than it was possible on yachts like "Galilei" and "Carnegie".

In 1956 experimental work on board the "Zarya" was carried out in the Baltic and North Seas and the ship made a voyage from the Norwegian shores to those of Northern Iceland, then through the Dutch strait, along the southern coast of Iceland to the northern shores of England.

The results obtained have proved that the adopted methods give quite satisfactory accuracy for magnetic observations. The results proved to be interesting for cartography too. During its voyage the "Zarya" discovered considerable anomalies of some separate regions.

In 1957—1958 the "Zarya" will participate in the IGY and will make magnetic observations along a route of about 50.000 miles in the Atlantic, Indian Oceans and the Western Pacific. The "Zarya" will visit a number of magnetic observatories of the world and make observations in a few regions of the supposed maximum secular movement of the magnetic elements.

Polar wandering, shifting of the earth's axis and dipole variations

by W. S. Jardetzky

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Manhattan College, New York, N.Y.

The complete text is published in Ann. Géophys., 14, pp. 502—505, 1958; (IAGA Bull. 16a, pp. 63—66, 1959).

Results obtained with rocket-borne ion spectrometers

by C. Y. Johnson

U.S. Naval Research Laboratory, Washington, D.C.

The complete text has been published (by C. Y. Johnson, J. P. Heppner, J. C. Holmes and E. B. Meadows) in Ann. Géophys., 14, pp. 475—482, 1958; (IAGA Bull. 16b, pp. 83—90, 1959).

Temperatures in the high atmosphere

by F. S. Johnson

Lockheed Aircraft Corporation, Palo Alto, Calif.

The complete text has been published in Ann. Géophys., 14, pp. 94—108, 1958; (IAGA Bull. 16b, pp. 37—51, 1959).

Oxygen and calcium in twilight

by A. V. Jones

Physics Department, University of Saskatchewan, Saskatoon

The complete text has been published under the title "Calcium and oxygen in the twilight airglow" in Ann. Géophys., 14, pp. 179—185, 1958; (IAGA Bull. 16b, pp. 310—316, 1959).

Relationships between auroral ionization and magnetic disturbance

by T. R. Kaiser

Department of Physics, University of Sheffield

The complete text has been published in Ann. Géophys., 14, pp. 76—79, 1958; (IAGA Bull. 16b, pp. 194—197, 1959).

Some results of investigating magnetic properties of rocks and geological bodies

by A. G. Kalashnikov, M. A. Grabovsky and G. N. Petrova

USSR

The complete text has been published (by A. G. Kalashnikov) in Ann. Géophys., 15, pp. 67—74, 1959; (IAGA Bull. 16a, pp. 77—84, 1959). See also: M. A. Grabovsky: "Magnetic properties of anisotropic rocks"; Ann. Géophys., 15, pp. 119—121, 1959; (IAGA Bull. 16a, pp. 67—69, 1959); "The problem of the formation of remanence with an opposite polarity in rocks"; Ann. Géophys., 15, pp. 121, 1959; (IAGA Bull. 16a, p. 69, 1959); and G. N. Petrova: "On magnetic stability of rocks"; Ann. Géophys., 15, pp. 60—66, 1959; (IAGA Bull. 16a, pp. 70—76, 1959).

Method of forecasting secular geomagnetic variations

by Y. D. Kalinin

USSR

Changes in the annual values of geomagnetic elements observed at magnetic observatories, are the combined effects of changes in the geomagnetic field effected by internal causes (δfc) and of changes connected with geomagnetic activity (δfa).

Changes of annual values of geomagnetic elements averaged for 10—11 years can be regarded as almost fully independent of δfa.

Data from magnetic observatories give the following:

a) a series of quantities equal to changes of annual values of geomagnetic elements (δf) from year to year;

b) a series of quantities equal to the changes of the mean (δfc) for 11 years, from year to year.

The quantities δf, δfa, δfc are connected by the expression:

$$\delta f = \delta fc + \delta fa + A,$$

where A is the mean effect of geomagnetic activity for 11 years.

The examination of the morphology of the δfc and δfa based on the data from some magnetic observatories reveals some space- and time-laws of these quantities. In particular, the variations of δfc at observatories in Eurasia are of a smooth, quasiperiodical character with a period of a few decades. The quantities δfa have an eleven-year variation.

The utilization of the laws ascertained for δfc and δfa practically ensures a sufficiently accurate forecast of the average values of δf for five years. Experimental data for the period of 1949—1954 have shown that the errors of such a forecast in δD do not exceed $\pm$ 1 min. per year, in δH — $\pm$ 10 γ per year and in δZ — $\pm$ 10—15 γ per year.

This method practically ensures the necessary data on δf for constructing magnetic charts of the nearest epochs.

A new model of the atmosphere and ionosphere

by H. K. Kallmann

University of California, Los Angeles

The complete text has been published in Ann. Géophys., 14, pp. 140—143, 1958; (IAGA Bull. 16b, pp. 99—102, 1959).

Studies on geomagnetic and cosmic ray storms in relation to geomagnetic pulsations

by Y. Kato and T. Watanabe

In our opinion, the geomagnetic pulsation of continued wave train type, pc, is caused by the outer atmospheric oscillation, which is excited by the turbulent motion of the solar corpuscular stream. The power law in the amplitude-period spectrum can be derived, assuming Weizäcker's $k^{-\frac{5}{3}}$ turbulent energy spectrum in the solar corpuscular stream and the ionospheric screening effect. The particle density of the stream is obtained by equating the rate of dissipation of the outer atmospheric oscillation to that of the inflow of the turbulent energy of the stream, and the scale of the energy bearing eddies is guessed from the period of pulsation with the help of the theory of the structure of the earth's surface wind. When the amplitude of pulsation is great, of the order of several gammas, and the period is long, of the order of several minutes, the turbulent energy and the scale of the energy bearing eddies in the stream are so great that Morrison's magnetic cloud might be developed remarkably, which causes the decrease of the cosmic ray intensity. In relation to geomagnetic storms, there is an important fact: during

several hours following the sudden commencement the pulsational activity is quiet in general, but after that it becomes very intense. This is difficult to explain by the usual theory of the geomagnetic storm, but seems to be explained well by the shock front theory, which assumes as the agent of the sudden commencement and the initial phase the interplanetary plasma swept forwards by the solar corpuscular stream instead of the stream itself. A new mechanism of the main phase is also proposed, which, as the cause of decrease of the earth's field intensity, assumes the hydromagnetic rotation of the outer atmosphere, driven by the mutual interaction between the corpuscular stream and the outer atmosphere.

Lightning mechanisms and radiation of atmospherics

by A. Kimpara and H. Ishikawa

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The records of electro-static field change, and wave-form of atmospherics, each pair obtained at the same moment of a cloud discharge, have been investigated and the possibilities have been suggested that some of the slow discharge processes in thunderclouds are mainly composed of corona discharges of various types between two charge centres in the cloud.

The difficulties in using quaternary varved sediments for palaeomagnetic studies of the secular variation

by R. F. King

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The complete text has been published under the title "An assessment of the difficulties involved in using quaternary varved sediments for palaeomagnetic studies of the secular variation" (by D. H. Griffiths, R. F. King and A. E. Wright) in Ann. Géophys., 14, pp. 515—518, 1958; (IAGA Bull. 16a, pp. 11—14, 1959).

Field-changes due to lightning discharges and their discharge mechanisms

by N. Kitagawa

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In order to record correctly the field-change due to the lightning discharge the author used simultaneously two different methods of recording: an electro-static fluxmeter and an amplifier oscillograph (1). The former is essentially the same as that devised by D. J. Malan and B. F. J. Schonland (2) and records the slower components of field-change. The latter, a

kind of atmospheric wave-form recorder, records the faster components by using a recording technique similar to that of E. T. Pierce (3), a horizontal time base having the period of 1—4 m-sec being combined with a camera which moves 16 mm film vertically with the speed of 20—24 cm/sec, and the time of several microseconds can be resolved.

The observation was carried out during two thunderstorm seasons when active thunderstorms broke out within a distance of 15 km of the station. Owing to the continuous recording methods, the field-change due to lightning discharge was recorded throughout its whole duration without missing any initial changes.

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Results of investigations of airglow and aurorae in the USSR

by V. I. Krassovsky

Institute of Atmospheric Physics, Academy of Sciences of the USSR, Moscow

The complete text has been published under the title "Results from studies of the night airglow and aurorae in the USSR" (by V. I. Krassovsky, G. I. Galperin, A. V. Mironov, V. S. Prokudina, N. N. Shefov, N. I. Fedorova and B. A. Bagariazky) in Ann. Géophys., 14, pp. 356—367, 1958; (IAGA Bull. 16b, pp. 207—218, 1959).

Nature of emissions of the upper atmosphere

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The complete text has been published in Ann. Géophys., 14, pp. 395—413, 1958; (IAGA Bull. 16b, pp. 281—299, 1959).

Establishment of the net of secular variation stations in Poland

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As announced in a previous report, the net of secular variation stations in Poland was established in the late months of 1955 by the Institute of Geodesy and Cartography. The net included 21 stations, of which six are points of the old survey, whereas the rest are new stations, established as near as possible

to the places of the points of the old Polish Magnetic Survey executed by Prof. St. Kalinowski.

The establishment was preceded by a reconnaissance which stated that:

1. no artificial disturbances are to be expected,
2. there is no risk for the point to be covered with buildings in the nearest ten years.
3. the horizontal gradient of the vertical component is not greater than $10\gamma/100$ m,
4. there are good conditions for fixing the points and making the measurements (favourable ground conditions, no strong winds, long visas and so on).

All points are fixed with concrete marks with a center and four excenters (underground).

In the last years measurements have been executed on some additional points by E. Widomska, St. Maloszewski, K. Karaczun and the Institute of Geodesy and Cartography (D only).

A reoccupation of all points is planned for 1957 by the Institute of Geodesy and Cartography. Further plans call for a reoccupation of the net every three years.

A report on some recent measurements of atmospheric ozone in Kashmir (Lat. 34° N)

by R. N. Kulkarni and K. R. Ramanathan

India

A Dobson spectrophotometer was installed in Kashmir in May 1955 for regular observations of total ozone amount and the vertical distribution of ozone by the Umkehr method.

In the calculation of the vertical distribution of ozone by the Umkehr method, it is known that the neglect of higher orders of scattering in the calculation of I/I' for any assumed ozone distribution is a source of error. G. F. Walton's theoretical calculations and the results obtained from differential Umkehr observations with two pairs of wave-lengths made at Mt. Abu showed that the effect of taking multiple scattering into account was to increase the ozone amount in the layers and bring down its C.G. by 2 to 3 km.

The note contains a summary of the results of the calculations of the vertical distribution of ozone over Srinagar and Gulmarg in the autumn and winter of 1955—56, in which

(1) correction was made for secondary scattering, and

(2) the new IGY tables prepared by Ramanathan and Dave with a division of the atmosphere up to 54 km into 9 layers, each of 6 km thickness, were used.

The results show that:

(1) There is a significant amount of ozone even in the lowest 0—12 km.

(2) When the total ozone amount increases in winter or spring, there is sometimes more ozone in 6—12 km than in 12—18 km, thus giving a secondary maximum in the ozone distribution.

(3) Above 36 km the ozone amount does not change appreciably.

(4) Compared with the distribution over Abu, there is in Kashmir, on days of high ozone amount, more ozone in 6—12 km and in 18—24 km.

Extreme ultraviolet radiation in the night sky

by J. E. Kupperian, Jr.

USA

The complete text (by J. E. Kupperian, Jr., E. Byram, T. A. Chubb and H. Friedman) has been published in Ann. Géophys., 14, pp. 329—333, 1958; (IAGA Bull. 16b, pp. 317—321, 1959).

The arctic upper atmosphere

by H. E. LaGow

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The complete text has been published under the title "Rocket measurements of the arctic upper atmosphere" (by H. E. LaGow, R. Horowitz and J. Ainsworth) in Ann. Géophys., 14, pp. 131—139, 1958; (IAGA Bull. 16b, pp. 74—82, 1959).

The eddy model of the secular variation

by F. J. Lowes

Physics Dept., King's College, University of Durham, Newcastle

The complete text has been published under the title "The eddy model of the non-dipole field and the secular variation" (by A. Herzenberg and F. J. Lowes) in Ann. Géophys., 14, pp. 526—529, 1958; (IAGA Bull. 16a, pp. 89—92, 1959).

Some theoretical investigations on the study of the high and outer atmosphere

by K. Maeda

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The complete text has been published under the title "Distortion of the magnetic field in the outer atmosphere due to the

rotation of the earth" in Ann. Géophys., 14, pp. 154—166, 1958; (IAGA Bull. 16b, pp. 139—151, 1959).

Sodium night sky experiments

by E. R. Manring

Geophysics Research Directorate, A. F. Cambridge Research Center, Bedford, Mass.

The complete text is published under the title "Study of sodium vapor ejected into the upper atmosphere" (by J. F. Bedinger, E. R. Manring and S. N. Ghosh) in J. Geophys. Res., v. 63, pp. 19—29, 1958; a summary has been published in IAGA Bull. 16b, p. 280, 1959.

Lunar effects on the equatorial Es

by S. Matsushita

Geophysical Institute, Kyoto University

In the equatorial region, Es reflection is abnormally intense in the daytime (1). This equatorial Es occasionally disappears suddenly around noon or the early afternoon, although it usually continues till evening (2). After once disappearing the equatorial Es sometimes reappears half an hour to a few hours after the time of disappearance, and also occasionally disappears again. In this study, the time at which the Es first disappeared during the period from 10:00 to 20:00 75° W.M.T. on each day at Huancayo was obtained from ionograms obtained every 15 minutes with a vertical incidence ionosonde (N.B.S., Model C-3). The geomagnetic storm effect and the power change of the ionosonde were ignored in finding the Es disappearance-time. The approximate lunar age of each day was calculated, and the local time of the Es disappearance obtained was plotted as a function of the lunar age. The results showed that the equatorial Es often disappeared earlier than usual near the full and the new moons, particularly during the December-solstice months.

The solar time of the disappearance plotted as a function of corresponding lunar hour showed a much clearer relation; the equatorial Es often disappeared around noon or the early afternoon (solar local time) if these times lay between 00 and 03 h. or between 12 and 15 h. lunar time. In other words, the equatorial Es often disappears during the first half of the periods of the westward lunar electric current flow in the equatorial region. This current is responsible for the lunar daily magnetic variation (3). The lunar tidal variation of fEs at Huancayo has minima at 00—03 h. and 12—15 h. lunar time (4), which also agrees with the present result. It is interesting that there is a

6 hours time lag between the lunar effect on the Es and the lunar stratification of F2 (5).

The equatorial Es may be caused by the vertical upward drift-force due to the eastward electric current jet of Sq. Accordingly, the disappearance of the equatorial Es may be explained by the assumption that the vertical upward drift-force due to the eastward electric current of the solar magnetic variation is weakened by the downward drift-force due to the westward electric current of the lunar magnetic variation. The lunar stratification of F2 seems to be caused by the eastward lunar current effect, in contrast with the disappearance of the Es.

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Some studies of the high atmosphere in auroral latitudes

by S. Matsushita

Geophysical Institute, Kyoto University

The complete text has been published under the title "Some studies of the upper atmosphere in the auroral zone" in Ann. Géophys., 14, pp. 483—491, 1958; (IAGA Bull. 16b, pp. 198—206, 1959).

Appareil compteur automatique d'ions

par L. de Miguel Gonzales Miranda

Observatoire Central Géophysique de Tolède

Le compteur automatique d'ions, installé dans l'Observatoire Central Géophysique de Tolède, dépendant de l'Institut Géographique et Cadastral, consiste en un compteur d'ions du modèle Ebert auquel on a ajouté un dispositif automatique qui permet d'obtenir une valeur horaire de la densité des ions, aussi bien positifs que négatifs.

Le compteur proprement dit, consiste en un condensateur cylindrique par lequel on fait circuler un courant d'air de volume connu. La tige intérieure préalablement chargée à un certain potentiel, positif ou négatif, se décharge par les ions de polarité contraire qui tombent sur elle. A tout moment, on connaît le potentiel de la tige qui, étant parfaitement isolée communique avec un électromètre bifilaire type Wulf qui devient enregistreur, en faisant coincider l'image réelle des fils sur une bande de papier photographique enfermée dans une petite

chambre obscure située en face de l'oculaire de l'électromètre qui est convenablement illuminé par la partie postérieure.

Indépendamment, une commutateur giratoire dont le tambour principal fait un tour par heure, réalise les fonctions suivantes: (a) Charge de la tige centrale du condensateur chaque 15 minutes. (b) Inversion de la polarité du potentiel de charge chaque 30 minutes. (c) Mise en circuit de l'aspirateur d'air pendant 15 minutes en alternant avec 15 minutes de repos qu'on utilise pour déterminer les pertes par défaut d'isolement.

La quantité d'air qui circule par le tube condensateur se détermine par un anémomètre totalisateur qui enregistre un point sur la bande photographique tous les 100 litres.

Le nombre total d'ions à chaque intervalle de 15 minutes est donné par $N = C\ (V\text{-}v)/300Me$, C étant la capacité du condensateur, V-v la chute de tension de son armature intérieure, M la quantité de l'air aspiré et "e", la charge d'un ion.

Ionisation — Année 1954

par L. de Miguel Gonzales Miranda
Observatoire Central Géophysique de Tolède

Après une période d'épreuves, l'appareil compteur automatique d'ions est entré en service d'une manière continue dans l'Observatoire Central Géophysique de Tolède; dans cet appareil, qui a été déjà décrit dans un travail antérieur, quelques modifications ont été introduites. La modification principale est l'introduction d'un nouveau commutateur giratoire dans lequel le cylindre de commutation a été substitué par un arbre denté avec un dispositif spécial pour produire l'ouverture et la fermature de tous les circuits électriques d'une manière brusque. De cette façon, on a réduit au minimum les étincelles qui provoquaient des avaries dans le commutateur antérieur d'interruption lente.

On expose les résultats des premières expériences réalisées pendant l'année 1954 et, dans des tables, on consigne les valeurs moyennes journalières de la densité des ions aussi bien positifs que négatifs, ainsi que la somme $n^+ + n^-$ et la relation n^+/n^-. Ce dernier résultat est normalement un peu supérieur à l'unité.

Dans d'autres tables, on consigne la variation journalière par moyennes horaires de la valeur moyenne mensuelle et de l'annuelle.

Courants telluriques. Année 1950 et suivantes

par L. de Miguel Gonzales Miranda
Observatoire Central Géophysique de Tolède

Grâce à l'installation de courants telluriques dans l'Observatoire Central Géophysique de Tolède, dépendant de l'Institut

Géographique et Cadastral, on a obtenu des valeurs horaires de la variation du gradient du potentiel tellurique dans ses deux composantes N-S et E-W; et, à partir de celles-ci, la variation moyenne mensuelle, trimestrielles et annuelle, en observant un minimum à midi et deux maxima au lever et au coucher du soleil.

Tenant compte de l'amplitude relative des deux composantes, on a observé une direction dominante très marquée 20° au N de l'E.

L'activité électrotellurique demeure représentée par les indices de caractère 0—1—2 et les indices tri-horaires qui varient de 0 à 9.

Dans les divers annuaires, en plus de consigner les données mentionnées, accompagnées de graphiques, on fait une étude détaillée de tous les types de perturbations, telles que les orages, les vibrations de période rapide et les sauts brusques.

Dans l'étude des orages, on les compare avec les orages enregistrés dans le magnétisme terrestre qui coïncident dans le temps mais non pas dans la forme. Ainsi, en tellurisme, on observe une grande amplitude des variations rapides alors que la valeur moyenne s'éloigne à peine de sa valeur normale; ceci est, précisément, le contraire de ce qui se passe dans le magnétisme.

Dans l'annuaire de 1950, on examine les diverses théories se rapportant aux orages magnétiques et l'on prouve que les orages électrotelluriques sont d'accord avec la théorie corpusculaire de Chapman, vu que, en de nombreuses occasions, on enregistre un saut brusque, précurseur de l'orage, quelques heures avant que celui-ci se produise.

Ce saut est l'effet de la radiation ultraviolette simultanée à la sortie des corpuscules du soleil, qui, en touchant la terre à une vitesse de 1.700 Kms., environ, à la seconde, produisent la perturbation persistante.

Enfin, on consigne les sauts brusques en les classifiant selon leur forme et leur période de vibration; on a pu observer une corrélation étroite entre ces sauts et les sauts géomagnétiques.

Sauts brusques dans les courants telluriques et leur relation avec les impulsions brusques du champ magnétique terrestre

par L. de Miguel Gonzales Miranda
Observatoire Central Géophysique de Tolède

Pendant ces dernières années, on a comparé, dans l'Observatoire Central Géophysique de Tolède, les impulsions brusques magnétiques avec les impulsions enregistrées dans les courants telluriques; on a observé une parité intéressante entre les deux phénomènes, bien qu'il y ait des différences essentielles quant à la forme des courbes qui sont celles que l'on présente en détail

dans ce travail-ci. On a observé une grande sensibilité des enregistrements électro-telluriques, bien plus grandes que celle des enregistrements magnétiques, pour l'enregistrement de certaines classes de perturbations, telles que celles de type polaire; quand elles sont de forme vibratoire, elles peuvent même passer inaperçues dans un enregistrement magnétique et, par contre, elles peuvent être appréciées avec une grande amplitude dans les enregistrements électro-telluriques. C'est pourquoi on conseille l'installation d'un équipement de courants telluriques dans les observatoires magnétiques, ce qui permettrait d'avoir une aide efficace dans l'étude des perturbations.

Transition probalities

by R. W. Nicholls

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The complete text has been published under the title "Studies upon transition probabilities and molecular excitation" in Ann. Géophys., 14, pp. 208—224, 1958; (IAGA Bull. 16b, pp. 348—364, 1959).

Distribution of chemical elements, atomic and molecular

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The complete text of the communication presented has been published under the title "La thermosphère" (by M. Nicolet) in Ann. Géophys., 15, pp. 1—22, 1959; (IAGA Bull. 16b, pp. 1—22, 1959).

Geographical distribution of magnetic disturbances in the arctic region near the pole

by A. P. Nikolsky

USSR

Irregular changes of the field are considered to be the main indication of magnetic disturbances in high latitudes.

The diurnal variation of magnetic activity (of irregular disturbances) is one of the main aspects of magnetic disturbances so far as its form and amplitude are determined by the effect of the Earth's permanent magnetic field upon corresponding fluxes of solar corpuscles.

The investigation of the diurnal variation of magnetic activity has shown that in high latitudes this phenomenon is very complex. There are three time intervals within the twenty-four hours

(in the morning, day and night) when magnetic activity reaches its top intensity.

The dependence of the time of occurrence of this or that maximum on latitude and longitude is complex. Previous investigations to elucidate this dependence yielded no definite results. It should be noted that the geographical distribution of magnetic activity in middle latitudes is not entirely clear either.

During 1948—1951 the Arctic Institute of the Head Department for the Arctic Sea Way undertook a number of high-latitude expeditions to the Central Arctic. The magnetic observations made by the expeditions have yielded new data on the diurnal variations of magnetic activity.

Observational data from twenty-eight observatories north of geomagnetic latitude 60° have shown that isolines indicating a simultaneous appearance of the morning maximum of magnetic disturbances in the Arctic represent a system of spirals issuing from the pole of homogeneous magnetization and scanning clockwise. The investigations of diurnal variations of magnetic activity made later by other scientists confirmed the laws discovered for the geographical distribution of magnetic disturbances.

The result obtained has been considered in the light of its agreement with Birkeland's ideas (experiments with "terrella") and with the theoretical conclusions by Störmer.

The analysis of the activity of magnetic disturbances in the polar region enabled us to conclude the existence of a second zone with a greater intensity and frequency of magnetic disturbances. This zone must be located at about 80° of geomagnetic latitude. The investigations of anomalous absorption in the ionosphere and of aurorae in these regions confirm the possibility of the existence of the second zone.

Recently, Alfven, proceeding from theoretical considerations, has indicated that the second zone is likely to exist in a region 10—12° from the geomagnetic pole, which agrees well with our conclusion.

The results obtained have been compared with those from investigations of ionospheric disturbances and aurorae. It was noted that the morning maximum present in the diurnal variation of the anomalous absorption in the high-latitude ionosphere coincided in time with the moment of a respective spiral, constructed on the basis of magnetic observations. As good a coincidence was detected for the morning maximum of aurorae, discovered by means of radar observations.

There are grounds for assuming that the geographical distribution of the morning magnetic disturbances, the anomalous absorption in the ionosphere observed at morning hours and of morning aurorae is similar to a large extent, and that all these phenomena have a common cause.

According to Birkeland's and Störmer's theoretical considerations, the isolines, spirals of simultaneous appearance of the morning maximum of magnetic disturbances in the Antarctic should scan counter-clockwise. A system of isolines which was a mirror reflection of that built for the Arctic has been drawn up. The comparison of the present data on the diurnal variations of magnetic activity for the Antarctic with the moments from this theoretical isolines system has shown that they agree well among themselves.

An especially good coincidence was observed for the data on the diurnal variations of magnetic activity obtained by the Soviet Antarctic observatory in Mirny. This comparison gives ground for considering the laws of the geographical distribution of magnetic disturbances for the Arctic to be mostly valid for the Antarctic too.

Further investigations in this direction can be possibly applied for solving the problem of the geographical distribution of magnetic disturbances and associated phenomena such as ionospheric disturbances and aurorae.

All these investigations are the first step towards the study of geophysical phenomena in high latitudes caused by invasions of solar corpuscles into the terrestrial atmosphere.

Results obtained recently regarding the mechanism of lightning discharges

by H. Norinder

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During the three thunderstorm seasons of 1954—57 extensive investigations of the mechanism of lightning discharges have been carried out at the Institute of High Tension Research, University of Uppsala. This institute is, by the conditions of a foundation, especially devoted to researches of lightning discharges and related phenomena. From preliminary tests it followed that measurements of the magnetic field variations from lightning discharges and related phenomena were most fit for an analysis of the lightning mechanism. Frame aerials with few turns were used to eliminate proper oscillations. The frames were effectively shielded from influence of electric field components. On a flat ground in the neighbourhood of Uppsala three stations were established for studies of lightning strokes in the vicinity regions – up to 20 kilometres – with frame aerials placed in vertical as well as in horizontal planes against the earth's surface. The turns were connected via aperiodic amplifiers and integrating circuits to cathode-ray oscillographs simultaneously recording at the three stations. The distances to the lightning strokes were determined by direct observations and their paths

were also simultaneously photographed in full daylight by a special device.

By the investigations it was possible to analyse both the predischarge mechanism and the main and partial discharges of the lightning strokes. Front variations, time sequence and variation forms of multiple strokes were obtained. The distribution of the magnetic field components with distances from the generating strokes were obtained.

Sudden commencements of magnetic storms and atmospheric dynamo action

by T. Obayashi and J. A. Jacobs

Geophysics Laboratory, University of Toronto

A statistical investigation of world-wide sudden commencements of magnetic storms (s.c.'s) has been carried out using data from over thirty magnetic observatories distributed all over the world. An appreciable diurnal change in the amplitude of s.c.'s has been found, and the average electric current-system for the Ds-field shows conspicuous current concentrations in the polar regions. The pattern of this current-system is similar to that caused by an electric doublet centred on the highly conducting region near the geomagnetic pole, and hence it is probable that the current-system exists within the earth's atmosphere. On the other hand, the Dst-field of s.c.'s seems more likely to be of extraterrestrial origin.

An atmospheric dynamo theory has been applied to interpret this Ds current-system, on the assumption that the main source of electromotive force generation is due to the enhancement of electrical conductivity in the polar region. The change at a s.c. is so abrupt (within a few minutes) that it is reasonable to assume that the wind-system in the ionosphere will not change. Thus using the wind-system estimated from the Sq-field, the current-system at the time of commencement of the storm has been computed assuming an appropriate change in the electrical conductivity. Good agreement with observed results has been obtained, and it suggests that a dynamo action in the upper atmosphere is the dominant cause of geomagnetic variations during disturbances. Moreover, there exists a consistent wind-system, which can produce the observed geomagnetic variations both for quiet and disturbed conditions with a reasonable range of conductivity changes in the polar regions. This wind-system consists of both a diurnal and a semidiurnal term, and the estimated order of magnitude agrees with recent ionospheric measurements.

Geomagnetic pulsations and the earth's outer atmosphere

by T. Obayashi

Geophysics Laboratory, University of Toronto

The complete text has been published in Ann. Géophys., 14, pp. 464—474, 1958; (IAGA Bull. 16b, pp. 384—394, 1959).

Trends in laboratory research related to aeronomy

by O. Oldenberg

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The complete text has been published in Ann. Géophys., 14, pp. 204—205, 1958; (IAGA Bull. 16b, pp. 344—345, 1959).

Atmospheric circulation and variation of the vertical ozone distribution

by H. K. Paetzold

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Recent measurements of the vertical ozone distribution by balloon ascents with an ultraviolet spectrograph and with radiosondes have shown the significance of the ozone variations for the study of problems of the atmospheric circulation. Some typical correlations could be found for the meridional circulation and the circulation system connected with height and lowness up to an altitude of 30 km. Therefore routine measurements with a simple ozone-radiosonde are necessary in future. The construction of an optical filter-sonde was possible by developing a new interference-filter for the spectral region of the ozone Hartley-band.

Measurements of the total ozone amount and its analysis

by H. K. Paetzold and H. Zschörner

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For the measurements of the total ozone-amount with the Dobson instrument the influence of the scattered light of the blue sky, of clouds and of haze was studied in Weissenau (450 m) and on the Zugspitze (2600 m). By using a new parameter, the colour-temperature of the scattered light, a correlation could be found to eliminate systematical errors. By this method, finer details of the fluctuations of the total ozone amount could be studied in different weather situations, e.g. Föhn, etc. Regarding the typical ozone variations observed by balloon ascents, an analysis of the fluctuations of the total ozone amount, finer than formerly, is now possible.

Variations de la composante horizontale en Pologne

par S. Pawlowski

Pologne

Les données analysées se rapportent aux variations de la composante horizontale du magnétisme terrestre en Pologne pendant la période 1928—1949.

L'auteur attire l'attention sur le problème qui se pose de la répartition variable d'isopores. Les données obtenues aux stations différentes varient entre 54 % et 101 % par rapport aux variations analogues enregistrées à Swider (100 %).

Il serait nécessaire pour éclaircir la question de poursuivre une nouvelle série d'examens méthodiques qui permettraient de rédiger les cartes des lignes isodynamiques et de rendre actuelles les données du mesurage, afin de pouvoir distinguer les anomalies éventuelles des variations séculaires qui sont en relation avec la structure géologique.

Variations des éléments magnétiques à Swider

par S. Pawlowski

Pologne

Les variations des éléments magnétiques en Pologne ne se produisent pas d'une façon uniforme ainsi que le révèlent de nombreuses mesures.

Un examen des données provenant des observatoires magnétiques voisins de Swider et de Potsdam permettrait de s'orienter d'une façon générale sur le caractère et les tendances de ce genre de variations.

On a discuté les variations des composantes verticale et horizontale, ainsi que les variations de la déclinaison.

Les variations des composantes verticale et horizontale sont plus rapides à Swider et représentent en moyenne pendant la période 1921—1942 150 % des variations que l'on observe à Potsdam. Les variations de la déclinaison, qui est actuellement occidentale dans les deux observatoires, sont plus lentes à Swider.

La différence des phases de variations a pour effet de compliquer le problème de la comparaison des variations séculaires sur différents points, ce qui est clairement indiqué par l'orientation des courbes, celle de la composante verticale en particulier, provenant des valeurs notées aux observatoires différents.

Night airglow at 5577 Å

by H. B. Pettit

Geophysics Research Directorate, A. F. Cambridge Research Center, Bedford, Mass.

The complete text has been published in the March, 1958 issue of the Journal of Geophysical Research; a summary was pub-

lished under the title "The 5577 Å emission of OI in the night airglow from Sacramento Peak, New Mexico" (by E. R. Manring and H. B. Pettit) in Ann. Géophys., 14, pp. 506—508, 1958; (IAGA Bull. 16b, pp. 322—324, 1959).

On neutron eruptions in the sun as sources of geomagnetic disturbances and aurorae

by V. A. Petukhov

Joint Institute for Nuclear Research, USSR

The complete text has been published under the title "On a possible mechanism of solar non-stable processes leading to neutron eruptions" in Ann. Géophys., 14, pp. 425—432, 1958; (IAGA Bull. 16b, pp. 165—172, 1959).

The effect of solar flares on the geomagnetic field

by R. Pratap

Dominion Observatory, Ottawa, Ontario

The dynamo equation is solved for a conductivity produced by solar flare ultraviolet radiations from the sun. The crochet amplitudes in horizontal field components are then computed and compared with observed results. It is found that fair agreement exists between the theoretical and experimental values only if the seat of the crochet current system is within a few km. of the current system producing the quiet day solar variation.

Propagation of induced fields through the core

by P. H. Roberts

University of Durham, King's College, Newcastle

The complete text has been published in Ann. Géophys., 15, pp. 75—86, 1959; (IAGA Bull. 16a, pp. 93—104, 1959).

Transient solar phenomena as observed by solar observatories

by W. O. Roberts

High Altitude Observatory of the University of Colorado

The complete text has been published under the title "Transient solar phenomena observed optically" in IAGA Bull. 16b, pp. 157—160, 1959.

Palaeomagnetic results from five continents

by S. K. Runcorn, K. M. Creer, E. Irving, R. Green and A. E. M. Nairn.

The complete text has been published under the title "Palaeomagnetic results from different continents and their relation to the problem of continental drift" (by K. M. Creer, E. Irving,

A. E. M. Nairn and S. K. Runcorn) in Ann. Géophys., 14, pp. 492—501, 1958; (IAGA Bull. 16a, pp. 1—10, 1959). See also "Preliminary palaeomagnetic measurements from South America" by K. M. Creer; Ann. Géophys., 14, pp. 373—390, 1958; (IAGA Bull. 16a, pp. 15—32, 1959).

Theory of the secular variation

by S. K. Runcorn

Department of Physics, King's College, Newcastle

The complete text has been published under the title "On the theory of the geomagnetic secular variation" in Ann. Géophys., 15, pp. 87—92, 1959; (IAGA Bull. 16a, pp. 105—110, 1959).

Discussion by Prof. Thellier

Prof. Thellier fait observer que le Prof. Runcorn tire argument à la fois de la forme de la courbe de la variation de D et I à Londres et de la dérive de Bullard; or, il s'agit de phénoménes de "périodes" très différentes.

Comme il est question de la courbe de D et I de Bauer, il projette celle qu'il a tracée pour Paris en utilisant les résultats archéomagnétiques. La courbe nouvelle part maintenant de 1450 et sa forme, assez différente de celle de la courbe de Bauer jusque vers 1700, est certainement beaucoup plus prècise. D'autre part on a tracé 6 points relativement très sûrs (obtenus par mesure de D et I sur des parois de fours de potiers) correspondant à l'époque romaine, de 25 à 380 après J. C. environ. Pendant cette période la déclinaison a peu varié et l'inclinaison a décrû de 68 à 61° environ. Un fait très clair, à souligner, est que le point figuratif de la courbe de Bauer ne décrivait pas du tout, à l'époque romaine, un ovale analogue à celui bien connu des siècles récents.

Palaeomagnetic research at the State University of Utrecht

by M. G. Rutten

State University, Utrecht

The complete text has been published (by M. G. Rutten and J. Veldkamp) in Ann. Géophys., 14, pp. 519—521, 1958; (IAGA Bull. 16a, pp. 60—62, 1959).

Comparaison entre les variations moyennes diurnes et annuelles du champ magnétique terrestre, enregistrées dans les divers observatoires ibériques

par J. Sancho de San Roman

Observatoire Central Géophysique de Tolède

Il semble admise en général l'hypothèse que, dans les régions non polaires, deux points dont la distance n'est pas supérieure à 500 Kms., présentent approximativement les mêmes variations

temporaires du champ géomagnétique, excepté pendant les perturbations magnétiques importantes.

Pour voir jusqu'à quel point cette hypothèse se vérifie dans le cas de la Péninsule Ibérique, il a paru intéressant de comparer Coimbra, San Fernando et l'Ebre avec Tolède, vu que cette ville est distante des trois premiers lieux de moins de 500 kms.

Vu que la variation séculaire est connue avec une approximation suffisante dans chacun de ces points, car leur distribution géographique est très régulière sur des surfaces de l'ordre de 1.000 Kms^2, il nous restait comme variations principales à comparer, la variation diurne solaire S et la variation annuelle A.

Le présent travail a un caractère de simple essai, car nous nous sommes limités à étudier la période 1951—1953.

La comparaison des variations S a consisté à calculer les différences: Variation de l'Observatoire X moins la Variation de Tolède, c.a.d les différences des valeurs moyennes horaires correspondantes. Chaque année, nous comparons quatre variations diurnes moyennes: les trois variations saisonnières et la variation annuelle. Ce calcul a donné naissance à huit tables où l'on observe que les différences maxima obtenues en déclinaison ont été: 1.2′ (avec l'Ebre), 2.0′ (avec S. Fernando) et 1.1′ (avec Coimbra); en intensité horizontale: 5 γ (avec Ebre), 14 γ (avec S. F.) et 8 γ (avec Ci); en intensité verticale: 8 γ (avec Ebre) et 11 γ (avec Ci). San Fernando n'enregistre pas les variations de ce dernier composant.

La comparaison des variations A a été réalisée en réduisant les valeurs absolues moyennes mensuelles au centre de l'année respective pour les corriger ainsi de la variation séculaire. Ensuite, avec ces valeurs réduites, on a tracé des graphiques de manière qu'il soit facile de comparer les variations correspondantes. De leur examen, on déduit, d'une part, des parallélismes notables, et, d'autre part, la présence de certaines différences dont il serait intéressant de discuter les causes. Il conviendrait cependant d'étendre préalablement cette comparaison à une période plus longue.

Eine Anlage zur Registrierung örtlicher geomagnetischer Feldstärkedifferenzen

von H. Schmidt

Adolf-Schmidt-Observatorium, Niemegk

Am Adolf-Schmidt-Observatorium in Niemegk wurde der Bau einer Anlage zur Registrierung örtlicher Gradienten in Angriff genommen. Das Kernstück dieser Anlage ist ein mit Stromsubtraktion arbeitender Differenzanzeiger. Das Princip der Differenzbildung besteht darin, dass an zwei kilometerweit entfernten Messpunkten mit Hilfe lichtelektrisch kompensierter

Magnetometer Ströme erzeugt werden, die den Variationen der betreffenden Komponente an den Messorten proportional sind. Die Ströme werden über Erdkabel einer Zentralstation zugeführt und in einem temperierten Widerstandsnetzwerk subtrahiert. Die Anzeige dieses Differenzstromes, der der Feldstärkedifferenz proportional ist, geschieht mit Fallbügelschreibern zur Direktsichtanzeige und mit Galvanometern photographisch. Es sind vier Aussenstationen vorgesehen, so dass Ringdifferenzmessungen durchgeführt werden können.

Thermonuclear explosions and the ozonosphere

by A. J. Schneiderov

Institute of Philosophical Inquiry, Polycultural University of America

Explosions of hydrogen bombs reach beyond the maximum density altitude of the ozonosphere, injecting dust, vapors, and gases into it. Stratospheric currents, turbulence and diffusion carry and distribute these debris all over the globe, and into the ionosphere.

Radioactive particles, molecules and atoms forced there by the explosion emit both corpuscular and ultra-short high energy radiation which, under certain conditions can dissociate O_2, and form O_3 when a sufficient amount of dust particles, molecules and atoms is accumulated in the ozone atmospheric layer.

The reactions may be as follows:

(1) $O_2 + h\nu \rightarrow O + O$, followed by $O + O_2 + m \rightarrow O_3 + m$[1], or
(2) $O + O_2 + m \rightarrow O_3 + m$, or (3) $O_2^* + O_2 \rightarrow O_3 + O$[2],

where m is a dust particle, a molecule or an atom capable of absorbing the extra momentum and energy.

On the other hand, non radio-active dissociated molecules and ionized atoms coming from thermonuclear explosions may affect the recombination rate of atomic oxygen, and decrease the amount of ozone in the layer according to the following reactions:

(4) $O_3 + O_3 \rightarrow O_2^* + O_2^* + O_2^* + 67.8$ cal, and
(5) $O_3 + m \rightarrow O_2 + O + m - 24.3$ cal[3].

The excess of material particles injected into the ozonosphere can serve as multiple absorbers and re-emitters of energy, acting so until the energy level suitable to participate in O, O_2, O_3, m reactions is reached.

Although thermal dissociation of ozone occurs infrequently under reaction (4), and the yield of reaction (5) is small under normal conditions, these processes may contribute considerably to the disturbance in the photo-chemical balance of ozone formation when suitable conditions induced by thermonuclear, or plain nuclear, fission explosions are present.

In the light of an unquestionable correlation that exists between weather and the ozone contents, it seems reasonable to expect formations of "ozone clouds" at the locations of sporadic thermonuclear explosions. An increase in the number and frequency of such disturbances may cause an "ozonic overcast" of the sky, and the subsequent local and general climate changes.

To what extent such changes can be induced by man seems to me a task for physical chemists and meteorologists to determine.

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(4) Coblentz, W., and Stair, R., Journ. Research Nat. Bureau of Stand., 22, 537, 1939.
(5) Götz, F. W. P., Helv. Phys. Acta, 5, 336, 1932.

The ionosphere

by J. Carl Seddon

U.S. Naval Research Laboratory, Washington, D.C.

The complete text has been published under the title "Ionospheric electron densities and differential absorption" (by J. Carl Seddon and John E. Jackson) in Ann. Géophys., 14, pp. 456—463, 1958; (IAGA Bull. 16b, pp. 91—98, 1959).

Elementary processes in the upper atmosphere and their activity in emissions

by I. S. Shklovsky

Institute for Atmospheric Physics, Academy of Sciences of the USSR, Moscow

The complete text has been published under the title "Elementary processes in the upper atmosphere and their manifestation in emissions" in Ann. Géophys., 14, pp. 414—424, 1958; (IAGA Bull. 16b, pp. 333—343, 1959).

Magnetic storms

by S. F. Singer

Physics Department, University of Maryland

To explain the sudden commencement (SC) of magnetic storms, the reverse sudden commencement (SC*), and pre-SC disturbances, we invoke the following model: The solar eruption produces a shock wave which arrives at the Earth 22—34 hours later. High-velocity particles having a smaller interaction precede the shock wave and cause the pre-SC bay-like disturbances at high latitudes. The shock wave itself is retarded by the body forces produced by the geomagnetic field, but speeds up as it

enters the auroral zones. In pushing out lines of force, it creates the polar SC* events. Charge separation in the shock wave produces the driving force for the SC currents, which flow in the atmosphere (in accordance with Vestine's analysis).

The storm decrease is produced by the high-velocity particles following the shock wave (up to nine hours later) which enter because of field perturbations into the normally inaccessible Störmer regions around the dipole. Here they are trapped and will drift, producing the ring current which gives rise to the storm decrease. Particles with a small pitch angle, however, can reach the Earth's atmosphere and contribute to aurora, the airglow, and ionospheric ionization. These particles are replenished by perturbations produced by solar influences having a 27-day recurrence. Many other particles are absorbed or scattered out of the trapping regions so that their number diminishes rapidly in a day or so, as does the magnetic-storm decrease.

The model thus attempts to explain for the first time the cause of the SC*, the atmospheric nature of SC, the delay between SC and the main phase, and the formation and decay of the ring current. A by-product is auroral-particle acceleration by a Fermi and betatron mechanism.

New experimental tests are suggested by the model: (a) Acoustic observations with balloons to look for the shock wave penetrating into the atmosphere in the auroral zones. (b) Observations with rockets or satellites to establish the location of the SC and main-phase currents. (c) Measurements of the nature and energy of the auroral particles.

See also "Geophysical effects of solar corpuscular radiation", Ann. Géophys., 14, pp. 433—437, 1958; (IAGA Bull. 16b, pp. 173—177, 1959).

Sur l'intervalle de temps entre l'activité solaire et les perturbations géomagnétiques

par O. N. Sipahioglu

Observatoire de Kandilli — Istanbul

L'hypothèse suivant laquelle les perturbations géomagnétiques seraient dues à des émissions solaires a servi de base à d'assez nombreux travaux relatifs au temps de parcours des faisceaux corpusculaires entre le Soleil et la Terre. Les conclusions apparaissant très dispersées nous avons discuté presque tous ces travaux et recherché si les données plus nombreuses que l'on possède actuellement permettraient d'aboutir à un résultat plus net.

Les documents que nous avons choisis après un contrôle minutieux, sont les SFE certains, les SSC et SI publiés depuis 1949 jusqu'à nos jours dans les Bulletins de l'IATME et de l'IAGA;

et, en outre, quelques SFE "remarquables" enregistrés à Witteveen entre 1939—1949.

Il ressort de notre examen qu'il importe de distinguer dans l'association d'une perturbation géomagnétique à un SFE qui la précède, le cas où elle se manifeste par un orage, et celui où elle se manifeste par une impulsion isolée (SI). Dans le premier cas, notre travail semble montrer que la corrélation éruption-orage, même à début brusque, est très floue. Dans le second cas, nous pensons avoir apporté un élément nouvau en montrant que l'intervalle de temps entre le SFE et le SI qui le suit peut être défini avec une précision beaucoup plus grande; un maximum net se présentant entre 25 et 30 heures après le SFE. De plus, l'intervalle minimum paraît descendre jusqu'à 12,5 heures au lieu de 17,5 heures.

La plus ancienne détermination de la déclinaison magnétique faite par les Turcs

par O. N. Sipahioglu

Observatoire de Kandilli — Istanbul

Dans une longue notice supplémentaire inclue par *Ibrahim Müteferrika* dans le célèbre traité turc de géographie *Cihannüma* dont le manuscrit date de 1648 et l'édition de 1727, il est dit que "en l'an 1140 de l'Hédjir, c'est-à-dire, en 1727 de l'Ere chrétienne, à Istanbul, on a fait par un groupe de savants turcs, une détermination de la déclinaison magnétique à l'aide d'une boussole à longue aiguille construite à Istanbul, et l'on a trouvé une déclinaison de 11,5 degrés vers l'Ouest."

Quoique le relateur donne assez de détails qui rassurent la validité de l'expérience, nous avons recherché si cette valeur de la déclinaison était en accord avec celles obtenues par les Européens à Istanbul entre les dates 1600 et 1858, et conclu que la concordance est bien satisfaisante.

De l'autre côté un essai historique que nous avons publié tout récemment en turc met en évidence les points suivants:

(1) Dans la première moitié du XVIe siècle le compas et la boussole flottante étaient répandus en Turquie.

(2) Les navigateurs turcs utilisaient dès 1554 une déclinaison de 7 degrés vers l'Est; mais, ignorant la variation de cet élément et dans le temps et d'un lieu à l'autre, ils avaient emprunté cette valeur aux sources portugaise et française.

(3) En 1731, l'auteur de la susdite notice a publié un livre indépendant sur le magnétisme terrestre où il parle la première fois en Turquie de l'inclinaison magnétique; et fait un résumé assez complet des connaissances géomagnétiques jusqu'alors en Europe.

(4) Les Arabes ne connaissaient pas, paraît-il, la boussole avant les Européens.

Some problems in antarctic geomagnetism

by L. Slaucitajs

Observatorio Astronómico, La Plata

With the increasing activity in direct magnetic measurement arrangements for Antarctica we will probably have a better opportunity to draw more exact magnetic maps. It seems that the interpolated or extrapolated values used until now for large areas, can differ in intensity from the measured data by many hundreds, even a thousand gammas, not speaking especially of anomalies only. Every possible survey extension in Antarctica is very desirable.

Otherwise in Antarctica or in its environs we observe the intensive foci of secular variation: in H a very deep focus in the South Atlantic, and in Z two, also deep, foci — one in W Antarctica, the other near Wilkes Land. Special attention must be paid also to the reoccupation of repeat stations in Antarctica.

Experimental photodetachment cross section and ionospheric detachment rate for O_2^-

by S. J. Smith, D. S. Burch and L. M. Branscomb

National Bureau of Standards, Washington, D.C.

The complete text has been published in Ann. Géophys., 14, pp. 225—231, 1958; (IAGA Bull. 16b, pp. 365—371, 1959).

Protons outside the earth's atmosphere

by O. Storey

Defence Research Telecommunications Establishment,
Defence Research Board, Ottawa, Ontario

The complete text has been published in Ann. Géophys., 14, pp. 144—153, 1958; (IAGA Bull. 16b, pp. 129—138, 1959).

Researches on the intensity of the earth's magnetic field in the past

by E. Thellier and O. Thellier

Institut de Physique du Globe, Paris

1. Previous attempts:
   - Koenigsberger's ratio Q_{nt}.
   - Redeposition of varves.
   - Coercive force.
   - Thermoremanent remagnetisation.
2. The direct thermoremanent method:
   - Principle and its utilisation and verification in 1936.
   - Successive attempts to elimate the causes of errors, particularly those due to the spontaneous evolution of minerals in the course of time and those due to reheating.
   - An example of the application of the complete method.

3. Results obtained for the historic period by the study of baked clays:
   Results already published for France during the 15th century and the Roman period.
   Unpublished results. France, several series of bricks of the 15th and 18th centuries; Switzerland, tiles of about 70 A.D. from Augst and 175 A.D. from Vindonissa; Carthage, walls of a forge of 146 B.C. and pottery kilns of the 8th and 2nd centuries B.C.
4. Trials for more remote periods:
   On baked clays, quaternary metamorphic clays.
   On volcanic rocks, account of preliminary trials, systematic trials, difficulties.

Night airglow from rockets

by R. Tousey

U.S. Naval Research Laboratory, Washington, D.C.

The complete text has been published under the title "Rocket measurements of the night airglow" in Ann. Géophys., 14, pp. 186—195, 1958; (IAGA Bull. 16b, pp. 300—309, 1959).

Atmospheric composition

by J. W. Townsend, Jr. and E. B. Meadows

U.S. Naval Research Laboratory, Washington, D.C.

The complete text has been published under the title "Diffusive separation in the winter night time arctic upper atmosphere 112 to 150 km" (by E. B. Meadows and J. W. Townsend, Jr.) in Ann. Géophys., 14, pp. 80—93, 1958; (IAGA Bull. 16b, pp. 23—36, 1959). See also "Density of the winter night time arctic upper atmosphere 110 to 170 km" (by J. W. Townsend, Jr. and E. B. Meadows) in Ann. Géophys., 14, pp. 117—130, 1958; (IAGA Bull. 16b, pp. 60—73, 1959).

Short period pulsations of the earth's electromagnetic field

by V. A. Troitskaya

USSR

1. The problem. Possibilities revealed by simultaneous studies of earth-current and magnetic records for the investigations of short-period pulsations.

2. Experimental materials that have been used in the investigations carried out. (Records on a quick-run time scale with 90 mm per hour and 1 mm per sec, simultaneous records on these two

time scales, records of several stations located in different geographical points, ranging from 34° E to 142° E and from 39° N to 73,2° N.)

3. Schemes of earth-current installations — a standard scheme of a twenty-four hour record with a ballast resistance and that taken by a seismic recorder with a screw drift. A capacity switched in series with the receiving lines cuts down all the slow changes of the field (time scale 1 mm per sec.).

4. Basic principles of the proposed classification for short-period pulsations of the Earth's electromagnetic field. The necessity of revealing a general physical criterion to be used in classifying the observed pulsations.

The general criterion of the proposed classification is found by the type of oscillation regimen, i. e. by the type of excitation.

5. Results of analysing short-period pulsations of the train type: daily curves of this type of oscillations; laws of excitation on the Earth's surface (simultaneity of excitation); periods and amplitudes of steady oscillations, their subdivision.

6. Results af analysing pulsations of continuous type: daily variation, laws of excitation on the Earth's surface, periods and amplitudes of continuous pulsations, their subdivision.

7. Requirements for the magnetic equipment registering the oscillations and prospects opened up by such co-ordinated measurements of the Earth's electromagnetic field.

8. Short-period oscillations of a beating type, with periods from 0.3 to 2 sec. Examples of the oscillations, laws of their excitation in space and time.

9. A genetic relation of steady and train oscillations, and other concrete forms of disturbances in the Earth's electromagnetic field. The connection of train-type oscillations, bays and specific irregular pulsations with average periods of about 2.5 sec. The probable connection between steady oscillations and specific polar disturbances.

10. Conclusions based on comparing the laws of excitation of the two main types of short-period oscillations of the Earth's electromagnetic field and the relative position of the Earth and the Sun in the hours most favourable for exciting these oscillations.

Hydrogen emission in the auroral spectrum

by A. E. Veller

Institute of Terrestrial Magnetism (USSR), Murmansk Department

The complete text has been published under the title "Hydrogen emission at the final stage of the aurora" in Ann. Géophys., 14, pp. 323—325, 1958; (IAGA Bull. 16b, pp. 219—221, 1959).

Erdmagnetische Erforschung von Zonen erhöhter elektrischer Leitfähigkeit im Untergrund (Tiefentellurik)

von H. Wiese

Adolf-Schmidt-Observatorium, Niemegk

Bei einer heterogenen elektrischen Leitfähigkeitsstruktur der tiefen Erdkruste zeigen sich markante Unterschiede der schnellen erdmagnetischen Variationen (Bays, ssc, sfe, Pulsationen) an teilweise dicht benachbarten Observatorien. Besonders in Japan und Europa sind diese Erscheinungen beobachtet worden. Der Verfasser konnte den Verlauf einer Zone anormaler elektrischer Leitfähigkeit fast durch ganz Europa nachweisen. Je kurzperiodischer die Variationen sind, desto oberflächennaher fliessen die Hauptinduktionsströme. Auch ihr Schwerpunkt kann sich bei verschieden schnellen Variationen verschieben. So liegt eine Station im norddeutschen Flachland bei Pulsationen südlich des Schwerpunktes des Induktionsstromes, bei Baystörungen aber etwas nördlich.

Genaue Vermessungen während des Internationalen Geophysikalischen Jahres, ausgeführt mit Feldregistrierstationen des Observatoriums Niemegk, sollen den Verlauf und die Tiefe der Leitfähigkeitszone in Osteuropa festlegen.

Simultaneous measurements of the positive and negative light ion conductivities to 20 kilometers

by R. H. Woessner, W. E. Cobb and Ross Gunn

U.S. Weather Bureau, Washington, D.C.

Continuous simultaneous measurements of the positive and negative light ion conductivities have been made to more than 20 kilometers altitude. A balloon carries aloft two nearly identical self-ventilated Gerdien tubes connected to utilize a new relaxation circuit which modulates a standard radiosonde transmitter. The operating signals for the positive and negative units are arranged to provide different characteristic pulses. Critical tests showed that saturation effects in the measurement have been eliminated. A number of successful flights up to 20 kilometers have provided more than a thousand simultaneous measurements. It is found that the negative conductivity normally exceeds the positive conductivity at all levels between 5 and 18 kilometers. The level of equal conductivities depends on the cleanliness of the lower layers and commonly varies from 3 to 7 kilometers. Below this level the positive conductivity was in excess. An improved expression for the dependence of conductivity upon altitude has been worked out.

Splashing of rain and atmospheric electricity observations in disturbed weather

by T. W. Wormell

Cavendish Laboratory, Cambridge

Some recent investigations at Cambridge (England) by Adkins and by Hon were briefly described and their implications discussed.

When rain splashes ions are released and a space charge is built up near the ground, a considerable part of the charge being carried on ions of low mobility. In strong fields the effect is greatly intensified and the sign of the charge is then controlled by that of the field.

In moderate rain, under conditions when all electrical effects are weak, turbulent diffusion of the space charge causes a vertical convection current which may be of opposite sign to the conduction current. This effect must be allowed for before secure inferences concerning the cloud electrification process can be made from observations of the total current into the ground and the field.

In rain with strong electric fields the large space charge which is produced causes a rapid increase of the field with height in the first few metres. Serious errors will be made if it is assumed, as has sometimes been done implicitly in calibrating apparatus, that, under such conditions, the field at the ground is not significantly different from the mean field over the first ten or twenty metres.

Rapid registration of small magnetic variations at subaudio frequences

by Sir Charles Wright

Pacific Naval Laboratory of Defence Research Board,
Victoria, British Columbia

This is a short report of preliminary results of work designed to cover the frequency range from 1/15 cps. to 30 cps.

This work is supported by the Defence Research Board of Canada and by the Pacific Naval Laboratory under Dr. Ford, its superintendent. It may be regarded as an extension of the work of this laboratory in the range from 5 secs. to 5 minutes which has been in progress under Dr. Duffus for some time. The statistical results of this work will be published shortly.

In the higher frequency range mentioned above, the work is still held up by lack of equipment ordered many months ago, which may be due partly to demands by IGY activities on the firm supplying the magnetic tape recorder.

Sufficient has been done, however, to decide the form of the

equipment for recording the geomagnetic variations in this frequency range. This will comprise a 400 cycle chapper preamplifier recording δX, δY and δZ on three channels of the tape-recorder (F.M.) at a speed of a few millimetres a minute. Earth currents will also be recorded simultaneously on other channels. According to present plans the tapes will be analysed by playback at much higher speeds into a battery of filter units.

At the moment, owing to lack of equipment, only δZ is being recorded at slow speed and only when we receive word at Victoria from IGY sources of "special world intervals" and "Alerts". The records of δZ are taken from a large horizontal coil of 20 ft. diameter. Simultaneously, when these warnings are received, the variations in the lower frequency ranges will probably be recorded, as at present, on paper running at about 2 cms. a minute.

In this equipment, a chapper amplifier is used and the output integrated so as to enable variations to be recorded in the range of 5 secs. to 5 mins. Values of δX and δY will be taken from 2 pairs of mumetal cored coils with axes lying N-S and E-W, geographical. When the magnetic tape recorder comes, this will not be necessary.

Records will be shown to exhibit the onset of a "sudden commencement" and the way in which the normal 15 second daytime variations are greatly enhanced during the subsequent disturbance. Sometimes the approach of a "sudden commencement" is anticipated on the record by a certain premonitory uneasiness.

Future plans look towards the use of a second equipment so that one may compare the results at more than a single station.

Part VI

Resolutions and Committees

Resolutions of the Association

The resolutions have previously been published in the "Comptes Rendus de la XIe Assemblée Générale de l'UGGI", Paris 1958, and are given here in the standard form of the Union publication. The French text of the resolutions is to be found on pp. 401—405. The resolutions 1 and 2, given here in the form in which they were passed by the Association, were later adopted by the General Assembly of the Union as Union resolutions (see "Comptes Rendus de la XIe Assemblée Générale de l'UGGI", pp. 182—183, Resolutions 15 and 16).

RESOLUTION NO. 1

The International Association of Geomagnetism and Aeronomy

Considering that in some countries the use of direct current for railways makes it impossible to observe in those countries the natural geomagnetic time-variations which provide valuable information on geophysical features of practical importance as well as on cosmic influences affecting the Earth.

Recommends the use of alternating current electric power.

RESOLUTION NO. 2

The International Association of Geomagnetism and Aeronomy

Considering that the need for World magnetic surveys stems from two principal sources, as follows

1. The requirement for data for theoretical studies of the source and origin of the earth's magnetic field and of the secular changes occurring therein,
2. The preparation of more accurate world magnetic charts as a primary source of information for nautical and aeronautical navigation.

Recommends that

the principal maritime and aeronautical nations should share the task of a world magnetic survey by sea and air;

all countries which can do so plan and execute individual magnetic surveys of a type which will contribute to a unified world survey as prepared by the Association of Geomagnetism and Aeronomy;

all countries give consideration to the establishment of airborne magnetic surveys to provide data on all elements of the geomagnetic field, and that such surveys be extended to all feasible areas whether adjacent to or remote from the operating countries, in order to establish world-wide continuity;

the USSR, now operating a non-magnetic survey ship, should give primary attention to areas of (a) Indian Ocean, (b) South Atlantic Ocean, and (c) South Pacific Ocean, which will be difficult to cover by airborne survey equipment;

all other countries which can do so, give consideration to arrangements for making magnetic measurements at sea;

the USA and Canada, now possessing instrumental equipment suitable for airborne all-component magnetic surveys give immediate consideration to assigning equipment for world surveys;

the United Kingdom and the USA, who have published magnetic charts of the world, to designate areas having the greatest need of prompt coverage for the guidance of all who may be in a position to conduct survey operations;

all countries participating in the world magnetic survey exchange and publish promptly the data derived from their operations.

RESOLUTION NO. 3

The International Association of Geomagnetism and Aeronomy

Considering the value of the magnetic observations which were furnished prior to 1943 by the Dehra Dun observatory.

Urges that every possible effort be made to reactivate the observatory, particularly because of its important location in the world distribution of magnetic observatories.

RESOLUTION NO. 4

The International Association of Geomagnetism and Aeronomy

Endorses the actions of its Committee on Magnetic Activity regarding:

(a) The provision of the proposed quarter-hourly Q indices to be derived by observatories of geomagnetic latitude greater than 58° north and south during the International Geophysical Year, and by some other observatories for certain selected times.

(b) The derivation of a continuous measure of the intensity of the equatorial ring current from horizontal-intensity observations at tropical observatories.

RESOLUTION NO. 5

The International Association of Geomagnetism and Aeronomy

Expresses its appreciation to the Institute of Terrestrial Magnetism, Ionosphere and Radio-wave Propagation at Moscow for

furnishing to the De Bilt center the K-indices from nineteen observatories for the year 1955.

Expresses the wish, in view of the great scientific value and international interest of the magnetic K-indices, that the K-indices from USSR observatories for the previous years be made available for publication in the Association's Bulletin No. 12.

RESOLUTION NO. 6

The International Association of Geomagnetism and Aeronomy

Notes with interest the work on diurnal variation of magnetic activity done by the Arctic Institute at Leningrad, and

Suggests that observatories in a position to do so provide tables of hourly ranges of horizontal intensity to assist such studies.

RESOLUTION NO. 7

The International Association of Geomagnetism and Aeronomy

Notes with great satisfaction that the USSR has built and is operating a non-magnetic survey ship, the "Zarya", and

Recommends that the USSR continue the work of the "Zarya" after the period of the International Geophysical Year, making it, if possible, a permanent part of the scientific survey work in the future.

RESOLUTION NO. 8

The International Association of Geomagnetism and Aeronomy

Considering the importance of a better knowledge of the magnetic secular variation in the region of pronounced foci in the South Atlantic between the coasts of South Africa and South America, and in view of the favourable position of Tristan da Cunha for an investigation of this phenomenon.

Recommends the establishment at an early date of a good magnetic repeat station on that Island.

RESOLUTION NO. 9

The International Association of Geomagnetism and Aeronomy

Endorses the resolutions proposed by the Committee No. 10 at its Copenhagen meeting concerning the classification of rapid variations and the style of the reports requested from magnetic observatories.*)

RESOLUTION NO. 10

The International Association of Geomagnetism and Aeronomy

Recognizes the efforts expended by Brazil in the establishment of the magnetic observatory at Tatuoca, and

Urges that every possible effort be made to put this observatory on a routine operating basis at an early date.

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*) See pp. 343–347.

RESOLUTION NO. 11

The International Association of Geomagnetism and Aeronomy

Recognizes the efforts expended by Colombia in the establishment of the magnetic observatory at Fuquene, and

Urges that every possible effort be made to put this observatory on a routine operating basis at an early date.

RESOLUTION NO. 12

The International Association of Geomagnetism and Aeronomy

Recognizes the efforts expended by Spain in the establishment of the magnetic observatory at Moka (Fernando Poo), and

Urges that every possible effort be made to put this observatory on a routine operating basis at an early date.

RESOLUTION NO. 13

The International Association of Geomagnetism and Aeronomy

Recognizes the efforts expended by Spain in the establishment of the magnetic observatory at Santa Cruz de Tenerife, and

Urges that every possible effort be made to put this observatory on a routine operating basis at an early date.

RESOLUTION NO. 14

The International Association of Geomagnetism and Aeronomy

Recognizes the efforts expended by Roumania in the establishment of the magnetic observatory at Surlari, and

Urges that every possible effort be made to put this observatory on a routine operating basis at an early date.

RESOLUTION NO. 15

The International Association of Geomagnetism and Aeronomy

Expresses the hope that work on the analysis of the Abinger magnetic data at present held in abeyance, will be continued at the earliest opportunity.

RESOLUTION NO. 16

The International Association of Geomagnetism and Aeronomy

Endorses the recommendations proposed by its Committee No. 2 and its I.G.Y. Committee on Aurora at the Toronto meeting concerning the operation of World Data Centers for aurora and the presentation of data for publication.*)

RESOLUTION NO. 17

The Joint Committee on Atmospheric Electricity, International Association of Geomagnetism and Aeronomy and International Association of Meteorology

Recognizes the action taken by CSAGI in September 1956 at

*) See pp. 293—294.

Barcelona concerning atmospheric-electric measurements and research during the International Geophysical Year:

"That systematic synoptic measurements of electric field, of conductivity and, to the extent possible, of vertical current in the atmosphere be undertaken during the International Geophysical Year at continental and marine stations with the particular suggestion that the North Atlantic stationary weather ships be equipped in a manner such as to permit the accomplishment of the measurements."

"That world charts of thunderstorms giving the distribution of thunderstorm centers and the interdiurnal and seasonal variations of their activity be prepared with the aid of all the technical means existing at the present time."

"The working group on Geomagnetism feels that the co-ordination center for atmospheric-electric measurements should be entrusted to the Joint Committee on Atmospheric Electricity of the IUGG."

Accepts the responsibility of establishing the co-ordination center referred to in the last recommendation.

Requests that provision be made by the two International Associations of Meteorology and of Geomagnetism and Aeronomy for limited financial support of the center.

Résolutions de l'Association

Les résolutions ont été publiées déjà dans les "Comptes Rendus de la XIe Assemblée Générale de l'UGGI", Paris 1958, et elle sont données ici dans la rédaction standard de la publication de l'Union. Le texte anglais des résolutions se trouve aux pp. 397—401. Les résolutions 1 et 2, données ici telles qu'elles ont été adoptées par l'Association, ont été soumises plus tard à l'Assemblée Générale de l'Union qui les a adoptées comme résolutions de l'Union (voir "Comptes Rendus de la XIe Assemblée Générale de l'UGGI", pp. 168—169, Résolutions 15 et 16).

RESOLUTION NO. 1

L'Association Internationale de Géomagnétisme et d'Aéronomie

Considérant que l'utilisation dans certains pays du courant continu pour la traction ferroviaire a pour conséquence regrettable des perturbations magnétiques qui rendent impossible l'observation des variations du champ magnétique terrestre dont la connaissance est fondamentale tant pour certaines applications pratiques que pour l'étude des influences cosmiques sur la Terre.

Recommande instamment l'usage de courant alternatif.

RESOLUTION NO. 2

L'Association Internationale de Géomagnétisme et d'Aéronomie

Considérant que les réseaux magnétiques mondiaux sont nécessaires:

1. pour fournir des données aux études théoriques sur les causes du champ magnétique terrestre et de sa variation au cours des siècles,
2. pour préparer des cartes magnétiques mondiales précises à l'usage de la navigation maritime et aérienne.

Recommande

que les Nations intéressées prennent la charge d'un réseau mondial maritime et aérien et en conséquence:

que toutes les Nations qui en auraient la possibilité prévoient et exécutent des réseaux régionaux tels qu'ils puissent s'intégrer dans un réseau mondial homogène préparé par l'Association de Géomagnétisme et d'Aéronomie;

que toutes les Nations envisagent l'établissement de réseaux magnétiques aériens fournissant une mesure de tous les éléments du champ terrestre, en étendant ces réseaux à toutes les régions possibles, qu'elles soient proches ou lointaines, de façon à obtenir une continuité mondiale;

que l'URSS qui opère maintenant avec un navire non magnétique porte son attention sur les régions suivantes: Océan Indien, Sud de l'Océan Atlantique et Sud de l'Océan Pacifique, qu'il est difficile de couvrir par des réseaux aériens;

que toutes les autres Nations qui en auraient la possibilité envisagent des arrangements qui leur permettraient de faire des mesures magnétiques sur mer;

que les Etats-Unis et le Canada qui possédent maintenant un équipement permettant la mesure par air de tous les éléments du champ terrestre, envisagent immédiatement une utilisation à plein-temps de cet équipement, au profit du réseau mondial;

que la Grande-Bretagne et les Etats-Unis qui ont publié des cartes magnétiques mondiales indiquent les régions les plus déshéritées en mesures magnétiques, de façon à orienter ceux qui sont en mesure d'exécuter des opérations de réseau;

que toutes les Nations participant au réseau mondial échangent et publient rapidement les résultats de leurs mesures.

RESOLUTION NO. 3

L'Association Internationale de Géomagnétisme et d'Aéronomie

Considérant la valeur des observations magnétiques qu'avait fournies l'observatoire de Dehra Dun jusqu'en 1943.

Recommande instamment que tous les efforts possibles soient tentés pour remettre en activité cet observatoire dont la position est particulièrement importante dans le réseau mondial des observatoires.

RESOLUTION NO. 4

L'Association Internationale de Géomagnétisme et d'Aéronomie

Approuve l'action de son Comité sur l'Activité Magnétique en ce qui concerne:

a) l'envoi des valeurs de l'indice quart-horaire Q d'activité, qui doit être établi pendant la durée de l'Année Géophy-

sique Internationale, dans les observatoires de latitude géomagnétique supérieure à 58°, et durant certaines périodes choisies dans d'autres observatoires;

b) l'élaboration d'une mesure continue de l'intensité du courant annulaire équatorial à partir des valeurs de H observées dans les stations tropicales.

RESOLUTION NO. 5

L'Association Internationale de Géomagnétisme et d'Aéronomie

Exprime sa reconnaissance à l'Institut de Magnétisme terrestre, Ionosphère et Propagation des ondes radio de Moscou pour avoir fourni au centre de De Bilt les indices magnétiques de 19 observatoires pour l'année 1955.

Exprime le voeu, étant donnés la grande valeur scientifique et l'intérêt international de ces indices, que les indices K des observatoires soviétiques, pour les années antérieures, soient fournis pour être publiés dans son Bulletin No. 12.

RESOLUTION NO. 6

L'Association Internationale de Géomagnétisme et d'Aéronomie

Considère avec intérêt l'étude sur les variations diurnes de l'activité magnétique effectuée par l'Institut Arctique de Léningrad.

Suggère aux observatoires qui en ont la possibilité d'établir des tables d'amplitude horaire de H pour contribuer à de telles études.

RESOLUTION NO. 7

L'Association Internationale de Géomagnétisme et d'Aéronomie

Apprend avec grand intérêt que l'URSS a construit un navire amagnétique, le "Zarya", engagé maintenant dans des mesures de réseau.

Recommande que l'URSS le maintienne en activité au-delà de la période de l'Année Géophysique Internationale, afin qu'il continue son action dans l'établissement du réseau magnétique mondial.

RESOLUTION NO. 8

L'Association Internationale de Géomagnétisme et d'Aéronomie

Considérant l'intérêt qu'il y aurait à améliorer la connaissance de la variation séculaire du champ magnétique terrestre dans la région à forte vitesse de variation, située dans l'Atlantique Sud entre les côtes de l'Afrique du Sud et de l'Amérique du Sud et étant donnée la position favorable à ce point de vue de Tristan da Cunha.

Recommande l'établissement rapide d'une bonne station de répétition sur cette île.

RESOLUTION NO. 9

L'Association Internationale de Géomagnétisme et d'Aéronomie

Adopte les résolutions proposées par le Comité No. 10 lors de sa réunion de Copenhague concernant la classification des variations rapides et les recommandations qui en découlent pour les observatoires.*)

RESOLUTION NO. 10

L'Association Internationale de Géomagnétisme et d'Aéronomie

Reconnaissant les efforts faits par le Brésil pour établir un observatoire magnétique à Tatuoca.

Demande instamment qu'on s'efforce de mettre cet observatoire en service régulier dès que possible.

RESOLUTION NO. 11

L'Association Internationale de Géomagnétisme et d'Aéronomie

Reconnaissant les efforts faits par la Colombie pour établir un observatoire magnétique à Fuquene.

Demande instamment qu'on s'efforce de mettre cet observatoire en service régulier dès que possible.

RESOLUTION NO. 12

L'Association Internationale de Géomagnétisme et d'Aéronomie

Reconnaissant les efforts faits par l'Espagne pour établir un observatoire magnétique à Moka (Fernando Poo).

Demande instamment qu'on s'efforce de mettre cet observatoire en service régulier dès que possible.

RESOLUTION NO. 13

L'Association Internationale de Géomagnétisme et d'Aéronomie

Reconnaissant les efforts faits par l'Espagne pour établir un observatoire magnétique à Santa Cruz de Tenerife.

Demande instamment qu'on s'efforce de mettre cet observatoire en service régulier dès que possible.

RESOLUTION NO. 14

L'Association Internationale de Géomagnétisme et d'Aéronomie

Reconnaissant les efforts faits par la Roumanie pour établir un observatoire magnétique à Surlari.

Demande instamment qu'on s'efforce de mettre cet observatoire en service régulier dès que possible.

RESOLUTION NO. 15

L'Association Internationale de Géomagnétisme et d'Aéronomie

Exprime le voeu que le travail d'analyse des données magnétiques de l'observatoire d'Abinger, maintenant arrêté, soit repris dès que possible.

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*) Voir pp. 338–343.

RESOLUTION NO. 16

L'Association Internationale de Géomagnétisme et d'Aéronomie

Adopte les recommandations faites par son Comité No. 2 et son Comité pour l'Année Géophysique Internationale sur les Aurores à l'Assemblée de Toronto, relatives aux centres mondiaux de rassemblement des documents auroraux et à la présentation des résultats en vue de leur publication.*)

RESOLUTION NO. 17

Le Comité Mixte d'Electricité Atmosphérique, Association Internationale de Géomagnétisme et d'Aéronomie et Association Internationale de Météorologie

Prend acte des résolutions prises par le CSAGI en Septembre 1956 à Barcelone au sujet des mesures et des recherches en électricité atmosphérique pendant l'Année Géophysique Internationale:

"Que des mesures synoptiques systématiques du champ électrique, de la conductibilité de l'air et autant que possible du courant vertical dans l'atmosphère soient entreprises pendant l'Année Géophysique Internationale en des stations continentales et maritimes et suggère en particulier que des navires météorologiques stationnaires de l'Atlantique Nord soient équipés de manière à leur permettre d'effectuer ces mesures."

"Que des cartes mondiales d'orages donnant la répartition des foyers orageux et les variations interdiurnes et saisonnières de leur activité soient préparées à l'aide de tous les moyens techniques existants à ce jour."

"Le groupe de travail de Géomagnétisme estime que le centre de coordination pour des mesures d'électricité atmosphérique doit être confié au Comité Mixte d'Electricité Atmosphérique de l'UGGI."

Accepte la responsabilité de l'établissement du centre de coordination, dont mention est faite dans la dernière recommandation.

Prie les deux Associations Internationales de Météorologie et de Géomagnétisme et d'Aéronomie de bien vouloir envisager une aide financière limitée à ce centre.

*) Voir pp. 293—294.

Executive Committee and Special Committees of the Association

A. EXECUTIVE COMMITTEE

President:

Prof. J. Kaplan, Institute of Geophysics, University of California, Los Angeles 24, California, USA.

Vice-Presidents:

Prof. A. G. Kalashnikov, Institute of the Physics of the Earth, B. Gruzinskaya 10, Moscow, USSR.

Mr. V. Laursen, Meteorologisk Institut, Charlottenlund, Denmark.

Secretary and Director of the Central Bureau:

Rev. Father J. O. Cardús, Observatorio del Ebro, Tortosa, Spain.

Members:

Prof. J. Bartels	Germany
Prof. T. Nagata	Japan
Prof. M. Nicolet	Belgium
Dr. J. M. Rayner	Australia
Dr. O. Schneider	Argentina
Prof. E. Thellier	France

B. SPECIAL COMMITTEES

1. COMMITTEE ON OBSERVATORIES

Captain Elliott B. Roberts, Chairman, U.S. Coast and Geodetic Survey, Washington 25, D.C., USA

Prof. J. Bartels	Germany
Dr. L. Constantinescu	Roumania
Prof. J. Coulomb	France
Prof. G. Fanselau	Germany
Dr. A. A. Giesecke	Peru
Prof. M. Giorgi	Italy
Dr. P. Herrinck	Belgian Congo
Dr. Y. D. Kalinin	USSR
Prof. E. Lahaye	Belgium
Dr. V. Laursen	Denmark
Dr. O. Lützow-Holm	Argentina
Dr. R. Glenn Madill	Canada
Dr. S. L. Malurkar	India
Dr. L. S. Prior	Australia
Dr. J. Rodriguez-Navarro de Fuentes	Spain
Prof. J. Veldkamp	Netherlands

2. COMMITTEE ON AURORA AND AIRGLOW

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Dr. D. Barbier	France
Prof. D. R. Bates	Northern Ireland
Dr. J. W. Chamberlain	USA
Prof. S. Chapman	Great Britain
Prof. J. Dufay	France
Dr. C. W. Gartlein	USA
Dr. N. C. Gerson	USA
Prof. L. Harang	Norway
Dr. N. Herlofson	Sweden
Dr. D. M. Hunten	Canada
Dr. M. Huruhata	Japan
Dr. S. I. Isaev	USSR
Dr. F. Jacka	Australia
Dr. A. V. Jones	Canada
Dr. V. I. Krassovsky	USSR
Prof. A. Lebedinsky	USSR
Dr. E. R. Manring	USA
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Dr. N. J. Oliver	USA
Dr. J. Paton	Great Britain
Dr. F. E. Roach	USA
Dr. O. Schneider	Argentina
Dr. I. L. Thomsen	New Zealand
Prof. L. Vegard	Norway

3. COMMITTEE ON AERONOMY

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Prof. D. R. Bates	Northern Ireland
Dr. N. P. Benkova	USSR
Dr. J. E. Blamont	France
Prof. S. Chapman	Great Britain
Prof. B. W. Currie	Canada
Dr. A. Dalgarno	USA
Dr. A. Ehmert	Germany
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Dr. J. W. Evans	USA
Dr. H. Friedman	USA
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Prof. L. Harang	Norway
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Prof. J. A. Jacobs	Canada

Dr. C. Y. Johnson	USA
Prof. J. Kaplan	USA
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Dr. P. Mange	USA
Dr. D. F. Martyn	Australia
Dr. P. M. Millman	Canada
Prof. T. Nagata	Japan
Dr. H. E. Newell	USA
Dr. R. W. Nicholls	Canada
Dr. H. K. Paetzold	Germany
Dr. K. R. Ramanathan	India
Dr. F. E. Roach	USA
Dr. J. C. Seddon	USA
Dr. I. S. Shklovsky	USSR
Dr. J. A. Simpson	USA
Dr. L. R. O. Storey	Canada
Dr. R. Tousey	USA
Dr. J. W. Townsend	USA
Prof. E. Vassy	France
Dr. F. L. Whipple	USA
Dr. M. Zelikoff	USA

4. COMMITTEE ON SECULAR VARIATION AND PALAEOMAGNETISM

Prof. T. Nagata, Chairman, Geophysical Institute, Tokyo University, Tokyo, Japan

Prof. G. Angenheister	Germany
Dr. J. R. Balsley	USA
Sir Edward Bullard	Great Britain
Prof. M. Giorgi	Italy
Dr. G. E. Gjellestad	Norway
Prof. Gustav Ising	Sweden
Prof. J. A. Jacobs	Canada
Prof. I. C. Jaeger	Australia
Dr. R. Glenn Madill	Canada
Dr. J. H. Nelson	USA
Dr. B. Peters	India
Dr. G. N. Petrova	USSR
Dr. T. Rikitake	Japan
Prof. S. K. Runcorn	Great Britain
Prof. E. Thellier	France
Dr. E. H. Vestine	USA

5. COMMITTEE ON WORLD MAGNETIC SURVEY AND MAGNETIC CHARTS

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Dr. E. H. Vestine, Chairman, The Rand Corporation, 1700 Main Street, Santa Monica, California, USA

Dr. N. Ambolt	Sweden
Dr. B. C. Byrnes	USA
Dr. H. F. Finch	Great Britain
Dr. M. M. Ivanov	USSR
Dr. C. A. Jarman	Great Britain
Dr. L. Koenigsfeld	Belgium
Dr. E. Maple	USA
Dr. O. Meyer	Germany
Dr. J. H. Nelson	USA
Dr. V. P. Orlov	USSR
Dr. J. M. Rayner	Australia
Dr. D. C. Rose	Canada
Prof. S. K. Runcorn	Great Britain
Dr. E. Selzer	France
Dr. P. H. Serson	Canada
Dr. T. Yoshimatsu	Japan

6. JOINT COMMITTEE ON LUNAR VARIATIONS*) WITH THE INTERNATIONAL ASSOCIATION OF METEOROLOGY AND ATMOSPHERIC PHYSICS

Prof. S. Chapman, Chairman, Geophysical Institute, University of Alaska, College, Alaska, USA

Prof. J. Bartels	Germany
Prof. M. Bossolasco	Italy
Dr. J. C. Cain	USA
Rev. Father J. O. Cardús	Spain
Dr. E. J. Chernosky	USA
Dr. C. H. Cummack	New Zealand
Dr. J. Egedal	Denmark
Dr. H. F. Finch	Great Britain
Dr. R. Gallet	USA
Dr. P. Herrinck	Belgian Congo
Dr. H. H. Howe	USA
Dr. S. L. Malurkar	India
Dr. D. F. Martyn	Australia
Dr. S. Matsushita	Japan
Dr. K. R. Ramanathan**)	India
Dr. P. Rougerie	France
Dr. V. Sarabhai	India
Dr. O. Schneider	Argentina

*) Concerning later modifications of the list of members see item (xii) of Notes to the Report of the Committee, p. 309.

**) Appointed by IAMAP.

Dr. J. A. Thomas	Australia
Dr. Andrew Thomson	Canada
Dr. K. K. Tschu	China
Dr. K. Weekes	Great Britain
Dr. A. M. van Wijk	South Africa
Dr. M. V. Wilkes	Great Britain

7. COMMITTEE ON COMPARISONS OF MAGNETIC STANDARDS

Mr. V. Laursen, Chairman, Meteorologisk Institut, Charlottenlund, Denmark

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Dr. P. Herrinck	Belgian Congo
Dr. L. Koenigsfeld	Belgium
Dr. O. Lützow-Holm	Argentina
Dr. R. Glenn Madill	Canada
Dr. O. Meyer	Germany
Capt. E. B. Roberts	USA
Dr. J. Rodriguez-Navarro de Fuentes	Spain
Dr. E. Selzer	France
Dr. R. F. Thyer	Australia
Dr. B. M. Yanovsky	USSR
Dr. T. Yoshimatsu	Japan

8. COMMITTEE ON MAGNETIC INSTRUMENTS

Dr. J. H. Nelson, Chairman, Geophysics Division, U.S. Coast and Geodetic Survey, Washington 25, D.C., USA

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Dr. J. Dooley	Australia
Dr. E. J. Chernosky	USA
Dr. H. F. Finch	Great Britain
Prof. G. Grenet	Algeria
Dr. Y. Kato	Japan
Dr. J. Olsen	Denmark
Dr. O. Meyer	Germany
Prof. E. Thellier	France
Dr. P. H. Serson	Canada
Dr. I. Tsubokawa	Japan
Dr. B. M. Yanovsky	USSR

9. COMMITTEE ON CHARACTERIZATION OF MAGNETIC ACTIVITY

Prof. J. Bartels, Chairman, Herzberger Landstrasse 180, (20b) Göttingen, Germany

Dr. E. J. Chernosky	USA
Dr. N. Fukushima	Japan
Dr. H. H. Howe	USA

Dr. H. F. Johnston	USA
Dr. W. Kertz	Germany
Rev. Father P. N. Mayaud	France
Prof. A. P. Nikolsky	USSR
Dr. L. S. Prior	Australia
Prof. J. Veldkamp	Netherlands
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10. COMMITTEE ON RAPID VARIATIONS AND EARTH-CURRENTS

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Prof. L. Cagniard	France
Dr. L. Constantinescu	Roumania
Dr. J. Dooley	Australia
Dr. V. C. A. Ferraro	Great Britain
Dr. G. E. Gjellestad	Norway
Prof. G. Grenet	Algeria
Dr. Y. Kato	Japan
Dr. L. Koenigsfeld	Belgium
Dr. E. Maple	USA
Dr. O. Meyer	Germany
Dr. J. H. Nelson	USA
Dr. E. Selzer	France
Mrs. V. Troitskaya	USSR
Prof. J. Veldkamp	Netherlands
Dr. A. de Voogt	Netherlands
Dr. K. Whitham	Canada

11. COMMITTEE ON THE HISTORY OF GEOMAGNETISM AND AERONOMY

Prof. N. Pushkov, Chairman, Institute of Terrestrial Magnetism, Vatutenki, Moscow, USSR

Prof. L. Cagniard	France
Prof. N. C. Gerson	USA
Dr. L. Koenigsfeld	Belgium
Dr. S. Matsushita	Japan
Capt. E. B. Roberts	USA
Mrs. T. M. Rose	USSR

JOINT COMMITTEE ON UPPER ATMOSPHERE WITH THE INTERNATIONAL ASSOCIATION OF METEOROLOGY AND ATMOSPHERIC PHYSICS

Members appointed by the IAMAP:

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Prof. M. Nicolet	Belgium
Prof. E. Palmén	Finland

Members appointed by the IAGA:

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Dr. T. R. Kaiser	Great Britain
Prof. J. Kaplan	USA
Dr. H. E. Newell	USA
Prof. K. R. Ramanathan	India

JOINT COMMITTEE ON ATMOSPHERIC ELECTRICITY WITH THE INTERNATIONAL ASSOCIATION OF METEOROLOGY AND ATMOSPHERIC PHYSICS

Members appointed by the IAGA:

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Dr. L. Koenigsfeld, Chairman, Rue Etat Tiers 17, Liège, Belgium

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Dr. P. J. Nolan	Ireland
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