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International Union of Geodesy and Geophysics

## ASSOCIATION OF GEOMAGNETISM AND AERONOMY

TRANSACTIONS

of the

XVII GENERAL ASSEMBLY

CANBERRA, AUSTRALIA, 1979

edited by Naoshi FUKUSHIMA Secretary General, IAGA The INTERNATIONAL ASSOCIATION OF GEOMAGNETISM AND AERONOMY (IAGA) is one of the seven Associations in the International Union of Geodesy and Geophysics (IUGG). The countries which adhere to the IUGG are members of IAGA and may participate in the activities of IAGA. Each Member Country is represented by a single body (called IAGA National Body), established in that country by the body that adheres to the IUGG.

The objectives of IAGA are:

- to promote studies of magnetism and aeronomy of the Earth and other bodies of the solar system, and of the interplanetary medium and its interaction with these bodies, where such studies have international interest;
- b) to encourage research in the above subjects by individual countries, institutions or persons and to facilitate its international coordination;
- to provide an opportunity, on an international basis, for discussion and publication of the results of the research work indicated above;
- d) to promote appropriate standardizations of observational programs, data acquisition systems, data analysis and publication.

At present, the components of IAGA are as follows.

Division I: Internal Magnetic Fields

Division II: Aeronomic Phenomena

Division III: Magnetospheric Phenomena

Division IV: Solar Wind and Interplanetary Magnetic Field Division V: Observatories, Instruments, Indices and Data

Interdivisional Commission on Antarctic Research

Interdivisional Commission on History

Interdivisional Commission on the Middle Atmosphere

Interdivisional Working Group on Relations between External and Internal

Magnetic Variations

Each Division (and some Interdivisional Commissions also) has Working Groups or Topic Groups for specific items of research.

IAGA holds its ordinary General Assembly every four years in connection with each ordinary General Assembly of IUGG. Between ordinary General Assemblies, IAGA holds a General Scientific Assembly, so that IAGA meets every other year.

IAGA has two kinds of publications, i.e. IAGA Bulletins and the IAGA News. The IAGA Bulletins include

Transactions of the IAGA General Assemblies

Programs and Abstracts of Papers for IAGA General Assemblies

Geomagnetic Indices and Data (published yearly)

Special Data Summary or Useful Information Booklet (published occasionally).

All the IAGA Bulletins are on sale at the IUGG Publications Office (39ter, rue Gay-Lussac, 75005 Paris, France). In 1960's some proceedings of special IAGA symposia were also published from the IUGG Publications Office.

IAGA issues an internal publication called "IAGA News" which contains various information of general interest to the IAGA community. The IAGA News is usually published on a yearly basis, and is available free of charge on request from the Secretary General of IAGA.

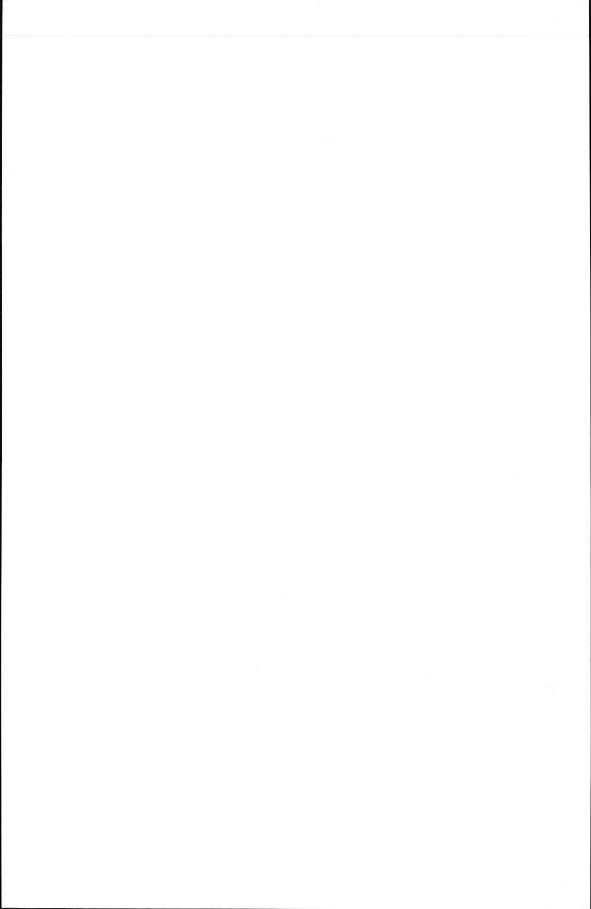
N. Fukushima Secretary General, IAGA Geophysics Research Laboratory University of Tokyo Tokyo 113, Japan

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# TRANSACTIONS of the XVII GENERAL ASSEMBLY CANBERRA, AUSTRALIA, 1979

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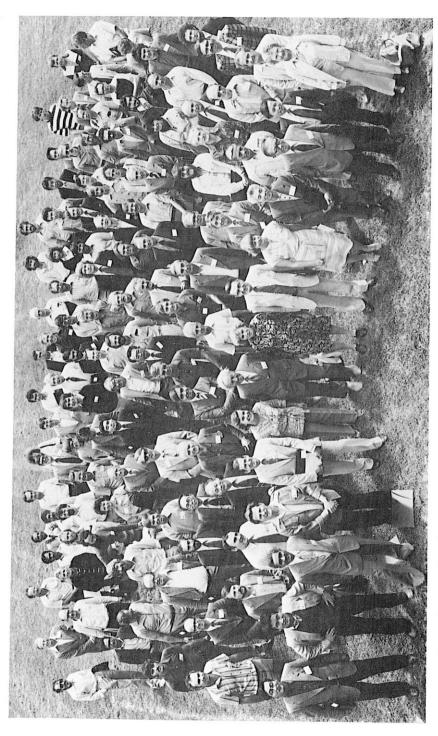


Melville Hall



Copland Building

(by Courtesy of the Australian National University)



Group photograph at the IMS Symposium in La Trobe University, Melbourne, Australia (27 November 1979)

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### GENERAL REMARK

About a year was needed to compile the manuscripts and print the Transactions of the IAGA Canberra Assembly held during 3–15 December 1979, with a brief report on the IMS Symposium held in Melbourne during the 27 November -1 December 1979. Since the Canberra Assembly IAGA has lost some officers (such as A. N. Pushkov and S. M. Mansurov), however their names remain in the Transactions in order to keep the record at the IAGA Canberra Assembly.

Some of the convenors' reports in the "Programs and Highlights of the IAGA Sessions" of the Canberra Assembly appeared in early 1980 in EOS (Transactions of the American Geophysical Union) with AGU copyright. The permission was given to IAGA for the reproduction of such reports, and the courtesy of the American Geophysical Union is acknowledged.

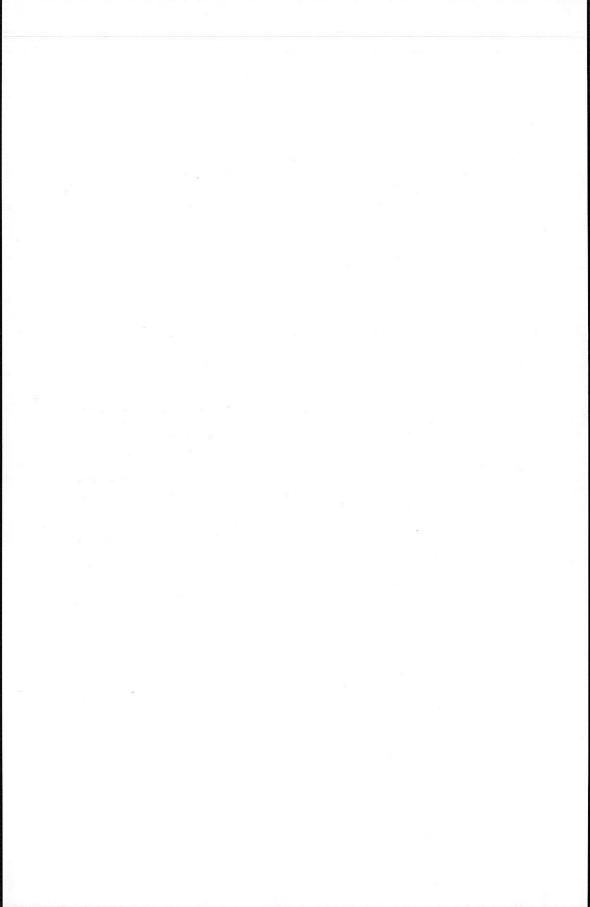
A copy of the Transactions of the IAGA Canberra Assembly is being distributed free of charge to all the IAGA registrants of the IUGG General Assembly in Canberra. Each IAGA/IUGG member country is entitled to receive some free copies, the number of which is the same as the category of each member country in the IUGG financial contribution.

The IUGG Publications Office (39 ter, Rue Gay-Lussac, 75005 Paris, France) will receive orders for this publication (IAGA Bulletin No. 44) at the price of \$10 per copy.

The Program-Abstracts booklet of the IMS Symposium in Melbourne (IAGA Bulletin No. 42) and that of the IAGA General Assembly in Canberra (IAGA Bulletin No. 43) are now also available from the IUGG Publications Office at the cost of \$3 and \$5, respectively.

December 1980

N. Fukushima Secretary General, IAGA



### **ACKNOWLEDGEMENTS**

IAGA held its XVII General Assembly in Canberra, Australia, 3–14 December 1979 during the IUGG General Assembly. The IMS Symposium in Melbourne, which was held from 27 November to 1 December 1979, under the joint IAGA-SCOSTEP program, was also arranged in conjunction with the 1979 IUGG General Assembly, and sponsored also by the Australian Institute of Physics and the Australian Academy of Science. The success of these two IAGA meetings was, of course, based upon the cooperation of a number of people who worked both in the planning stage and during the conference.

For the IMS Symposium the excellent local arrangement was due to the Organizing Committee [K. D. Cole (Chairman), E. Butcher, P. L. Dyson, E. Essex, J. van Geelen, P. Hammer, K. Orchison, M. Tolhurst, and R. Tuttleby (Secretary/Treasurer)] with secretariat help by Mrs. A. Whalley, J. O'Brien and B. Steward. The ladies programs were arranged by Mrs. A. Cole and Mrs. T. Scott. Prof. J. F. Scott (Vice Chancellor of La Trobe University) and the Government of the State of Victoria provided great support to the IMS Symposium. The scientific programme of the IMS Symposium was arranged by the Program Committee [J. G. Roederer (Chairman), K. D. Cole, P. L. Dyson, C.-G. Fälthammar, G. Haerendel, G. Rostoker, C. T. Russell, B. A. Tinsley, V. A. Troitskaya and D. J. Williams].

The XVII IAGA General Assembly in Canberra was a part of the XVII General Assembly of IUGG, the local organization of which, was arranged by the Australian Academy of Science. [The Local Organizing Committee consisted of Prof. P. V. Angus-Leppan (Chairman, during his absence April 1978—January 1979, Dr. Phillip acted as Chairman), Prof. A. L. Hales, (Deputy Chairman until May 1978), Dr. M. W. McElhinny (Deputy Chairman from May 1978), Dr. B. P. Lambert (Executive Director), Prof. K. D. Cole (for IMS), Dr. P. Morgan (IUGG Assistant Secretary General), Mr. A. A. Robertson (Australian National University), Mr. H. A. W. Southon (Australian Academy of Science), and Treasurer of the Academy (exofficio).] Dr. W. D. Parkinson and Mr. P. M. McGregor helped the Organizing Committee as the IAGA Representative and the Nominee. The participants of the IAGA Assembly received general benefits from the people who worked for registration, accomodation, social events, excursion and other conveniences, under the arrangements of the Local Organizing Committee.

The IAGA Secretariat was assisted by Mr. Peter M. McGregor and his colleagues (Messrs. Graeme Small, Ron Smith, Maurice McMullan, Kevin Wake-Dyster, Vic Dent, Geoff Thomas and Andrew McEwin) from the Bureau of Mineral Resources, Geology and Geophysics. Its Director, Mr. L. W. Williams is gratefully acknowledged for his approval in not only providing the service of personnel from his Bureau but also the facilities used for the secretariat work. The IAGA Secretariat was supported also through the efficient work of Mrs. Helga Wilm (secretary to the IAGA President) and Mrs. Suzanne Hill (secretary to the IAGA Secretary General until

June 1979 and in Canberra since August 1979). The Program Committee consisted of the Division Chairmen (who have devoted themselves to leading their Divisions in the past four years) and myself. This "Transactions of the IAGA Canberra Assembly" was completed due to the contributions from the new and retired Chairmen of IAGA Divisions and Interdivisional Bodies, Leaders of Working Groups, and the convenors of all IAGA sessions, and other key persons in the conference activity, including the retired President and Executive Committee members. The Secretary General is very grateful to all these key persons for their kind cooperation, excellent service to the IAGA community, and great help to him. He also thanks Mrs. Diane Hiscock for her assistance in Tokyo with this publication.

30 August 1980

N. Fukushima Secretary General, IAGA

### MINUTES OF THE IAGA CONFERENCE OF DELEGATES

during the XVII IAGA General Assembly Canberra, Australia

IAGA had two meetings of the Conference of Delegates during the XVII IAGA General Assembly in Canberra, Australia. Delegates from 32 IAGA/IUGG member countries attended the Conference of Delegates. The accredited Chief Delegates and their nominated representatives of the member countries were as follows.

Membe	er Countr	v
111 011100	Commit	,

Portugal South Africa

Spain

### Chief Delegate (and nominated representatives)

Argentina D. A. Valencio
Australia W. D. Parkinson
Belgium M. Scherer (M. Nicolet)

Canada D. I. Gough
Chile J. R. Bannister
China Q.-L. Liu
Czechoslovakia V. Bucha
Denmark K. Lassen
Egypt A. A. Ashour
Finland J. Oksman

France M. L. Chanin (B. Bauer, R. Schlich)

W. Mundt D. R. Germany F. R. Germany P. Fabian P. K. Das India Indonesia R. Susanto F. Mariani Italy H. Maeda Japan Mexico L. Chargoy E. Netherlands D. van Sabben New Zealand R. S. Unwin Nigeria E. Oni A. Egeland Norway

Sweden C.-G. Fälthammar Switzerland G. Fischer Turkey A. M. Isikara U.S.S.R. V. V. Migulin

H. Fonseca

J. O. Cardus

A. D. M. Walker

U. K. U.S.A.

Zimbabwe-Rhodesia

B. R. Leaton

B. A. Tinsley

P. L. McFadden

### I. The First Conference of Delegates on 3 December 1979, 1400–1530 in Melville Hall

President Roederer called the Conference of Delegates (CD) to order. Secretary General Fukushima confirmed that a quorum existed as specified in Statute 19 of the Association (27 Chief Delegates present out of 32 accredited).

The President made a few introductory remarks and pointed out that this was the first meeting of the CD with the XVII General Assembly. This meeting also represents the opening session of the IAGA General Assembly and includes mostly information items plus a few action items on which a discussion and a vote should be called for. The President referred to the following Agenda:

- I. Welcome Address and Remarks from the Organizing Committee
- II. Set up of Ad Hoc Committees for the Canberra Assembly
  - 1) Resolutions Committee
  - 2) Nominating Committee
  - 3) Finance Committee
- III. Report of the Secretary General
- IV. Other Items
- V. Presidential Address.

He informed the CD that under Item IV, "Other Items," the Executive Committee (EC) proposes to include:

- (1) CD concurrence to EC decisions taken at its 1978 meeting in La Londe, in accordance with Statute 6.
- (2) Proposed change in Bylaw 16c.
- (3) Ratification of new Division leadership, as per Bylaw 3.
- (4) Information item: voting procedure for election of the next EC.

Before submitting this amended agenda for adoption, the President asked the CD for further comments. The Chief Delegate from UK presented 3 points for inclusion under Item IV: (1) He suggested on behalf of the British National Committee that the IAGA structure be modified to include again a group dealing with Sq and L variations; (2) A UK scientist has complained to the British National Correspondent about the late notice received concerning a recent international meeting co-sponsored by IAGA, and suggests that some ground rules need to be established to insure that workshops and meetings sponsored by IAGA are of a truly international nature; and (3) the UK delegation feels strongly that a change in Statutes may be desirable to insure that: "With the exception of the election of the Secretary General, no person shall be eligible for election to any position on the IAGA Executive who has served already on the Committee for the proceeding four consecutive periods."

The President resonded that point (1) mentioned by the Chief Delegate of the UK should be referred to Divisions II and III since, according to Bylaw Division leaders should deal with a problem of this nature before the EC gives approval. He indicated that point (2) will be

considered in the discussion when CD concurrence is requested concerning the mechanism of IAGA sponsorship of conferences. Concerning point (3), he suggested that the British Committee submit a formal request at least six months before the next IAGA Assembly, as specified in Statute 22.

The amended agenda for the plenary session (an administrative matter) was then approved unanimously by the Chief Delegates.

The President invited Dr. Dudley Parkinson to address the delegates on behalf of the Local Organizing Committee. Dr. Parkinson did so, expressing the appreciation of the Local Organizing committee for the efforts expended by the delegates to attend the General Assembly in this remote location. He specifically thanked Mr. Peter McGregor for his efforts to organize the details of the local IAGA organization. In conclusion, Dr. Parkinson expressed his hope that many would be able to stay after the conference to see and enjoy Australia, and that those who could not would be able to return here some day.

The Secretary General then announced the composition of the following committee:

Resolutions Committee:

M. Gadsden (UK), Chairman

(Appointed by the EC)

P. Bauer (France)

H. Oya (Japan)
W. D. Parkinson (Australia)

O. M. Raspopov (USSR)

Chairman Gadsden addressed the delegates and reminded them to provide the name and address of the organization(s) or person(s) most concerned with each resolution submitted to the Committee. He also requested that resolutions for IUGG be submitted in English and French, while IAGA resolutions need only be submitted in English (the Committee will translate them). He also provided information concerning timing and deadline for resolution submission.

The Secretary General then proceeded with the announcement of the committee:

Nominations Committee:

M. Nicolet (Belgium), Chairman

(Appointed by the President)

J. O. Cardus (Spain) V. V. Migulin (USSR)

R.G. Rastogi (India)

G. C. Reid (USA) (proxy vote by T. E. VanZandt)

The President commented that the work of the Nominations Committee was to have been completed by correspondence prior to the Assembly; however, this had not been possible. The Committee would prepare the slate of EC nominations without further delay and distribute it to the Chief Delegates before tomorrow evening. Roederer further explained his action when he learned that Dr. Reid would not be able to come to Canberra. Since he did not feel it proper for the President to appoint a new person to replace Dr. Reid on short notice before the meeting, he requested that Dr. Reid designate his alternate and give the latter his proxy vote. Dr. Reid chose Dr. VanZandt (USA).

The Secretary General announced the membership of the third committee:

Finance Committee:

R. G. Johnson (USA), Chairman

(Appointed by the EC)

C. G. Sucksdorff (Finland)

H. Maeda (Japan)

The Secretary General presented his report to the delegates, beginning with a request for a

minute of silence in honour of recently deceased members, too numerous to name individually. (See the Secretary General's full report on pp. 15–16).

At the conclusion of the Secretary General's report, the President called for a motion to accept the report, which was made, seconded and approved unanimously. He commented on the tremendously hard work performed by the Secretary General in preparation of this Assembly and all other IAGA business. The delegates enthusiastically applauded the Secretary General's efforts.

The President then proceeded to Item IV on the Agenda:

First point included in this item was the request of the concurrence by the CD of EC decisions taken at La Londe in September 1978. The President informed that there was only one decision that required concurrence, related to the co-sponsorship by IAGA of meetings, workshops, and symposia. The President read from the 1978 EC meeting minutes (IAGA News No. 17, p. 25 bottom): "It was noted that meetings to be cosponsored usually can be divided into three categories: 1. Major meetings requiring financial support from IAGA and with IAGA representation on the organizing committee; 2. Major meetings not requiring financial support, but whose organization still requires IAGA representation; 3. Meetings or Workshops of limited scope or regional nature, to be attended by IAGA scientists. It was agreed that IAGA co-sponsorship rules given at the Borok EC meeting (the conference must be truly international, and a IAGA representative must be appointed to the Organizing Committee during the early stage of planning) apply to 1 and 2 above, while type 3 meeting cosponsorship may be approved by the President. For meetings of category 1 and 2, a 3-4 page report will be requested, to be published in IAGA News. All three types of meetings will be announced in IAGA News. IAGA cosponsorship should be indicated in the programs of the meetings; acknowledgement of IAGA support should be made in a prominent place in case of meetings of category 1."

The President invited the Chief Delegate of the UK to present his case again. After a lengthy discussion, the President assured the CD that the EC will consider the case at its meeting. After this discussion, the President requested a vote of concurrence for the decision concerning cosponsorship (reproduced above between quotes). Approval was unanimous.

The President proceeded to point 2 of IV and explained in detail the change in Bylaw 16c proposed by the EC (see IAGA News No. 17, p. 19). He read both the old text and the proposed text, explaining that the reason for the proposed change was to make a clear distinction between "Local Correspondents" in non-member countries, and the National Bodies of member countries (Statute 4). The designation "corresponding members" of the present text of Bylaw 16c had been judged inappropriate, for it might induce the notion of "membership" in IAGA. Only *countries* are members of IUGG Associations, the President said. The vote was taken and the change in Bylaw 16c was approved (with one abstention) to read: "c) invite persons or institutions belonging to countries which are not members of the Association, to be local correspondents to the Association."

The President proceeded to point 3 of IV, concerning the new leadership of the Division and Commissions. He reminded the CD that the Association believes in change and that the new leadership should be made up of scientists of high reputation and be known for their quick response to correspondence. He also pointed out that according to Bylaw 5, appointments should be made with due respect to adequate geographic distribution. Vice-President Cole displayed the slate of candidates on the blackboard [Note: Since the names of the new

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leadership of IAGA Divisions and Interdivisional Bodies are shown elsewhere in this publication, the listing is omitted here. The names shown in this first CD were, Division I (chairmen and one vice-chairman), Division II (chairman and for three co-chairmen), Division III (chairman and three co-chairmen), Division IV (chairman and two co-chairmen), and Division V (chairman only). The remaining leaders were proposed during the assembly and shown in the second CD on 13 December.]

The President commented that the slate of candidates had been approved by the EC earlier and was placed before the Delegates for their ratification in accordance with Bylaw 5. The slate of candidates was approved unanimously by the Chief Delegates as an administrative matter.

The President turned to point 4 of IV, explaining the voting procedure and schedule for the election of the new EC, as set forth by the EC (IAGA News No. 17, p. 29). No questions arose from the floor.

Vice-president Cole took over the meeting and invited President Roederer to deliver his presidential address (see the full text of address on pp. 11–14). At the conclusion, Cole commented that this address would no doubt be referred to many times in future years and that he thought that it contained many excellent and inspiring remarks.

### II. Second Conference of Delegates on 14 December 1979, 1600–1800 in Copland Hall

President Roederer called the meeting to order and reported that the Secretary General had confirmed quorum: 21 of 32 accredited chief delegates were present. Roederer called attention to the agenda for the meeting as listed in the IAGA Abstract Booklet (p. 88) and added that there were several items to include under "Other Business." The Chief Delegate of the UK requested that a review be made of the value of the National Reports. Roederer then summed up the items to be added under "Other Business":

- (1) Approval of the additional Division leaders appointed since the first CD;
- (2) Request by the UK for re-establishment of the Sq and L Working Group;
- (3) Concurrence of the Chief Delegates with recent EC decisions;
- (4) Review of the value of the national reports. The amended agenda was adopted.

### 1. Report of the Resolutions Committee and the Adoption of Resolutions

Roederer invited Gadsden to present the resolutions (a copy of which had previously been distributed to all members). Roederer requested that comments be limited to changes of substance and that minor details of syntax, spelling and punctuation should be brought to the attention of the chairman of the Resolutions Committee or the Secretary General after the CD.

Gadsden thanked the Resolutions Committee for their dedicated efforts and fast work, adding special thanks for Dr. Blanc's offer to expeditiously translate the resolutions into French. Gadsden continued that two proposed resolutions were withdrawn and that one was deleted by the EC since its content had been deemed inappropriate for an IUGG resolution. He stated that three of the proposed resolutions originated in the EC.

Gadsden proceeded to offer the proposed resolutions for adoption: the Resolution of Thanks was adopted unanimously; however, the Chief Delegate of Egypt suggested it might be desirable to add specific names in this resolution since the Union would do the same with its

general resolution of thanks. A brief discussion ensued about past IAGA practice and it was agreed that the outgoing Association President would write letters of thanks directed to specific persons of the local Organizing Committee, thanking them for their efforts on behalf of IAGA. After this, the Resolutions were discussed one by one. Some minor amendments were introduced in some. Roederer thanked the Resolutions Committee for their excelent work. (The list of resolutions as approved by the CD is given separately in this "Transactions."

### 2. Report of the Finance Committee

Roederer invited the Finance Committee to present its report. Sucksdorff read the report (Appendix 1) and projected the budget mentioned in the report (Appendix 2) on the screen. The Report of the Finance Committee was then formally accepted by the Chief Delegates. Roederer commented that letters will be written as requested by the Finance Committee in their report to the Secretary General for his diligent handling of IAGA funds, to the Japanese Government for the considerable support provided, and to the University of Tokyo for its generous assistance, all which have contributed in important ways to keep the administrative expenses of IAGA at a low level. The delegates showed by enthusiastic acclamation their appreciation of the tremendous efforts made by the Secretary General in attending to IAGA business matters.

Roederer commented on the meaning of a "period" as used for financial reporting purposes by the Union and added that the EC had agreed it would be helpful to have budget information on an annual basis for internal reporting procedures. Such additional breakdown would facilitate the determination of actual funds available to the Divisions as well as actual expenditures of funds for EC meetings. Roederer further pointed out to the delegates the new fact that an allocation of \$12,000 was budgeted as a line item for IAGA participation in ICSU projects. The Chief Delegate of Egypt recommended that this fact be made known to the Union. Roederer displayed on the screen the allocations apportioned by the EC to the Divisions (Appendix 3). UK Delegate Creer inquired about the method used to determine the individual amounts. Roederer stated that this was based on past participation in meetings and interest shown by the IAGA constituency in a questionnaire. Creer suggested that it might be better based on actual meeting attendance. Fukushima pointed out that page 131 of IAGA News #17 showed a histogram which had been prepared on the basis of the questionnaire sent to all IAGA scientists, and that it had been used in determining the allocation of Division funds. Creer reiterated that another look might be good. Roederer said he would pass this suggestion on to the next EC, and added that the amounts shown were not frozen but could be readjusted by the EC at any time. Parkinson inquired whether Division money could be used for attendance at workshops. Roederer responded that Division Leaders are free to allocate their funds to further their Division's business. Also, there can be special EC-approved allocations for travel of IAGA representatives. Concurrence on the projected budget was then given by the Chief Delegates.

### 3. Reports from the Divisions and Interdivisional Bodies

Roederer proceeded with a review of highlights from the reports submitted by the Divisions and Commissions. He reported on the dissatisfaction of the EC with the fact that some Divisions had not achieved good geographic distribution in the selection of their Working Group leadership, and pointed out the poor representation from LDCs. He continued that the Bylaws currently enpower the Divisions to handle their own elections, but that the poor results may suggest the need for a change in one of the Bylaws. Comments ensued with US Chief

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Delegate Tinsley (outgoing Chairman of Division II) stating that Division II had followed the Bylaws and had consulted within its working groups, and that good geographic distribution had been achieved. The Chief Delegate of the UK commented that Bylaws should not be changed, but that proper guidance should be provided to the Divisions instead. Roederer requested comments on this problem from Division leaders. Creer stated that Division I Working Groups elected their leaders independently and that they did not compare results. Roederer acknowledged this problem but stated that mechanics must be found to facilitate better geographic distribution. The Chief Delegate of Egypt commented that although the current process was called "democratic," this was not really the case, since the selection was made only from those attending the business meetings in question. He further stated that limiting Working Groups or Reporters to 12 members is not a good number anymore. Roederer stated that the EC may propose to re-establish a "membership at large" as a possible solution to this problem. Creer admitted to a possible bias by the current selection process but emphasized the importance of selecting active people. Rastogi commented that most meetings are held in Europe and the USA, therefore the number of attendees from those countries is always greater, a fact which further contributed to bias representation. Roederer stated that the EC would take due note of all these comments.

Roederer proceeded with a review of the highlights of the Division and Commission Reports. He stated that, based on the fact that there would be no COSPAR meeting in 1981, the EC has added 2 topics to the proposed program of Division III for Edinburgh, namely (1) a Symposium on the Voyager Flyby of Saturn, and (2) a Symposium on Planetary Magnetospheres. Gringauz commented that the latter might be too soon after the Symposium on this subject at the 1980 meeting of COSPAR in Budapest. After a brief discussion, it was agreed that the Edinburgh Symposium should be on Theory of Planetary Magnetospheres. This would remove a possible conflict with COSPAR. Roederer noted that the idea of focussing on theory had already been in the back of the minds of the EC when the conveners, Drs. Galeev and Siscoe, two noted theoreticians, were chosen. Roederer concluded by informing the delegates that the tentative program for Edinburgh will be published in the coming IAGA News.

### 4. Election Results of the Executive Committee for the Next Four-Year Period.

Roederer reported on the election process that took place over the past weekend. The slate originally proposed by the Nominating Committee was elected. The two additional nominees did not achieve the necessary votes. There being no challenges from the floor, the election ballots were ordered to be destroyed. (The names of the new IAGA EC members are shown in the new membership list in this "Transactions."

### 5. Invitation to the Fourth General Scientific Assembly of IAGA

Roederer related that an invitation had been received from the British National Committee to hold the next Scientific Assembly in Edinburgh in 1981. The delegates approved acceptance by acclamation.

### 6. Other Business

(1) The names of additional Division and Commission leaders were displayed on the blackboard. Approval was given by the Chief Delegates. The final list of leaders (including those approved at the first CD on 3 December 1979) is seen in the new membership list.

- (2) Roederer reported that the request by the British National Committee for the reestablishment of an Sq and L working group had been accommodated as part of the Interdivisional Working Group on Relations between External and Internal Magnetic Variations.
- (3) Roederer reported that the EC has decided to establish an *ad hoc* committee charged with the establishment of an Interdivisional Commission to Stimulate IAGA Sciences in Developing Countries. The outgoing and new Association Presidents will constitute this *ad hoc* committee and will submit a plan of action to the next EC meeting.
- (4) Roederer related that the second joint IAGA/IAMAP EC meeting took place on December 12. Discussion had centered on consolidating a close contact between the Associations and the cooperation planned for joint meetings and symposia in Edinburgh and Hamburg. (The minutes of this meeting are given on pp. 35–36).
- (5) The Chief Delegate of the UK explained his request for a review of the value of IAGA National Reports, commenting that a lot of work and effort went into the preparation of these reports and thus expected that their value should correspond to this effort. The Chief Delegate of Canada commented that the Canadian Geophysical Bulletin was also used as the Canadian National Report and suggested that other countries may find a similar arrangement as a suitable solution to the problem. Comments from the floor showed a general consensus that the National Reports were indeed valuable, that they call attention to the research that is being conducted, and to papers which might otherwise not be made known. Roederer commented in conclusion that the EC will take note of the British Chief Delegate's comment and will urge maximum use of National Reports.

### 7. Concluding Remarks by the Outgoing President

Roederer indicated that the time had come for his concluding remarks as outgoing President. He began by commenting that, according to an old Austrian proverb, "all things have an end, except the sausage, which has two." So, although his term was ending, he would be around for four more years as past president. He mentioned that these have been four long and exciting years, indeed. At the personal level, particular excitement began when he moved to Alaska as Director of the Geophysical Institute in Fairbanks. This new position helped him broaden his horizon immensely, allowing him to perceive clearly the differences in idiosyncrasy and methodology among the various IUGG and IAGA disciplines, which were all covered by his Institute. He went on to point out that one of the most exciting aspects of his tenure as president was the personal contact and friendship established with so many scientists from so many different countries. He concluded his remarks by symbolically transferring the presidency of the Association to President-elect Keith Cole affirming, with the words of an old Argentine saying, that the Association was "very much alive and wagging its tail."

President-elect Cole expressed his gratitude to the Association for conferring this high office upon him. He expressed his hope to be able to maintain the high standards set by the previous leadership, and while he was aware of the heavy duty of the office, he was willing to take it on. He expressed his appreciation for the leadership provided by Juan Roederer, for the dedication and hard work the outgoing president brought to this strong and vibrant organization, and expressed his hope to be able to maintain these standards and perhaps even improve upon them. Roederer declared the CD closed at 1800 hrs.

### PRESIDENTIAL ADDRESS

Juan G. Roederer

During my first presidential address at the IAGA Scientific Assembly in Seattle, I broke with previous tradition and spoke about problems related to international science policy and international scientific cooperation. This time, however, under the watchful eye of our parent Union, I will return to the more traditional practice of focusing on matters specific to our Association.

During the past eight years, IAGA has gone through a big transition and evolution. Between Moscow and Grenoble it underwent a metamorphosis, emerging with a drastically new structure after the Kyoto Assembly. Between Grenoble and Canberra, it has had a chance of testing this new structure, and adopted new statutes and by-laws at the Seattle Assembly.

I believe that these changes were definitely not just changes in paper structure. There were changes in approach, in philosophy, and most importantly, changes in the pace and volume of our activities.

I believe that we have successfully completed a much needed transition from ceremonial traditionalism to scientific activism.

I believe that we have completed a transition from an instrument or technique-oriented structure to one that is discipline or program-oriented.

I believe that we are now an Association of the Union whose activities have fully turned toward truly serving its grassroot scientific constituency.

I believe that our Association has become *the* internationally recognized stable forum for magnetospheric physics, aeronomy, and solid-earth geomagnetism; that it is establishing itself as an important forum for ionospheric physics, and that it is beginning to play a useful role in solar wind physics.

Our Association is the first one of the Union which has the planets written into its objectives in the new statutes, and which at its meetings routinely deals with planetary magnetospheres, atmospheres and fields as a natural and logical extension of geophysics.

It is of course difficult to measure how successful all these transitions really have been. Three ways of testing come to my mind. First, to monitor the number and quality of papers presented at our meetings and the total number of participants. Or, perhaps a far more realistic measure of interest and effort to attend a meeting, to compute the total amount of participant-miles travelled per meeting. Such numbers indeed show that we have done impressively well.

Another way is to simply look at our mailing list. For instance, IAGA News is now distributed to 2400 addresses, compared to 1500 in 1975. Or the publications: statistics show that 86% of all IUGG publication sales pertain to IAGA publications.

Finally, less quantitative but perhaps even more relevant, is to observe the impact of IAGA's activities on other ISCU bodies. For instance:

URSI has reorganized its own structure and meetings by realistically taking into account IAGA's recent reorganization and the trends in scope, subjects and attendance of IAGA meetings.

COSPAR has decided to hold its meetings biannually instead of annually, out of phase with the IAGA scientific assemblies. Already, for years before, COSPAR has adjusted through active liaison with IAGA the topics for the meetings of its relevant working groups.

SCOSTEP has, from the very beginning, recognized the functions and the role of IAGA, and has drawn heavily on the talent housed in IAGA to staff its limited-duration projects. As a matter of fact, I believe that it is fair to say that in terms of magnetospheric and solar wind projects, SCOSTEP acts as a sort of "time-dependent arm" of IAGA! The International Magnetospheric Study is a case in point, whose official phase is ending but which has left a lasting impact on magnetospheric research in terms of data and information systems—not to speak of the new knowledge already gained.

So, where do we go from now? I said before that during the two previous Assembly periods, IAGA has gone through reorganization and testing of the new structure.

It is obvious that the next period should be one of consolidation. A period of adjustment, of fine tuning. Remove what did not work efficiently, fill in gaps, make better what is already good.

We have a very good chance of becoming "Number One" among international scientific non-governmental organizations dedicated to near-earth space, upper atmosphere and planetary magnetism. But we are far from being number one at home, for instance when it comes to financial support. We are one out of seven Union children. In Grenoble, mainly thanks to the efforts of our past president, Mme Troitskaya, the Union instituted categories of Associations with different levels of support. I believe that this process of reapportionment should be further refined, taking into account needs of the Associations, as for instance expressed by the number of symposia organized and papers presented, per period.

This task will not be easy. The Union itself is under great pressure. A radically new procedure by the ICSU of distributing its UNESCO appropriation to the Unions is in effect. There is a fixed allocation, independent of the size of the Union, plus contracts to support individual proposals from the Unions, reviewed and recommended upon by, believe it or not, ISCU's Finance Committee made up of seven members, about half of whom are biologists. Our Association will be in a real financial bind during the next period if we do not carefully learn the required game of grantsmanship that this new ICSU procedure warrants.

But it is not just a matter of finances. I feel that the representation of IAGA disciplines in the Union's governing bodies is in no way in proportion to our size and strength. This of course is a matter that only the national IUGG committees and their delegates can resolve. I suggest that IAGA devise a strategy to persuade its National Adherents to promote within their own countries a better representation of IAGA disciplines in the IUGG Council and Bureau.

Our first reorganization, the increased emphasis on space subjects, and the transition from

an instrument oriented structure to a discipline oriented structure, have led to what I sense is a certain degree of alienation of developing countries from the participation in IAGA affairs. Ways and strategies must be found to counteract this most undesirable trend. It is not to be solved by just staffing IAGA units with a token LDC scientist here and there. This procedure is neither honest nor effective in its ultimate purpose. I propose that IAGA develop a plan of what in my country is called "affirmative action"; in other words a plan of action in which the initiatives to engage developing countries in IAGA affairs come from the representatives of advanced countries, with special projects, programs or meeting topics targeted specifically to the interest of developing countries.

IAGA must keep a constantly watchful eye on developments in the reorganization of ICSU. IAGA in itself is bigger than quite a number of Unions. As stated before, we are being recognized as the stable forum for a large chunk of what one usually calls space research. Yet as just one of seven Associations of what really is a "superunion", we have no direct channel whatwoever to ICSU. I submit that it is time to start more than just thinking about this circumstance.

In terms of scientific activities in the future I have the following comments. First, I would like to see a strong involvement of IAGA in the Middle Atmosphere Program of SCOSTEP. As strong an involvement as was IAGA's participation in the IMS. The same applies to the IUGG-IUGS follow-up to the Geodynamics Project, recently named the International Decade of Earth's Crust and Mantle (IDECAM). But, if I may speak from my own experience with IMS, it is not enough to just participate in planning meetings. One must cause impact through constructive and innovative commotion!

I would like to see a strengthening of our role in solar wind physics and an expansion of our coverage of the aeronomy and magnetism of other planets.

Our improved relationship with IAMAP has not yet really come to any tangible fruition except for the conduct of some joint symposia.

In this coming period we must look into the second half of the eighties and we must keep constantly informed of what our member countries and other ICSU bodies are planning. Let us not miss the boat!

Now that the official observational phase of the IMS is nearing an end, IAGA should consider offering its auspices to the new services set up during the IMS, such as the Central Information Exchange Office, the Satellite Situation Center, the series of Coordinated Data Analysis Workshops, all of which according to general consensus, should continue in operation throughout the eighties.

And, last but not least, IAGA must turn aggressively to the new project-oriented, contract-oriented financing policy of ISCU to which I have referred before, to secure the support it needs by whatever means are called for—even if this requires open or behind-the-scene lobbying!

In the long range, IAGA's problems will be compounded by the increasing difficulty in many countries of securing adequate governmental support of basic science projects. Less and less is science left to take its own course of direction and course of action. More and more scientists are forced to achieve preset goals within preset times. As I already stated in my

Seattle address, there is a widespread trend in many countries of demanding from basic science societal relevance, immediate accountability and immediate applicability. This trend is prostituting basic research endeavours by tempting us protagonists into making unrealistic, unfulfillable, often outright dishonest promises to our sponsors.

In order for the IAGA to prosper scientifically, IAGA Executive and Division officers must not only be good and active scientists. They must be keenly aware of science policy issues and trends in the member countries, in order to steer the Association along a path that recognizes realities. However, for what its worth, the Association, through its constituency, must also contribute effectively to alerting the science administrators and state and political organs of its member countries to the true role and value of basic science for their well-being and economic strength in the long term. As centuries of history have shown, basic science has *shaped* our society. For it is from that basic science whose development is spurred by intellectual curiosity and by nothing else, that technology ultimately spins off. *Any* topic of basic science is relevant, no matter how removed from applicability it appears at one time or another during the course of its development—as long as it contributes to the understanding of our world and man's place in it.

IAGA deals mainly with basic research topics, although no doubt many of them have, or will have in the near future, a direct link to applied research. In view of our international character and the harmonious relationships, often strong bonds of personal friendships, among its constituent scientists from many nations and political systems, we are in a vantage position to join scientists from other disciplines in a missionary action on which, I submit, the future of human society may well depend: to preach on behalf of the salvation of basic reasearch.

### REPORT OF THE SECRETARY GENERAL

### N. Fukushima

It is a great honour for me to report to you the activities of IAGA during the past four years since the Grenoble Assembly held in September 1975. I assumed the position of Secretary General immediately after the Grenoble Assembly, and was at once aware of the great effort of my predecessor, Dr. Leroy R. Alldredge, and the past presidents who contributed greatly to the remarkable growth of IAGA activities. IAGA has now become the most active and probably the largest Association within IUGG.

IAGA's growth of activity is of course the result of the great effort by you and your colleagues over the past years. Unfortunately, during the last four years we have lost some of our distinguished IAGA scientists, such as Drs. Albert Price (U.K.), Jan Bouska (Czechoslovakia), David Knapp (U.S.A.), Ulf Fahleson (Sweden), Takao Tohmatsu and Naoto Kawai (Japan) and other who were seen often at past IAGA meetings. Other key persons who contributed very much to the IAGA activity in member countries have also passed away. They were Drs. Ispir (Turkey), D. C. Martin and W. Bullerwell (U.K.) Zhe-ming Chen (China), Y. Hagihara and Y. Aono (Japan) and others. It is practically impossible to list the names of all our deceased colleagues who supported our research work. I would like to ask you now to have a minute's silence to pay tribute to those colleagues of the IAGA community.

This Assembly in Canberra is the first occasion in the past 60 years' history of IUGG/IAGA to have our meeting in the Southern Hemisphere. Just prior to this Assembly IAGA held a major symposium on the International Magnetospheric Study in Melbourne organized jointly with SCOSTEP. Most of these participants have come to Canberra to participate in the IAGA Canberra Assembly.

In preparing the IMS symposium and this IAGA General Assembly, our colleagues in Australia have worked extremely hard to make our meetings enjoyable and successful. On behalf of all the participants I would like to express our sincere thanks to them, especially to Drs. Keith Cole, Dudley Parkinson, Peter McGregor and their colleagues.

In the preparation of the IAGA programs for this Assembly, the IAGA Programs Committee tried to avoid conflict with simultaneous sessions of IUGG symposia and those within IAGA as much as possible. Still, it is practically impossible to solve this problem because IAGA's activities are now so wide.

The main events of IAGA during the past four years are already known to you through the IAGA News. So I will not repeat them now. IAGA held its Third General Scientific Assembly in Seattle in August/September 1977 with IAMAP, and the Transactions of the Seattle Assembly published in 1978 describe every detail of this successful assembly. IAGA adopted the new Statutes and By-Laws at the Seattle Assembly, and now all IAGA administration is being conducted according to these new Statutes and By-Laws.

As to the implementation of the IAGA Resolutions of the Seattle Assembly, I received reports from Australia, Portugal, Spain and Sweden. It is clear that the resolutions have been very useful for improving the background for future development of research and study in geomagnetism and aeronomy. I will summarize this matter in the next issue of the IAGA News.

IAGA has a friendly relationship with its sister associations in IUGG, other unions or committees in the ICSU family such as URSI, IUPAP, IUGS, SCAR, COSPAR, SCOSTEP, and others. The reports of the co-sponsored international meetings have been published each time in the IAGA News.

IAGA News has been published on a yearly basis, but the publication of No. 18 has been postponed until early 1980, in order to report the important results of this Assembly to our colleagues who unfortunately are unable to attend. The IAGA News No. 19 will be issued at the end of 1980, and this will contain the information on our next Scientific Assembly which will be held in August 1981 in Edinburgh, as a result of the kind invitation of our British colleagues. Now the IAGA News is being distributed to about 2400 persons and organizations, an increase from approximately 1500 in 1975, which also shows the great expansion of IAGA's activity in recent years, including quite a number of new young colleagues. My wish is to distribute the IAGA News to all of our colleagues over the world, but in this I need your help to complete the distribution list. Please let me know the names and addresses of your new colleagues. I would also welcome your comments and advice on the IAGA News, and I am very grateful to those of you who have kindly supplied me with useful information for the IAGA community.

As to our other publications I have to mention the great effort of the International Service of Geomagnetic Indices which has been publishing these yearly publications for the entire geophysical community. All IAGA publications play an important role in the world geophysical community.

As to the finance of IAGA, I am now asking the Finance Committee to check the report for the past four-year period. IAGA allocated to each Division and Interdivisional Body some funds to encourage their own activities. This policy will be followed also in the next four-year period. Although the IUGG's financial situation is facing difficulties due to the world's inflation and IAGA cannot expect to receive more funds from IUGG, IAGA will try to use its funds as effectively as possible for the whole IAGA community.

I would like to thank all the IAGA member countries and their national correspondents who always make a great effort to obtain funds for their colleagues within the IAGA community. The success of this Assembly in Canberra owes a great deal to their efforts in obtaining travel expenses from their own sources.

Before I finish my talk, I would like to express our thanks on behalf of IAGA, to the leaders of IAGA Divisions, Interdivisional Commissions and Working Group, Topic Reporters and Working Group Leaders who devoted their time to the development of IAGA activities during the last four years. We thank also the convenors of various IAGA sessions of this Canberra Assembly for their great effort. Now I hope you enjoy this Canberra Assembly arranged by our Australian colleagues, and I believe that this Assembly will be a memorable milestone in the history of IAGA.

### Appendix 1.

### REPORT OF FINANCE COMMITTEE

The Finance Committee, consisting of R.G. Johnson, Chairman, H. Maeda and C.G. Sucksdorff, held a meeting on Friday, November 30, 1979 in Melbourne, and examined the finance account for the period 1 January 1975 to 31 December 1978. All the documents received from the General Secretary, Naoshi Fukushima, were very clear and had already been checked by the University of Tokyo Chief Accountant S. Ito.

At the beginning of the period the cash on hand and in banks amounted to \$31,201.52 and at the end of the period to \$32,168.87. A talk with the General Secretary revealed that a significant decrease of these funds is expected as a result of the expenses associated with the XVII General Assembly.

On the basis of the statement presented and the detailed information supplied by the General Secretary, which we deem satisfactory, we endorse the report and recommend that it be accepted.

We further propose that IAGA express its thanks to the General Secretary for the excellent management of the limited funds. Special thanks should go to the Government of Japan for considerable financial support, and to the University of Tokyo for its generous assistance, which have contributed in important ways to keeping the expenses to IAGA at a low level.

Melbourne, November 30, 1979.

H. Maeda

C.G. Sucksdorff

INTERNATIONAL ASSOCIATION OF GEOMAGNETISM AND AERONOMY

Financial Report for the Period 1975 - 1978

	GRANTS & CONTRACTS		×	×	×	×	×	×	0	0	0	0		0	4,000		0	0	0	0	0	0	4,000	0	4,000
	IUGG		3,426.50	0	584.60	8,987.23	5,042.41	0	8.639.80	0	14,596.31	0		1,593.12	10,058.14		0	8,446.07	23,312.92	0	0	276.78	84,963.88	32,168.87	117,132.75
Exchange Rate	EXPENDITURES	ADMINISTRATION		. (quarters (rents and services)	. Supplies and Equipment	. Communications	. Travel (administrative only)	. Miscellaneous					ASSEMBLIES	. Organization	. Travel	SYMPOSIA	. Organization	. Travel	SCIENTIFIC MEETINGS	GRANTS (Permanent Services, etc.)	CONTRACTS WITH UNESCO, etc	MISCELLANEOUS	TOTAL EXPENDITURES	CASH ON HAND & IN BANKS Dec 31, 1978	TOTAL117,132.75
Exch	EXPE	11.	11.1.	11.2.	11.3	11.4.	11.5.	11.6.	12.1	12.2.	12.3	12.4.	13.	13.1.	13.2.	14.	14.1.	14.2.	15.	17.	18.	19.	20.	21.	23.
dollars	GRANTS & CONTRACTS	×	0	7,000	0	×	×	4,000		0	4,000								0701 10 10	Dec 31, 1970	:	:			
Amounts in USA dollars	DOUL	77,400.00	×	×	×	5,477.92	3,053.31	85,931.23		31,201.52	117,132.75									Jan 1, 1975 1	:	:			
Aπ	RECEIPTS	16. IUGG ALLOCATION	2. UNESCO GRANTS	3. OTHER GRANTS	4. CONTRACTS WITH UNESCO etc.	5. SALES OF PUBLICATIONS	6. MISCELLANEOUS	7. TOTAL RECEIPTS	8. CASH ON HAND & IN BANKS	Jan 1, 1975	10. TOTAL117,132.75								-		24. ACCOUNTS KECELVABLE	25. ACCOUNTS PAYABLE			

Appendix 2a.

S. Ito, Chief Accountant Faculty of Science, University of Tokyo

Audited by

Date: 23 February 1979

# INTERNATIONAL ASSOCIATION OF GEOMAGNETISM AND AERONOMY

(FORM 2)

Financial Report for the Year 1978

Amounts in USA dollars

Exchange rate....

	S								- 8	Арр	endi	x 2t	).			
GRANTS &	CONTRACTS	×	0	0	0	0	0	0	0	0	0	0				
IUGG		7,653.04	11,277.53	0	0	5,322.81	0	0	12.71	24,266.09	32,168.87	56,434.96				
EXPENDITURE		11. ADMINISTRATION	PUBLICATIONS	ASSEMBLIES	SYMPOSIA	SCIENTIFIC MEETINGS		GRANTS WITH UNESCO etc	MISCELLANEOUS		CASH IN HAND AND IN BANKS Dec. 31, 1978	TOTAL	Dec. 31, 1978	0 0	0 0	
EXP		11.	12.	13. /	14.	15.	17.	18.	19.	20.	21.	23.				
GRANTS &	CONTRACTS	×	0	0	0	×	×		0	0	0		1978	0	0	
INGG		24,700.00	×	×	×	785.26	406.26	25 801 52	27,071.72	30,543.44	56,434.96		Jan. 1, 1978	0	0	
RECEIPTS		16. IUGG ALLOCATION 24,700.00	2. UNESCO GRANTS	3. OTHER GRANTS	4. CONTRACTS WITH UNESCO etc.	5. SALES OF PUBLICATIONS	6. MISCELLANEOUS	7 TOTAL BECEIDT	8. CASH ON HAND AND IN BANKS	Jan. 1, 1978 30,543.44	10. TOTAL			24. ACCOUNTS RECEIVABLE	25. ACCOUNTS PAYABLE	

Break-Down of Item 11	Break-Down of Item 12	
11.1 Personeel 1,800.00	12.1 C.R. Seattle Assembly 6,739.80	
11.2 Quarters 0	12.2 C.R. Symposia 0	Date: 23
11.3 Supplies and Equipment 584.60	12.3 Periodicals (IAGA NEWS) 4,537.73	חמרה. בה
11.4 Communications 3,484.60	12.4 Others 0	
11.5 Travel (administrative) . 1,783.84	Total 11 277 53	1

Total ..... 7,653.04

February 1979

N. Fukushima Secretary General, IAGA

### DETAILED BREAKDOWN OF THE PROPOSED IAGA 1980-1983 BUDGET

Appendix 3.

For	Amount	Remark
Publications Secretariat Administration Assemblies Allocation to Division I  "Division II  "Division III  "Division IV  "Division V  "Antarctic Res. Comm. "History Commission "Middle Atmosphere Comm. "Ext/Int. Interdiv. WG	\$ 35,000 28,000 14,000 5,000 6,500 6,500 3,500 5,000 500 1,500 1,500	2 Transactions and 4 News mainly postage, 0 for quarters organization and travel  These may be used for administration, internal publication, and travel support, and others.
"IAGA/URSI Joint WGs Permanent Service of Geomag. Indices Miscellaneous IUGG Travel Grants IAGA Participation in ICSU Programs	1,500 4,000 2,000 6,000 12,000	Support to ISGI Bank handling charge, etc for developing countries Approval by EC required

Total: \$133,000

# MINUTES OF THE IAGA EXECUTIVE COMMITTEE

# during the XVII IAGA General Assembly Canberra, Australia

The IAGA Executive Committee (henceforth EC) met 10 times during the Canberra Assembly as shown below.

December 3, 0700-0900, 1215-1345\*; December 4, 1930-2150; December 5, 1930-2200;

December 11, 0700-1100; December 12, 0830-1015\*, 1400-1700, 1900-2100\*\*;

December 13, 1500-1550, December 14, 0800-1000\*.

(Remark \* with Division and Interdivisional Body leaders

\*\* with IAMAP Executive Committee)

All EC members were present except G. M. Weill and M. Ackerman who expressed regrets for their absence. V. Bucha missed the first meeting because of his travel schedule, and A. J. Dessler had to miss the last 5 meetings because of his early departure from Canberra.

The minutes of the meetings with the leaders of IAGA Divisions and Interdivisional Bodies and with the IAMAP EC are given separately. The following is a summary of discussions of the IAGA EC meetings only, without keeping the chronological order of discussions.

### I. Approval of the Agenda

Roederer informed the EC that he and the Secretary General recommended a different ordering of Agenda items than that originally submitted to the EC members. The reason for the changes was a need to phase subjects with the course of events expected during the Assembly. After some minor changes the schedule was approved.

### II. Minutes of the Previous Meeting and Matters arising from the Minutes

No corrections of substance were suggested and the minutes were approved. Roederer led off the review of matters arising from the minutes, pointing out that the proposed change in Bylaw 16c had been accomplished at the Conference of Delegates. One matter still needing implementation is organization of the Interdivisional Commissions so as to satisfy Division representation (p. 19, minutes La Londe) Roederer referred to some action items suggested at La Londe concerning the subject of COSPAR reorganization. These, however, were not implemented. He had deemed it inappropriate to prepare a IAGA position paper on the subject at the suggested time, and he had been unable to attend the Bangalore meeting.

### III. Report on the IUGG Executive Committee and Council Meetings

Roederer explained that three series of meetings take place one after another, with nearly

the same agenda: 1. IUGG Bureau, 2. IUGG Executive Committee, 3. IUGG Council. He mentioned, in passing, the poor representation of IAGA-affiliated persons in all these bodies.

Some information items were:

- (1) Strong action will be taken against those member countries in arrears.
- (2) A new scheme is in effect at ICSU for distribution of UNESCO funds to the Unions: a fixed sum is given to each one irrespective of its size; beyond that, funds are made available on contract basis. In order to share in the money, IAGA must develop skills in grantsmanship. The IUGG Secretary General has been asked to supply to the Associations the rules and regulations governing these grants and has indicated that each Association should set up a scheme by means of which proposals are routed within the Association to its Secretary, who then is to submit these to IUGG. The Union will *not* make judgements of proposals from Associations because ICSU's Finance Committee will consider projects individually, and without regard to their origin. In addition, Roederer reported that the ICSU subcommittee on Scientific Priorities is requesting proposals for special projects for the period 1984–89 (separate from the yearly contracts with the Unions), to be submitted by August 1, 1980.
- (3) The Union will be unable to increase its allocation to the Associations in spite of an expected 15% increase in income from dues.
- (4) Roederer said that the structure of ICSU is under study. The suggestion seems to be that there should be groups of Unions, and that more power be given to the Unions. On the other hand, there is talk of a "bicameral" structure for ICSU, with a scientific body and a governmental body ruling the organization. Roederer said that this could be the end of ICSU.
- (5) The changes in statutes proposed by the IUGG Bureau were all approved by the Council. The main gist of these changes was to remove veto power of the Assembly over items passed by the Council. Also, the Bylaw stating that Associations cannot hold meetings on their own during IUGG General Assemblies was removed.
- (6) The IUGG Bureau has authorized funds for the follow-up program to the Geodynamics Project, the new International Decade of the Earth's Crust and Mantle, IDECAM, to be provided in 2-year cycles. Carl Kisslinger will be chairman of the Steering Committee.
- (7) IUGG President Ashour urged that participation of developing countries in Association affairs be substantive rather than token.
- (8) Roederer reported that a discussion was held on Union representation in various ICSU Scientific and Special Committees, Interunion Commissions and Services. The two representatives in SCOSTEP (Roederer, Belmont) will remain until the end of 1980. IAGA and IAMAP will be asked to propose the new representatives next year.
- (9) The Union lectures will be taped this time and will appear in the IUGG Chronicle. Melchior has requested that the Associations prepare 3-4 page reports highlighting their meeting activities, also to be published in the Chronicle.
- (10) Proposed meeting places were discussed for the 1983 IUGG Assembly. The proposals from the Federal Republic of Germany, India and Chile must be voted on at the second IUGG Council Meeting on 14 December.

Finally, Roederer mentioned that the question of the membership of China was again brought up. A tricky problem is that there seem to be two ICSU bodies which will have both Chinas as members, like the two Koreas, Germanys, etc.

### IV. Preparation for the IAGA Conference of Delegates (CD) during the Canberra Assembly

The Committee then turned to the preparation for the first CD (scheduled on 3 December afternoon) of the Canberra Assembly. It appeared that only three items will require voting, i.e. concurrence with EC decisions taken in La Londe des Maures, ratification of new Division leadership, and the proposed change in bylaws. The remaining items will be for information only. The address of welcome is to be given by Dr. W. D. Parkinson.

Some problems encountered with the Nominating Committee were discussed; it had proved impossible for them to prepare a slate in time for the first CD; however the voting procedure calls for nominations to be made known to the Chief Delegates at the latest by Tuesday (4 December) evening and this deadline would be met. Additional nominations have to be submitted to the Chairman of the Nominating Committee by Thursday (6 December), and the ballots are to be received by Saturday (8 December) evening. The candidates for the scrutineers were also considered.

For the second CD (scheduled on 13 December), all the decisions of the EC meetings during this Canberra Assembly are to be reported in addition to the scheduled agenda (Resolutions, Finance Committee Report, etc.).

### V. Review of IAGA Activities

Fukushima stated that a number of reports from Working Groups and Commissions have been received and expressed his hope that a complete set would be available for publication in the next IAGA Transactions. He further reported on the receipt of a proposal from the British National Committee about possible improvement of the internal IAGA structure, which was forwarded to the pertinent Division leaders. A lengthy discussion ensued on where best to fit the British proposal to give an appropriate slot for the phenomena that result from dynamo action in the ionosphere and oceans such as Sq and L. Consensus of the EC was to recommend to the Interdivisional Working Group on External/Internal Variations that they broaden their scope to include the subject of Lunar and Sq variations.

Roederer reminded the EC that, in accordance with Bylaw 2, it is required to review the productivity of the Divisions and Working Groups. Gadsden inquired about the activity of the Interdivisional Commission on the Middle Atmosphere. Fukushima reported that they had been asked to establish their internal structure. Roederer stated that there should be an effort of this Commission to interact with other Divisions. Gadsden and Roederer will confer with Megill upon his arrival. It was also reported that Fukushima was informing the Interdivisional Commission and Working Group Chairmen to make efforts to make these bodies truly interdivisional.

Dessler mentioned that he and Cole had discussed the fact that not much is being done about inclusion of developing countries in IAGA activities. Perhaps some meaningful offices could be created within each Division, such as assistants to the leaders so that scientists from LDC's may acquire knowledge and gain experience in IAGA affairs. Roederer suggested the establishment of an Interdividisonal Commission on Education and said that the Union is embarked on such a project. A lively discussion ensued, with Roederer commenting that such approaches are often rejected by developing countries for lack of relevance to their current problems. Troitskaya agreed that it would be difficult but not impossible to find the

appropriate subject. Roederer commented that a Mayaud-type trip of a scientist from an advanced country travelling under IAGA sponsorship to developing countries would be useful. Roederer and Troitskaya agreed that to succeed, the approach must be "revolutionary" and insure that IAGA can be truly influential in its implementation. The EC agreed to establish an ad hoc Committee with the charge to recommend to the EC in 1980 the possibility of formation of an Interdivisional Commission to Stimulate IAGA Sciences in Developing Countries. The ad hoc committee should also propose means of operation, programs and possible activities (working groups or symposia) for IAGA Assemblies on the subject in question. Consideration then turned to the make-up of this ad hoc committee. It was agreed that the new and the past IAGA President should comprise this ad hoc committee and that they should prepare a plan of action for presentation at the next EC meeting.

It was introduced that there were inquiries why the excellent Reporter Reviews are not published all together in one place. A discussion ensued about the desirability of doing this and possible ways and means. Although no conclusion was reached, this is a matter that should be discussed again at some future date.

### VI. Liaison with IAGA National Bodies of Member Countries

Fukushima reported that contact with the National Bodies had been good, and that many requests have been received from developing countries for IAGA News. He added that the IAGA News has been distributed also to 19 organizations and 30 individuals in 21 non-member countries. Roederer commented however that the number of responses to Fukushima's request for comments on the effect of the resolutions has not been as good as hoped for. Gadsden said that this should improve since in future the names and addresses of the original proponents would be on record.

It was felt desirable to express IAGA's gratitude to those member countries that hosted in recent years successful international conferences in the field of IAGA's interest, including IMS and other projects, with or without the cosponsorship of IAGA.

### VII. Cooperation of IAGA with Other Association or Inter-Association Bodies within IUGG

Fukushima reported that at present the only Interassociation body within IAGA is the joint IAGA/IAMAP Advisory Board. The joint IAGA/IAMAP EC meeting to take place next Wednesday evening, will discuss how this Advisory Board will function.

Fukushima reported on the IAGA representatives on IUGG committees; i.e. Committee on Geochemistry (Weill is IAGA Representative), Committee on Advice to Developing Countries (Ashour is chairman and may also be considered the IAGA representative), and the Committee on Mathematical Geophysics (where Runcorn may be considered the IAGA Representative). A discussion ensued about the known activities of these committees, with Roederer commenting that the committee dealing with developing countries might be a point of contact for IAGA's *ad hoc* committee.

Fukushima continued his report on this agenda item, relating that a letter was received from Shebalin, requesting support for the IUGG ad hoc Working Group on Earth Parameterization. A lengthy discussion followed when the EC tried to determine what support could reasonably be provided and who could best do it. It was noted that while

parameterization is possible in solid earth geophysics and on some long-term aspects of the oceans and the atmosphere, IAGA deals mostly with rapidly varying systems for which parameterization does not make much sense. Agreement was reached that Roederer would contact Dr. W. Olson to determine what interaction there has been with that WG and then try to talk with Shebalin to determine exactly what kind of input he was expecting from IAGA.

Concerning the ELAS project, Fukushima stated that IASPEI has expressed a desire for better cooperation.

# VIII. Cooperation of IAGA with URSI, COSPAR, SCOSTEP, and other ICSU Bodies

Fukushima reported that IAGA had good relations with URSI. Four Joint Working Groups exist which meet at General Assemblies of IAGA. The EC agreed to make an official statement that this cooperation be continued through these four Joint Working Groups. It was reported that Roederer had sent a congratulatory message when URSI celebrated its 60th Anniversary in September 1979. A brief discussion followed about the time conflict with the next IAGA Assembly (3–15 August 1981) and the next URSI General Assembly (10–17 August 1981). The Division leaders have been alerted regarding the partially overlapping dates.

The COSPAR report on its XXII Meeting and Associated Activities in Bangalore will be part of the next issue of IAGA News. From 1980 on, COSPAR will hold its meetings in even years, which will avoid conflict with IAGA Assemblies. On the COSPAR Panel on Potentially Environmentally Detrimental Activities in Space, Weill is the IAGA and IUGG representative. This panel has been working very well. the COSPAR Meeting in 1982 (Toronto, Canada) will also feature the regular 4-year cycle STP Symposium.

The relationship with SCOSTEP was reported to be excellent. Cole, President of SCOSTEP, reported that a financial problem may arise now that SCOSTEP has been made a Scientific Committee; such ICSU Committees are not normally supported by the Unions. Roederer mentioned that there are several areas where IAGA has strong interactions with SCOSTEP, for instance the Data Analysis Phase of IMS, MAP, STIP, SMY, the Committee on Sun-Weather Relations, etc. Agreement was reached that a strong recommendation would be made to IUGG emphasizing the importance of continued support to SCOSTEP by the Union even if it is now a Scientific Committee. In addition, a recommendation by IAMAP to the same effect should be solicited. A new SCOSTEP constitution has been drafted in which more influence will be given to the national representatives, giving them a say in the selection of the chief officers. Ratification of the constitution will take place at the Budapest meeting. So far as programs are concerned, Cole mentioned that all are going very well. The STP meeting in 1982 will follow the pattern of past meetings and will be held in association with COSPAR.

Troitskaya asked whether a possible date could be determined for the IMS meeting recommended by the IMS Steering Committee to be held in the USSR. The EC reviewed the various dates of STP, IAGA and IMS-related meetings already firm and known at this time, and concluded that it would be difficult to fit such an IMS meeting within the time frame 1981–1983.

Fukushima reported that the ISCU Panel on WDC's is very active now. Copies of the Panel's Fourth Consolidated Guide to International Data Exchange has been sent to IAGA National Committees as well as principal institutions and observatories. The Commission on Cosmic Rays of IUPAP is planning a joint meeting with IAU, and the next one is proposed to

be held jointly with IAGA in three years. Roederer commented that he felt it very important for IAGA to become involved with interplanetary space programs.

Fukushima continued that Nagata, the IUGG representative to SCAR, had pointed out the lack of formal IAGA representation on SCAR's permanent Working Group on Upper Atmosphere Physics. this was brought to the attention of the IUGG Executive Committee. There was consensus that Nagata would be the IAGA representative.

### IX. IAGA's Participation in the Middle Atmosphere Program and other International Projects (including cooperation with IAMAP)

Fukushima stated that a report has been received from Taubenheim on MAP, in which he states that he will attend the 1980 MAP Steering Committee meeting. Gadsden related that the Interdivisional Commission on the Middle Atmosphere would work closely with Divisions II and III, and that the following symposium is planned: four half-days during the second week in Edinburgh (Middle Atmosphere Scientific Symposium I), and four half-days during the first week in Hamburg (MASS II). This symposium will be closely coordinated with Ruttenberg through a joint Program Committee. Gadsen further related that Megill is planning a session on the measurement of solar maximum effects on the mesosphere.

A brief discussion ensued about the composition of the Joint Advisory Body with IAMAP, noting the lack of a IAMAP representative for ICMUA. It was decided that an offer would be made to IAMAP to have an additional representative in the Joint Body (i.e., four vs. three from IAGA). Gadsden commented that Rishbeth will head the program committee for MASS but may want to appoint his own deputy. He continued that current plans are to ask Rostoker to appoint M. H. Rees as Division II representative, which was later confirmed.

Roederer referred to the letters received from Valencio and Bucha on the IUGG Task Group on Post-International Geodynamics Program Planning. Future IAGA representation on IDECAM was discussed and it was agreed to designate Valencio in that capacity.

#### X. IAGA Cosponsorship of International Conferences

Fukushima reported on the cosponsorships approved at the previous EC meeting. Reports on these meetings will be included in the next issue of the IAGA News. The IAGA/URSI Joint Working Group was responsible for IAGA Session II-1 at this Canberra Assembly. The session was sponsored through COSPAR and URSI.

SCOSTEP had asked for IAGA cosponsorship of the STIP Workshop on Solar Radio Astronomy, Interplanetary Scintillations and their Co-ordination with Spacecraft at Culgoora, Australia, in November 1979. Gringauz was the IAGA representative although he could not attend. The IAGA cosponsorship was given to the Symposium on Middle Atmosphere Dynamics and Transport to be held in Urbana, Illinois, U.S.A. during July 28-August 2, 1980 and Megill was appointed IAGA representative. Roederer commented that the above were requests for cosponsorship of "category 3" meetings which require only president's approval, since they were of a regional nature and required no money.

Three requests received from COSPAR, however, should be approved by the EC. These are: (1) Symposium on Progress in Planetary Exploration; (2) Symposium on Cosmic Rays in the Heliosphere; and (3) Symposium on Active Experiments in Space Plasmas. The requests were discussed and conclusion was reached that a letter would be sent to Dr. Denisse,

informing him that cosponsorship had been approved for Symposium 1 (N. F. Ness will be the IAGA representative), and that cosponsorship of Symposium 2 is approved (name of IAGA representative will be informed when it is decided). Symposium 3 had been earlier approved by IAGA.

The EC also considered and approved sponsorship and financial support (to the extent of travel for the IAGA representative) of the Sixth International Symposium on Equatorial Aeronomy (SEA), scheduled for 17–24 July 1980 in Puerto Rico. Dr. H. Rishbeth will be the IAGA representative.

It was reported that IAGA Working Group I-3 planned to have its Fifth Workshop on Electromagnetic Induction in the Earth and Moon during 17–24 August 1980 in Istanbul, Turkey. The EC agreed to give IAGA cosponsorship to this workshop.

The IAGA cosponsorship was also extended to the Workshop on Latin American Geomagnetic Observatory and Survey Practice (20–26 July 1980, in Rio de Janeiro) as a category 3 conference. K. L. Svendsen is included as a coorganizer.

Roederer brought up the matter of the complaint from one individual British scientist concerning his short notice of a recent IAGA-sponsored meeting. The EC discussed this in some detail and concluded that the British Chief Delegate will be informed that the EC appreciates being made aware of this incident and that it will keep the requirement for reasonable advance notice in mind when considering future requests for sponsorship. No action was deemed necessary to amend in any way the La Londe action which clarified the rules governing cosponsorship of international meetings. (IAGA News 17, p. 26)

#### XI. IAGA Publications

Fukushima reported on the publication of the IAGA Bulletin series as follows.

- No. 41 IAGA Transactions of the Third General Scientific Assembly, Seattle, U.S.A., 22 August-3 September 1977 (appeared in August 1978). Price \$10
- No. 42 Program and Abstracts of the Symposium on the International Magnetospheric Study, 27 November-1 December 1979, Melbourne, Australia. Price \$3
- No. 43 Program and Abstracts of the XVII IAGA General Assembly, Canberra, Australia, 3–15 December 1979. Price \$5

It was also reported that IAGA Bulletin No. 32—series "Geomagnetic Data (Indices, Rapid Variations, Special Intervals)" have been published regulary on a yearly basis, with the effort of the International Service of Geomagnetic Indices, De Bilt, Netherlands, despite the reduction of financial support from UNESCO.

The IAGA EC agreed to express its thanks to Dr. D. van Sabben for his continuous effort to maintain the ISGI service. It was also introduced that 86% of the IUGG publications sales are IAGA Bulletins, showing the usefulness of IAGA publications in the world geophysical community.

As to IAGA News No. 18, which will contain the brief summary of the Canberra Assembly, it was agreed to delay the printing schedule to February 1980, in order to include the French translation of the Canberra resolutions. It was reported also that the need for IAGA News is increasing steadily (now 2400 copies in comparison with 1500 in 1975).

#### XII. IAGA Finances

Roederer asked the EC to review the Financial Report prepared by Fukushima, covering the period 1975 through 1978 (shown on p. 18) and the Estimate of Income and Expenses for 1979-1982. Alldredge conveyed a message from the IUGG Treasurer that a small technical amendment was necessary in the Finance Report for 1975-1978 regarding the grants from UNESCO and IUGG. Fukushima commented that the Financial Report for 1975-1978 was already checked by the Finance Committee, and its report was to be presented to the second Conference of Delegates. He also emphasized that the IAGA's balance is not at all strong despite the impression from the figures in the report, because the cash on hand and in banks on December 31, 1978 contained a considerable amount of funds reserved by Divisions for use for this Canberra Assembly. A lengthy discussion followed when confusion arose over carry-forward funds, actual balances available to the new Division leaders, how to determine the true costs of the EC meetings, and how to provide for desired support of specific limited duration projects. Three recommendations emerged concerning the budget preparation; (1) Roederer recommended that the new EC develop an internal budgeting procedure running on periods (as defined in Statute 5) rather than on calendar years, which will provde a clearer break-down of what funds are available for administrative purposes; (2) Roederer also stated that the new Division leaders will have to be informed exactly on what funds are available for their Division for the interval 1980-1983; (3) Cole recommended that a line item be included in the internal IAGA budget to provide \$12,000 for IAGA participation in ICSU programs (with provisional amounts of \$4,000 for MAP, \$4,000 for the IMS Data Analysis Phase, \$2,500 for SMY, and \$1,500 as an inflationary cushion). Gadsden commented that this reduces the expected cash-in-hand balance by \$12,000 and will be in keeping with requests from the Union to reduce this balance. Corresponding adjustments were then made on the Estimate of Income and Expenses for 1979–1982. Roederer stated that this action will be explained to the Delegates when the budget is presented to the CD. A motion that the amended finance report be accepted was approved (see p. 20).

#### XIII. Resolutions

The proposed resolutions were discussed one by one and reviewed for intent, appropriateness, preciseness of wording and content. Two resolutions of the draft submission were deleted; the EC requested the President prepare instead a letter of appreciation to the Canadian Government about the establishment of the Yellowknife Magnetic Observatory, and a letter of thanks to the Soviet Geophysical Committee for the organization of the Workshop on Solar Wind Studies. Another resolution was deleted as inappropriate in intent for the subject of a resolution. Two other resolutions were referred back to the originators for clarification of language. Roederer stated that he would rearrange the order of the remaining resolutions in order to group according to subject areas.

Roederer reminded the EC that some matters had arisen at previous EC meetings which might be translated into resolutions, namely the continued support by the Union of SCOSTEP which has now become a Scientific Committee; the representation on the Union Council which does not adequately reflect the strong activity in IAGA disciplines in countries where this is the case; and that it might be desirable to focus IUGG attention on the need for continued support of basic research. A lengthy discussion ensued about these matters, with Cole commenting that

the statistics of the Union Council representation should be brought to the attention of the national bodies and should be an IUGG resolution. On a resolution about basic research, Roederer prepared draft resolutions for review by the EC.

Later when the final draft of resolutions was discussed again just before the second CD, Gadsden related matters arising from the resolutions: two letters need to be written by the President in lieu of the proposed resolutions; a request from the Interdivisional Commission on History would be deferred to the next EC meeting; concerning J. W. King's request for a resolution: the EC agreed to make this into a resolution proposed by the EC which would be presented to the CD.

### XIV. Information on the Fourth General Scientific Assembly in Edinburgh, 3–15 August 1981

Fukushima reported that a local organizing committee had already been established for the Edinburgh Assembly and informed that this committee had written to him, asking for a loan from IAGA. Gadsden explained that this money was needed to go ahead with the printing and preparation of the Circulars and that it would be repaid to IAGA after recovery from registration fees. After a thorough discussion, agreement was reached that IAGA would advance \$2,000 for the printing of the First Circular, and that the situation would be reviewed again at the next IAGA EC meeting.

As to the scientific programs for the Edinburgh Assembly, the proposals from Division leaders were thoroughly reviewed. Some Divisions proposed quite a number of sessions despite the preliminary allotment of 10–14 half-day sessions per Division, Division I proposed parallel sessions without causing conflict of interest within the Division. Regarding Division III, it was agreed to add a Symposium on Planetary Magnetospheres and a Symposium on the Voyager Saturn flyby, in order to meet the proposal from the U. K. National Committee and to note that COSPAR could well sponsor the Saturn symposium because of no COSPAR meeting in 1981. It was also noted that the proposals from Divisions I and V on the use of MAGSAT results would be more effective if they combined.

Some discussion ensued about how to proceed with the proposed programs. Troitskaya proposed that the Conference of Delegates should be told that the EC agrees in principle with the proposed sessions, but that specific details of overlap, cosponsorship and precise session titles will have to be worked out later by the new Program Committee.

#### XV. Other Business

Roederer reported that Rostoker had declined the appointment offered by the IUGG EC as alternate IUGG Representative to COSPAR. After some discussion, the EC agreed that Roederer should be designated in such capacity. Melchior will be notified of this decision (note: the IUGG Executive Committee later appointed Roederer principal IUGG Representative; no alternate was designated).

The additional nominations for Division leadership were reviewed and approved. Discussion again ensued about the poor geographic distribution in Divisions I and III. Gadsden commented that in the case of Division I, the selection of the Working Group leadership reflected rather a parochial attitude. Alldredge pointed out that the Bylaws as they stand empower the Divisions to elect their own Working Group leadership.

Roederer continued with the review of changes in structure and of the topics submitted by the Divisions. There was some discussion about proposing a change in the By-Laws to require approval by the EC of Division structure, in order to rectify the problem of inadequate geographic distribution of working group leaders. It was agreed that not much could be done to change the present slate, except to add some key members and thereby improve the geographic distribution. Roederer again suggested that the new EC may seriously wish to consider a change in Bylaws to address this problem. Furthermore, he said it would be pointed out to the Division leaders that one person should not hold 2 offices within the same Division. The size of working group or commission membership was also discussed, and this may be considered at the EC meeting in 1980.

Roederer stated that Fukushima had requested the appointment of an assistant to deal with financial matters in the Secretary's absence and empowered to deal with the IAGA Account in Tokyo (but always under the direction of the President). It was agreed to appoint T. Oguti as requested.

Possible dates for the next EC meeting were discussed. Cole stated that Dessler would arrange a suitable place in the US, and this was approved. The tentative dates would be 2–3 days at the end of October 1980.

After thanking all EC members for their hard work during these past two weeks of Assembly, Roederer declared the 1979 meeting of the IAGA Executive Committee closed.

# MINUTES OF THE IAGA EC MEETING WITH DIVISION LEADERS

#### I. Meeting on 3 December, 1215-1345

Division leaders present: B. A. Tinsley, C.-G. Fälthammar, K. I. Gringauz, H. B. Garrett (for E. J. Chernosky).

Roederer welcomed the Division leaders. The purpose of the meeting was to discuss the scientific leadership of the Divisions and Commissions during the next four-year period. He asked the Division leaders to report on their candidate nominations. He reminded everyone that the final slate would be reviewed by the Executive Committee in executive session to ensure as fair a geographic distribution as possible, that the EC may add names by executive action, and that final ratification must come from the Conference of Delegates.

The Division chairmen reported on their lists of candidates; the Secretary General reported for Divisions I and V whose leaders were not present, but whose recommendations he had received in writing.

The list of candidates was discussed at length. Roederer requested comments from all present concerning their knowledge of the candidates and how they would fit into the desired geographic and discipline distribution. The final slate of candidates agreed upon in executive session by the EC for presentation to the Conference of Delegates at the Plenary Session on Monday, 3 December, at 2 p.m. was as follows:

Division I	D. I. Gough (Canada)—Chairman
	A. N. Pushkov (USSR)-Vice-chairman
	one more to be named later

Division II	H. Rishbeth (UK)—Chairman
	M. H. Rees (USA)—Co-chairman
	P. Bauer (France) —Co-chairman
	A.D. Danilov (USSR)-Co-chairman

Division III	G. Rostoker (Canada)—Chairman
	A. Nishida (Japan)—Co-chairman
	R. G. Rastogi (India)—Co-chairman
	M. I. Pudovkin (USSR)—Co-chairman
Division IV	H. Rosenbauer (FRG)—Chairman

	T. Gombosi (Hungary)—Co-chairman	
	L. F. Burlaga (USA)—Co-chairman	
Division V	C. G. Sucksdorff (Finland)—Chairman	

Division V C. G. Sucksdorff (Finland)—Chairman three co-chairmen to be named later

The additional Vice-chairman and three co-chairmen must be named by the Division leaders of Division I and V respectively. These additional names will be presented to the Conference of Delegates at the second plenary session for ratification by the Chief Delegates. [Remark: The EC approved later the request from Division I that it needs three vice-chairmen to cover the wide subjects of Division I.]

There was not sufficient time left to discuss the candidates for the Inter-Divisional Commissions and Working Groups. Roederer asked Garrett to consult with his colleagues in the Interdivisional Commission on History and prepare a list of candidates. It was agreed to ask other Interdivisional Body leaders to show the candidates of new leaders at a subsequent EC meeting before the second Conference of Delegates.

# II. Meeting on 12 December, 0830–1015 and on 14 December, 0800–1000

These meetings were held with the attendance of the new and old chairmen of IAGA Divisions and Interdivisional Bodies. The attendants except EC members are: K. M. Creer, D. I. Gough, B. A. Tinsley, H. Rishbeth (on 12 only), K. I. Gringauz (on 12 only), C. Sucksdorff, L. R. Megill (on 12 only), T. Nagata (on 12 only), E. J. Chernosky (on 14 only), H. B. Garrett (on 12 only), S. R. C. Malin, and D. A. Valencio (on 12 only).

After welcoming the new and old Division and Interdivisional Commission chairmen, Roederer stated that the purpose of this meeting was for the new leaders to become acquainted with the EC, its operations, philosophy, and its relationship with the Divisions and Commissions. Under the new structure of IAGA, the Divisions and Commissions are the scientific backbone of the Association and the role of the EC is to provide the necessary administration, trying to keep to a minimum the interference in the scientific affairs of the Divisions. The EC must, however, ensure that equilibrium is achieved within the Divisions and Commissions in the selection of representatives, disciplines and topics for symposia. Sometimes this requires executive action that may not please the Divisions and Comissions. Roederer reminded the Division leaders that IAGA is an international Association, that there is competition between Divisions, between Associations and between countries. Except for financial matters, within the IAGA all are equal, no matter how small or large the scope of scientific activity in a given country. The Association must serve equitably constituents with a tremendous variety of scope and scientific expertise. Roederer then stated the agenda items for the joint meeting:

(1) Division Chairmen's comments on the mechanics of the Canberra Assembly; (2) proposed topics for the Edinburgh Assembly; (3) budgeting for special projects; and (4) some long-term business of the Association. However, because of the time restriction, the discussion was limited to the items (1) and (2).

#### 1) Comments on the mechanics of the Canberra Assembly

Gringauz stated that no papers or symposia had been scheduled on cold plasmas in space. Roederer commented this might indicate there were no relevant results to report. Gringauz did not concur and responded that this topic should be specifically selected for a future meeting. A brief discussion ensued about the desirability of the selection of specific and

restricted topics for IAGA scientific sessions. General consensus was that this was desirable, provided that sufficient time was left for general contributions. Roederer stated that the EC would take note of Gringauz' remark concerning cold plasmas.

Garrett commented that the poster sessions were poorly organized, in that no specific time or place had been scheduled. Comments ensued with a general consensus emerging that it would be desirable to set aside a specific time, during the day, for these sessions. Roederer remarked that in many countries poster sessions are still considered "second rate" presentations, which is not the case at all. Garrett continued that he had found no organized system for distribution of preprints. Rishbeth responded that it was a good feature of IAGA that no preprints were required from the authors. Garrett further stated that the lack of papers in the History Commission was due to not being able to find a journal willing to publish such articles. Troitskaya recommended that he get in touch with Powsner who is editor of such a journal in the USSR.

A discussion then ensued about how to handle cancelled papers and how much time shifting in the schedule could be allowed. General consensus was that the schedule should be adhered to with no more than a 5-minute shift and that the extra time could be used for discussion. Gough stated that his Division had used late papers to fill in the gaps, but Roederer responded that acceptance of late papers should be discouraged as much as possible. Tinsley stated that the rule permitting only authors or co-authors to read papers was inhibitive; however, Roederer responded that this was a Union rule and that it had been made for specific reasons to avoid that one person would read a number of papers, without being able to comment on them with any expertise.

In conclusion of this item, Roederer encouraged the Division and Interdivisional Commission leaders to prepare a summary of their constructive criticism on the mechanics of the Canberra Assembly, so that these could be taken into account by the EC for the Edinburgh meeting.

#### 2) Proposed Topics for Edinburgh

The Division leaders presented in turn their proposed schedule and request for time allocation. These were discussed at great length and were considered later by the EC in executive session.

Roederer reminded everyone that, as in the past, the Scientific Assembly Program Committee will be chaired by the Secretary General; during the 1980 EC meeting, the EC will then become the Program Committee for just a few days, during which time the final schedule will be defined. Scheduling the sessions with minimum overlap or conflict usually proves to be a very difficult task. Division chairmen should set up their programs keeping this clearly in mind. When appointing conveners, care must be taken to select persons who will actually do the work intended for them. The Secretary General will send out instructions and rules about the sessions, the presentations and other details.

Roederer explained that it would be useful to go over the proposed program of each Division and talk about overlap. Roederer also reminded everyone that a 2-3 sentence description must be prepared for each session and submitted to the Secretary General.

Roederer then briefly read the proposed programs and commented on the recommendations made by the EC concerning the improvement of some titles, the addition of symposia in Division III, and concerning some obvious overlaps. After he excused himself to attend an IUGG Executive Committee meeting, the discussion was continued and chaired by

Program Committee Chairman Fukushima.

Fukushima asked all Division leaders to write their proposed programs on the blackboard for simultaneous overview. This was done. Some titles were changed where the subject was not entirely clear; some overlaps were eliminated, and some joint sessions were determined.

In conclusion the scheduling of the deadlines were discussed. IAGA News #18, scheduled for publication in February 1980, will show session titles only. Gadsden indicated it is planned to enclose a limited version of the First Circular on the Edinburgh meeting in IAGA News #18. The Second Circular is scheduled for October 1980. IAGA News #19 is scheduled for publication in November/December 1980 and will contain conveners' explanations and the deadline for submission of abstracts, which was provisionally determined as March 31, 1981.

Fukushima indicated that he would prepare a master matrix showing detailed time scheduling. He took note of several Division requests for preferred timing of certain sessions and linkage with others. He stated that this matrix would be available within some weeks, and the meeting was closed.

# MINUTES OF THE JOINT IAGA/IAMAP EC MEETING

12 December, 1979, 1930-2045, University House, Canberra

Present: IAGA: L. Alldredge
V. Bucha
K. Cole
N. Fukushima

N. Fukushima M. Gadsden J. Roederer

V. Troitskaya

IAMAP: A. Belmont

A. Dyer W. Godson P. Goldsmith S. Hess

W. Hitschfeld K. Isono C. Junge

R. Newell S. Ruttenberg

Junge invited Roederer to open the meeting. Roederer related some of the history of the two Associations' efforts to cooperate, adding that this was the second joint EC meeting and expressing his hope that such meetings would become common practice. Referring to Professor Junge's recent presidential address, he stressed that the strong interdisciplinary activities of both Associations make this cooperation beneficial in many areas where the interests of both Associations overlap. Our functions should be cooperative, rather than competitive: what is one Association's "input" or "boundary condition," is the others "output." Cooperation should go beyond that of planning joint Symposia. International research programs such as MAP are an important area of joint endeavour. Other areas for possible cooperation are in the study of atmospheric electric fields, electromagnetic waves at lower altitudes in the low frequency range, and planetary atmospheres. Roederer recalled that a joint Advisory Body had been set up for MAP at the last joint IAGA-IAMAP EC meeting, and noted the lack of representation of ICMUA in that Advisory Body. He informed those present that the IAGA EC had decided to invite IAMAP to add an additional member to that Body as the representative of ICMUA.

Junge responded that this was the spirit of cooperation he had hoped for, and stated that every attempt would be made to keep it that way. He continued that the joint organizing committee for the MAP Symposia in Edinburgh and Hamburg would come up with a program which will satisfy everyone and reiterated that there are three broad areas for cooperation, namely the middle atmosphere, the upper atmosphere and planetary atmospheres. Roederer stated that he would ask Division II leader Rishbeth to keep close contact with IAMAP, especially in relation to the Edinburgh/Hamburg meetings. Roederer and Ruttenberg gave a brief account of the topics provisionally planned for these assemblies.

It was agreed that the IAGA/IAMAP Joint Coordinating Committee would be the Joint Program Committee for the Symposium on Middle Atmosphere Science, Part I of which will be at Edinburgh, Part II of which will continue at Hamburg. There was also agreement that, in

view of the different structure of IAGA and IAMAP, IAMAP could be represented by 4 people (Radiation, Ozone, Atmospheric Chemistry and Upper Atmosphere Commission); it was also agreed, at least in principle, that the IAGA Division II, Division III and Interdivisional Commission on Middle Atmosphere Chairmen could, if so desired, appoint their representative to the Joint Program Committee.

Ruttenberg reiterated that IAMAP would present in its newsletter information on IAGA meetings so that, in the areas of joint efforts, the people will know what is going on. Likewise, notification of IAMAP events will occur in IAGA News. After a brief discussion, it was decided that in connection with the IAGA and IAMAP Scientific Assemblies in 1981, the two Secretaries General would explore the possibility of a joint EC meeting during that time.

Roederer then turned to IAGA resolutions of possible interest to IAMAP. He read the resolution concerning SCOSTEP (IAGA Resolution No. 2). Junge commented that this resolution would indeed be in the interest of IAMAP and offered to bring this matter up at their Plenary Session. Roederer then read the IAGA resolution concerning representation in the IUGG Executive Committee and the IUGG Council (IAGA Resolution No. 1). General comments indicated that IAMAP also suffers from an inequitable representation in the IUGG administration. Ruttenberg offered to inform the IAMAP National Correspondents about this problem and Junge agreed that this matter would be discussed within IAMAP. Roederer then read the resolution proposed as an IUGG resolution on the support of basic research (IAGA Resolution No. 17). Junge agreed that this resolution should be submitted to IUGG as a joint one and indicated that he would bring this up at the IAMAP Plenary Session.

Roederer thanked all present for attending this joint EC meeting and expressed the IAGA EC's gratitude to IAMAP for hosting this joint meeting.

# REPORTS FROM IAGA ORGANIZATIONAL UNITS

#### DIVISION I ON INTERNAL MAGNETIC FIELDS

#### REPORTER REVIEW SESSION

The Reporter Review Session of the IAGA Division I was held in the morning of 7 December 1979 in the Melville Hall, chaired by K. M. Creer. The reports were presented in the following order:

- Working Group I-1. Analysis of the Main Field and Secular Variation (by B. R. Leaton)
- Working Group I-2. Theory of Magnetic Fields and Geomagnetic Secular Variation (by P. H. Roberts)
- Working Group I-3. Electromagnetic Induction and Electrical Conductivity (Earth and Moon) (prepared by U. Schmucker and read by W. D. Parkinson)
- Working Group I-4. Magnetic Anomalies (land and sea) (by J. R. Heirtzler and C. C. Weber)
- Working Group I-5. Paleomagnetism (by J. C. Briden)
- Working Group I-6. Rock Magnetism (by G. N. Petrova)

The contents of these reports from each Working Group, will be seen following the report on the Business Meeting of Division I.

#### BUSINESS MEETING OF DIVISION I

The business meeting of Division I was held at the Copland Theatre, ANU, Canberra at 20.00 h on 7 December 1979.

1. New Division officers were elected as follows:

Chairman:

D. I. Gough (Canada)

Vice Chairmen:

V. R. S. Hutton (U.K.), A. N. Pushkov (U.S.S.R.) and

D. E. Winch (Australia)

- 2. Two resolutions were discussed and put forward to the Executive Committee and subsequently passed at the IAGA Plenary Session:
- (i) From Working Group I-4: IAGA, considering the interest in global magnetic anomalies and that a certain number of countries have already completed maps on a scale 1: 2, 500,000, urges the compilation of such maps within the next four years as a contribution to a global magnetic anomaly map.
- (ii) From Working Group I-5: IAGA, noting that a comprehensive study along an east-west profile of geomagnetic secular variations recorded in sediments deposited since the last glaciation in lakes is likely to yield new data basic to our understanding of the origin of the geomagnetic field and that such a profile would be optimally located in the Eurasian and American continents within a band of latitudes between 40° and 50°N, recommends that

National Bodies in the respective Countries support the preparation of a cooperative project in which standardized techniques will be used.

- 3. Scientific sessions for the Edinburgh assembly. A large number of titles were put forward to Division from Working Groups. These were reduced to thirteen at the Division business meeting. An allocation of twenty-three half-day sessions was requested from the executive committee. This will necessitate having parallel sessions in the Division I programme, but since the interest of the various working groups within Division I are so diverse, it was generally agreed that this need not create any problems of overlap of interests. A provisional time-table for the Division I sessions (in which Reporter Review session is scheduled late in the conference period to allow reporters to learn during the meeting) was placed before the executive committee for their consideration when drawing up the complete IAGA programme for the 1981 Assembly. A list of session titles with proposed convenors is as follows.
  - 1) Scientific results from the MAGSAT mission: main field (proposed by WG I-1; Convenors: R. A. Langel (USA) and D.R. Barraclough (UK); 2 half-day sessions).
  - Mathematical modelling of the main geomagnetic field (proposed by WG I-2; Convenors: N. W. Peddie (USA) and A. N. Pushkov (USSR); one half-day session).
  - 3) The magnetohydrodynamics of Planetary Cores (proposed by WG I-2; (Convener: D. Loper (USA); 1-2 half-day sessions).
  - 4) Electromagnetic studies in the oceans and their implications for sub-oceanic layers (proposed by WG I-3; Convenors: C. S. Cox (USA) and S. R. C. Malin (UK); 1 half-day session).
  - 5) Audio-frequency magnetotellurics and other studies using ELF wave propagation (proposed by WG I-3; Convenors: S. E. Hjelt (Finland), V. R. S. Hutton (UK) and D. Strangway (Canada); 1 half-day session plus Divisions II and III allocation if interested).
  - Regional electromagnetic induction studies (proposed by WG I-3; Convenors: J. Jankowski (Poland) and R. Banks (UK); 3 half-day sessions).
  - 7) Physical parameters related to geomagnetic anomalies (permanent or time-independent) (proposed by WG I-4; Convenors: W. Mundt (GDR), C. C. Weber (France) and C. G. A. Harrison (USA); 2 half-day sessions).
  - 8) Time scales of geomagnetic secular variation (proposed by WG I-5; Convenors: P. Tucholka (Poland) and C. E. Barton (UK); 2 half-day sessions).
  - Paleomagnetic aspects of the evolution of the Mediterranean and North Atlantic regions (proposed by WG I-5; Convenors: J. D. A. Zijderveld (Netherlands) and R. Van der Voo (USA); 2 half-day sessions)
  - 10) Magnetic reversal stratigraphy including studies of polarity transitions (proposed by WG I-5; Convenors: W. Lowrie (Switzerland) and A. N. Khramov (USSR); 2 halfday sessions).
  - 11) Properties of natural and synthetic titanomagnetites: application to magnetopetrology (proposed by WG I-6; Convenors: G. N. Petrova (USSR) and W. O'Reilly (UK); 2 half-day sessions).
  - 12) Physical and chemical processes of magnetization in relation to geological events (proposed by WG I-6; Convenors: I. G. Hedley (Switzerland), F. Heller (Switzerland) and D. J. Dunlop (Canada); 3 half-day sessions).
  - 13) Effects of stress on the magnetic properties of rocks and minerals (proposed by WG I-

- 6; Convenors: J. P. Hodych (Canada), H. Domen (Japan) and M. Jelenska (Poland); 1 half-day session).
- 4. Division I held a most successful programme of scientific sessions at the Canberra Assembly. All sessions listed in the programme were well attended. In fact many participants noted that the inclusion of a comprehensive programme of Division I scientific sessions was a most important factor contributing to their decision to attend the Assembly. Of eighteen contributions received for the General Contributions session only twelve, including one from the People's Republic of China, were actually presented. Nevertheless, that session provided a valuable opportunity for the inclusion of contributions in subject areas not covered by the titled sessions.
- 5. The six working groups held business meetings and new officers were elected where necessary. The content of the 1981 Edinburgh Assembly was also discussed and Session titles passed forward for discussion at the Division business meeting.

New Working Group Officers are:-

WG	Chairman	Vice-Chairman	
1	N. W. Peddie (USA)	D. R. Barraclough (UK)	
2	P. H. Roberts (UK)	I. A. Eltayeb (Sudan)	
3	A. Ádám (Hungary)	B. A. Hobbs (UK)	
4	C. C. Weber (France)	P. J. Hood (Canada)	
5	J. C. Briden (UK)	D. A. Valencio (Argentina)	
6	D. J. Dunlop (Canada)	H. C. Soffel (FRG)	
	1 2 3 4 5	N. W. Peddie (USA) P. H. Roberts (UK) A. Ádám (Hungary) C. C. Weber (France) J. C. Briden (UK)	1 N. W. Peddie (USA) D. R. Barraclough (UK) 2 P. H. Roberts (UK) I. A. Eltayeb (Sudan) 3 A. Ádám (Hungary) B. A. Hobbs (UK) 4 C. C. Weber (France) P. J. Hood (Canada) 5 J. C. Briden (UK) D. A. Valencio (Argentina)

# WG I-1 Analysis of the Main Field and Secular Variations

Work continues on the development of several methods of parametric representation including dipoles and current loops, but the favourite remains variants of spherical harmonic analysis.

It is currently agreed that up to n=m=8 is of core origin, n=m>15 is in the crust with an overlap between those limits, with the boundary between dominant contributions at about n=m=12. The field at the surface is well established up to at least n=m=8, but when extrapolated to the core boundary for studies of core motions, it is reliable only to about n=m=4.

The considerable power detected down to a wavelength of 150 kms cannot be explained in terms of present concepts of crust and mantle sources. Furthermore, the global spurt in secular change around 1970 suggests a core source with a period as short as 4 years. It can no longer be assumed that the mantle is practically translucent to core sources and mantle conductivity must be re-assessed and allowed for.

On the practical level we have IGRF (International Geomagnetic Reference Field). The 1965 and 1975 versions have known deficiencies. A few 1980 models are in the pipeline, but the next update must wait for MAGSAT. However there is more pressure for an early revision, which therefore should be decided by Edinburgh 1981. The expected higher accuracy may need and justify corrections for both the co-rotational and diurnal external parts, both dependent on solar activity levels. A new form for IGRF has been suggested having a retrospectively corrected part plus a current preliminary part. The precise format and how to

establish agreed parametric values have to be determined by WG I-1 which has not yet met at Canberra.

#### **Business Meeting**

Met 2000–2205 h 10 December 1979 under its chairman, B. R. Leaton. 17 delegates were present of whom 7 were members of the working group. Apologies were received from S. P. Srivastava and H. A. Roeser.

After discussion of user requirements for both theoretical and practical use of models, the following topics were debated at length referring to the next generation of the International Geomagnetic Reference Field:-

- 1. Should IGRF continue to be expressed in Spherical Harmonics?
- 2. The range in years
- 3. Date of issue of new model
- 4. The expression of secular change e.g. linear or with acceleration
- 5. Number of coefficients for (a) 1980, (b) earlier. Main field
- 6. Number of coefficients for (a) 1980, (b) earlier. Secular change
- 7. Going back before 1965
- 8. Method and schedule for evaluation
- 9. Schmidt or other normalization
- 10. Incorporation of external part and its dependence on solar activity

It was decided that IGRF 1980 should consist of models to 8th or 10th order and degree for the epochs 1965.0, 1970.0, 1975.0 and 1980.0 for the main field only plus a secular change forecast for the 5 years from 1980. Models should be submitted by March 31, 1980. The modellers themselves would constitute a review panel. IGRF 1980 would be adopted at the Edinburgh Assembly 1981. A detailed resume would be compiled for inclusion in the next IAGA news.

N. Peddie (U.S.A.) was elected by show of hands as the new WG Chairman. A similar vote for vice-chairman was indecisive. D. R. Barraclough (U.K.) was elected by paper ballot.

(B. R. Leaton, Chairman)

# WG I-2 Planetary Dynamos

Several matters raised in my report in IAGA News No. 16 have progressed further. A summary by *Srnka* of the activities of the Houston meeting on 'The Origins of Planetary Magnetism' appeared in EOS early last year, and the full proceedings were published by the Journal 'Physics of the Earth and Planetary Interiors' last autumn. The book on 'Rotating Fluids in Geophysics' edited by *Soward* and *Roberts* has appeared, and contains a large section devoted to the MHD of rotating fluids, in part relevant to geomagnetic dynamo theory. Not mentioned in my report was the Workshop on 'Dynamo Theory and the Generation of the Earth's Magnetic Field' held at Alsovice last October under the auspices of the Czechoslovakian Academy of Sciences, who plan to publish the proceedings early this year. Also of interest is the comprehensive tome on 'Cosmical Magnetic Fields' by *E. N. Parker* which has recently appeared. A significant event has, of course, been the Scientific Session on 'Planetary Dynamo Theory' held during the Canberra Assembly. A brief report by its convenor, *F. H. Busse*, appears in the Transactions of the Canberra Assembly.

Members of the Working Group look forward to three meetings prior to the Edinburgh Assembly. The first forms part of the Workshop on 'Comparative Studies of Planetary Interiors' to be held during the COSPAR General Assembly in Budapest (2–14 June, 1980) and organized by *H. Stiller*. The second is a session in the Conference on 'The Thermal Regime of the Earth's Interior' at Lake Arrowhead, California (27 July—4 August, 1980) and organized by *L. Johnson* and *G. Jones*. The third is a COSPAR Workshop on 'Planetary and Stellar Magnetism'. It is organized by *Roberts* and held simultaneously with the Budapest meeting of the EGS (25–29 August, 1980).

In recent publications, *Braginsky* has taken further his model-Z of the geomagnetic field and, with *Anufriev* and *Fishman*, has considered in greater detail one of its important ingredients: the coupling of core and mantle through topographic effects and through electromagnetic torques. *Copal* and *Hejda* have attempted further integrations of the kinematic dynamo problem in spherical geometry.

The study of magnetoconvection in rotating bodies, even in idealized geometries, continues to attract great interest. Fearn has re-examined and has extended the linear stability calculations of Eltayeb and Kumar on convection in a rotating sphere, and has confirmed their most important finding: the strongly destabilizing role of an imposed zonal field of adequate strength. Related research by Soward, published in the proceedings of the Houston meeting, have confronted Busse's model and its upper bound with a serious dilemma. Soward has also extended one of the linear models, that of Roberts and Stewartson, to non-linear regimes. Busse has published an article on scaling laws for planetary magnetism in the compendium 'Solar System Plasma Physics' edited by Kennel, Lanzerotti and Parker. Related work appears in Cuong's recent PhD thesis (UCLA). The anisotropic  $\alpha$ -effect characteristic of dynamos driven by magnetoconvection has been the subject of studies by Busse and by Rüdiger, who try to construct explicit models.

Work by *Hide* on the topology of field lines emerging from the core has shed light on the character of dynamo fields. *Hide, Palmer* and also *Benton* have advanced the techniques for extracting information about the MHD of the core from the observed field extrapolated to the base of the mantle.

Papers by Gubbins, Masters and Jacobs, by Loper, by Loper and Roberts, and by Müller and Häge develop the theory of compositional convection, driven by the release of light material at the base of the fluid core during the general cooling of the Earth. This may be the principal mechanism by which the core is stirred.

#### **Business Meeting**

During the business meeting held at the Canberra Assembly, it was decided to attempt to increase the interaction among active working group members by informing each other, through the Chairman, of topical publications and relevant meetings. The title of the Scientific Session sponsored by the working group at the Edinburgh Assembly will be 'The MHD of Planetary Cores'. D. Loper will be the convenor.

(P. H. Roberts, Chairman)

# WG I-3 Electromagnetic Induction

The activities of the Working Group can best be described by summarising the workshops held in Sopron (1976) and Murnau (1978).

A feature of recent work has been an extension of our interest to higher frequencies and more closely spaced stations. This has revealed a fine structure in conductivity not previously appreciated. This work has been helped by the development of more sensitive magnetometers such as the SQUID and high permeability fluxgate which are 2 to 3 orders of magnitude more sensitive than conventional instruments. Artificial sources also have given more insight into shallow crustal probing.

Attempts to use time variations of transfer functions (i.e. the functional relation between the vertical component and horizontal components of the variation field) as earthquake precursors have been hampered by the apparent dependence on strength and polarity of the primary field.

The oceans have always been a challenge to geophysics and nowhere more so than in the field of electromagnetic induction. Ingenious instruments used on the sea floor are beginning to yield reliable data. Earlier hints of a significantly different structure under oceans and continents are beginning to be confirmed. Seismic evidence on this point is ambiguous. Electromagnetic induction may be able to offer information of vital interest to the whole field of tectonics.

As for the ocean water itself, it now seems clear that thin layer induction in insulated oceans cannot explain the coast effect. This will be clarified soon as numerical methods of solving this difficult problem converge to a solution.

Numerical and analytical tools are becoming more sophisticated. Algorithms using a flat earth and uniform primary field are available for both three-dimensional bodies and irregular flat conductors connected to a conducting half-space. Analytical solutions of some of these models are now available to act as checks on numerical modelling.

Some of the most interesting developments in electromagnetic induction studies are attempts to tie in the highly conducting layer at a depth of about 100 kms with the low velocity layer of seismology and the asthenosphere of tectonics. We expect progress in this topic to be accelerated by the ELAS project, initiated by Resolution No. 6 of the IAGA Seattle Assembly.

Vital to the interpretation needed for this project is the continuing laboratory work on the conductivity of rocks. The news is not always encouraging. If you ask a laboratory worker whether conductivity depends on temperature, hydration, partial melting, crystal phase or oxygen fugacity you may well get the answer "Yes". However some progress is being made by combining such relationships as T vs melt-fraction with T vs conductivity.

(U. Schmucker, Chairman)

#### **Business Meeting**

In the absence of both Chairman (U. Schmucker) and Vice-chairman (A. Ádám), W. D. Parkinson presided the meeting as acting chairman. He read a review of the Working Group activities during the last four years, centering on the two workshops—Sopron in 1976 and Murnau in 1978.

Working group I-3 has elected new officers as follows:-

Chairman: Dr. A. Ádám (Hungary) Vice-Chairman: Dr. B. A. Hobbs (UK)

An invitation from the University of Istanbul to hold the Fifth Workshop there during the period 17–24 August 1980 was accepted.

#### WG I-4 Magnetic Anomalies

#### Part 1. Magnetic anomalies (land)

Progress during the past two years can be summarized under the following three headings.

#### 1. Field measurements

Much progress has been accomplished during these last years using supraconductive magnetometers. These have been very helpful for magnetotelluric sounding and for archeomagnetic purposes. However, SQUID magnetometers give such small anomalies, down to  $10^{-2}$  nT, that they are very difficult to interpret, or even to separate from the background noise. It is readily apparent that their future use will be as gradiometers.

#### 2. Anomaly maps

A large number of countries have completed the airborne magnetic coverage of their own territory. Australia has published a compilation covering a large part of the continent and adjacent oceanic area. In the US a National Magnetic Anomaly Map Committee has been nominated by the Society of Exploration Geophysicists. This committee and the US Geological Survey are currently engaged in the preparation of a regional photocomposite map, derived from publicly available data plus regional data contributed from the private sector, on a scale of 1/2 500 000 (about 50 to 70% of the US territory). In 1977 Canada issued the third edition of the Magnetic Anomaly Map of Canada on a scale of 1/5 000 000. The USSR has already published a magnetic chart at the 1/2 500 000 scale. Currently in various socialist countries of Eastern Europe, magnetic anomaly maps are being compiled mostly at a scale of 1/1 000 000. It is intended that they will subsequently be combined into a single composite map on a scale of 1/2 500 000 for the whole area. For Western Europe, BGR in Western Germany and BRGM in France plan to prepare an integrated map at the same scale, including where possible offshore surveys.

It would be a task for IAGA to recommend that other countries prepare magnetic anomaly maps at the same scale (1/2 500 000). It would also be very useful for magnetic survey coverage maps to be prepared as a first step in the preparation of magnetic anomaly maps of international scope.

#### 3. Interpretation of anomalies

It seems that no spectacular progress has been made recently in this field. One observes mostly investigations on well known techniques. Among many items it is possible to select a few trends.

- Standard use of calculations of the vertical gradient. Computations carried out in the frequency domain facilitates easy modelling of the sources.
  - Recursive filtering allows continuation down to the level of the sources.
- Inversion techniques have been extensively studied, using for instance Bacchus-Gilbert transforms. To obtain good results a sufficient number of constraints should be given. Another way is to carry out spectral analysis to define an equivalent magnetization surface to produce the observed anomalies. It is also possible to estimate from spectral analysis statistical parameters which characterize the distribution of probable magnetic sources.
- Several techniques have been studied to bring the data measured at varying elevations to a common datum; this will be very useful in the compilation of Magsat data.

Future work will be directed towards a better understanding of the geological interpretation of magnetic anomalies using not only sophisticated mathematical processing, but also a better knowledge of the physical parameters of the lithosphere related to anomalous bodies.

Investigations of the effect of stress-related changes in crustal magnetic anomalies should also be studied.

(C. C. Weber, Vice-Chairman)

#### Part 2. Marine magnetic anomaly studies

The results obtained in the 1970's stimulated several areas of study that are briefly reviewed here: marine magnetic surveys that provide insight into continental reconstructions, extention and revision of the geomagnetic reversal time scale, new and more efficient methods of handling and interpreting marine magnetic data, and studies of the marine rocks that may cause magnetic anomalies.

#### 1. Marine magnetic surveying

Recently some large areas of the oceans have been surveyed in great detail. Aeromagnetic and shipboard surveys of high precision have been undertaken during the last decade by the US Naval Oceanographic Office. Some of that data for the Northeast Atlantic and for parts of the Western North Atlantic were published. A detailed aeromagnetic anomaly map for all of the continental margin and adjacent seafloor off the eastern United States has been published. New major maps have been made for the islands of Japan and adjacent waters, for the Southeast Asia region, for the margins of Australia and for much of the Canadian margin.

#### 2. Methods of analysis

While the block model for two-dimensional anomalies proved a convenient artifice for developing a history of magnetic field reversals and seafloor spreading rates, deeptow magnetometers showed that the blocks did not have an infinitely sharp transition and deepsea drill holes into the basaltic basement showed that there were not uniformly magnetized blocks. As an alternative to the block model type of calculation an inversion method was devised. The magnetization predicted by these calculations was not found in deepsea drillholes either.

Although drilling has failed to show that there are normal and reversely magnetized blocks the block model continues to be useful. For example it has been possible to account for the anomalies in the regions around fracture zones by assuming there are two-dimensional magnetic blocks offset by a zone of zero magnetization. The block model is also very convenient for the calculation of seafloor spreading rates and ages. It also accounts, via the Vine-Matthews theory, for the normally magnetized basalt in the axis of actively spreading midocean ridges.

#### 3. Extention and revision of reversal time scale

A reversal from marine magnetic anomalies was developed from the last 77 million years. The longer marine anomaly time scale was derived from a marine magnetic profile from the South Atlantic Ocean that was thought to be free of discontinuous age jumps caused by fracture zones. Several authors have questioned whether these constraints were satisfied and have suggested modifications of that scale. These changes altered the original time scale by 7 percent in most cases and yielded 96 periods of normal polarity, separated by reversals or short period events within the last 108 million years. The so-called Japanese, Phoenix and Hawaiian lineations in the Pacific and the Keathley lineations in the western North Atlantic are believed to be Mesozoic in age and permit an extention of the reversal time scale back to 160 million years.

For the more recent reversals, extending back approximately 5 million years, some modifications in the reversal scale are likely to be made in the near future. A new hydraulic piston core, when used in conjunction with deep sea drilling in sediments, can obtain quite undisturbed cores of this age. Under the assumption that deepsea sedimentation rates have been constant in some areas for this long, or that deposition rates have been more constant than volcanic rocks on land or more constant than spreading rates near midocean ridge axes, an improved reversal scale should result.

#### 4. Magnetic source layer

The idea of a magnetic source originating at the axis of the midocean ridge and being alternately normally and reversely magnetized is central to the Vine-Matthews theory of tectonic plate formation. Significant penetration into the basaltic basement was made from 1974 until the present, especially on Legs 37, 49, 51, 53 and 55. Also starting in 1974 submersible scientists recovered samples especially in the Mid-Atlantic Ridge at about 36 degrees north (Projects FAMOUS and AMAR). On all of the deepsea drilling legs the recovered basalt shows magnetic inclination that is constant only for meters to tens of meters depth and not for 500 to 1000 meters as assumed in block models. Oriented samples obtained by submersible in the axial zone which had been assumed to be normal from surface measurements of the field did, in fact, turn out to be normally magnetized. The geologic setting in which these samples were found proved to be interesting because it showed some evidence of episodic volcanic activity along the axial line and some evidence of occasional volcanic slightly off axis. According to some authors the episodic and slightly scattered injections cause the magnetic layer to be nonuniformly magnetized near the times of magnetic field reversals but not so non-uniformly magnetized as to invalidate the essential block concept.

(J. R. Heirtzler, Chairman)

#### Business Meeting (Tuesday 11 December 1979)

In the absence of J. R. Heirtzler, the meeting was convened by C. C. Weber, Vice-Chairman. At the request of the Division executive an election for a new Chairman and Co-Chairman was carried out. It resulted in C. C. Weber (France) and P. J. Hood (Canada) being elected Chairman and Co-Chairman respectively.

Most of the discussion at the meeting centered on the *International Magnetic Anomaly Map Series* (IMAMS) at a scale of 1:2 500 000. The progress report summarizes the state of various compilation maps prepared during the past 2 years. It is intended during the next 4 years to give emphasis to the preparation of IMAMS for Australia, Europe and North America. The co-ordinators for these areas were nominated as follows:

Australia: R. Whitworth

Europe: W. Mundt, with the assistance of A. Hahn and T. Simonenko

North America: P. Hood, in conjunction with members of the National

Magnetic Anomaly Map Committee

In anticipation of IMAMS for the African Continent an index map showing the areas magnetically surveyed would be prepared by P. Hood.

As suggested by J. R. Heirtzler, it is intended that an article on IMAMS will be prepared for publication in a suitable journal such as EOS, Geophysics and Geophysical Prospecting. Symposia for the 1981 Edinburgh Meeting

It was agreed that the following symposium be held:

Physical parameters related to geomagnetic anomalies (permanent and time dependent) Convenors: W. Mundt and C. C. Weber

In addition it was agreed that it should be a joint symposium organized in conjunction with WG I-1, on long wavelength crustal anomalies, mostly observable in the MAGSAT data. Convenors for the Working Group I-4 should be A. Hahn and P. J. Hood.

Resolution: The following resolution was agreed upon:

IAGA, considering the interest of global magnetic anomalies and that a certain number of countries already completed maps on a scale 1:2 500 000, urges Member countries to compile

such maps within the next 4 years as a contribution to a global magnetic anomaly map.

(C. C. Weber, Vice-Chairman)

# WG I-5 Palaeomagnetism

Recent progress in palaeomagnetism is directly attributable to improvements in instrumentation and working techniques leading to improved precision and accuracy within established areas of investigation, and the initiation of new areas of detailed study of complex phenomena which have hitherto been beyond the practical limits of resolution.

Careful analysis of Mesozoic and Cenozoic rock formation in several continents is leading to the revision and refinement of apparent wander paths and the geomagnetic polarity time scale. Together with more precise dating of points on those paths and utilization of the improving ocean-floor palaeomagnetic records, these studies are leading to improved palaeocontinental reconstructions on a regional scale and progressively on the world scale. There is a growing consensus on continent configuration back to c 200 million years ago and much thought is now devoted to special problems posed by the records of Permian palaeomagnetism, tectonics and palaeogeography, the solution of which is an essential prerequisitie to the extension of map sequences with the earlier Palaezoic.

The recognition that many rocks—particularly those with complicated geological histories—carry several components of magnetization is a result of meticulous laboratory work in a detail which has rarely been approached before in palaeomagnetism. Whole new areas of study of the magnetic history of rocks are being developed: several points are already clear, for example (i) mild geologic events which leave scarcely any petrographic or fabric imprint can have quite strong magnetic effect, (ii) geologic events can rarely be categorized purely as either physical or chemical; thermal events are commonly accompanied by chemical or mineralogical modifications, (iii) it is often possible to distinguish CRM and PTRM acquired contemporaneously by study of their blocking temperature spectra, (iv) the time-temperature relationship for acquisition of TRM particularly by single domain grains facilitates study of cooling history of rocks in a variety of geologic settings, (v) where rocks whose NRM has a sufficiently broad range of blocking temperature have undergone slow cooling such as during uplift and erosion, the NRM records the time average (dipole) field within outcrops on the scale of metres or either within sampler on the scale of continents.

#### **Business Meeting**

The present chairman J. C. Briden (U.K.) and vice-chairman D. A. Valencio (Argentina) continue their terms of office until 1981.

(J. C. Briden, Chairman)

#### WG I-6 Rock Magnetism

Rock magnetic investigations have developed in three main directions. The first concerns the properties of single-domain and pseudo single-domain fine grain particles and their role in different types of remanent magnetization, and on the importance of grain interactions in assemblages. Some variations of the theory of the production of TRM in such assemblages have been worked out; in most of them TRM has been compared with ARM, and there is a rather good agreement between theory and experiment for assemblages of both synthetic and natural fine grains. Some predictions about the role of fine-grained particles in viscous and

piezoremanent magnetizations have been discussed. The results of some experiments concerning CRM are contradictory and the problem of its origin remains unsolved. Some investigators have studied postdepositional magnetization. An understanding of CRM and PDRM is especially important in applications of palaeomagnetism for studies of the fine structure of the geomagnetic field.

The second direction involves the investigation of the properties of magnetic minerals and diagnozing their presence in rocks. The best studied minerals are titanomagnetites and their oxidation products. The P-T-PO<sub>2</sub> conditions of their formation have been successfully studied. Some progress has been made in investigations of ilmeno-haematites and pyrrhotites. The investigation of lepidocrocite-goethite-haematite transformations have yielded unexpected new results about the properties of haematite and about the types of remanent magnetization it carries.

Third, developments have occurred in the analysis of multicomponent magnetizations.

Other areas of interest worthy of special mention are (i) investigations of meteorites, though these are not numerous, (ii) estimations of the intensity of the palaeofield with which difficulties continue to be experienced. Finally the development of rock magnetic techniques with the objective of applying them to the solution of geophysical and geological problems continues to constitute an important aspect of rock magnetic research.

Advances in geomagnetic study of the past few thousand years have been encouraged by convergence of directional records of the geomagnetic field from natural lake sediments and archaeological materials. The "refined archaeomagnetic time scales" have been used as a reference for palaeointensity estimates—obtained from a variety of new techniques—and appear to indicate the presence of previously unsuspected short period oscillations (about 10<sup>2</sup> y period) in the field. The time-temperature relation, mentioned previously for rocks, is equally pertinent to artefacts and is emerging as an important complication to palaeointensity estimation.

Perhaps as exciting as any of the advances is at the interface between rock magnetism and palaeomagnetism has been the successful use of analyzing transmission electron microscopes to resolve magnetic oxides down to about  $0.1\,\mu\text{m}$ , i.e. spanning the single domain size range in magnetite. A few cases are emerging where the several distinct carriers of multicomponent NRM can be distinguished.

The recognition (during the Canberra IUGG Symposia and the deliberations of the Working Group) of the topics mentioned here as frontiers of major potential advance in the next years, had led to proposals (tested elsewhere in this volume) for symposia in these areas at Edinburgh. The Working Group is also continuing to explore the feasibility and desirability of a Technical Session, attached to the Edinburgh Assembly, on palaeomagnetic data processing. It is intended that this session will enable the pooling of knowledge, and even resources, on computer/microprocessor interfacing and programs which have hitherto been developed independently and which are only advanced in a few widely scattered laboratories.

#### **Business Meeting**

D. J. Dunlop (Canada) and H. C. Soffel (Fed. Rep. Germany) were elected respectively Chairman and Vice-Chairman.

(G. N. Petrova, Chairman)

#### DIVISION II ON AERONOMIC PHENOMENA

#### Report on Activities during 1975-1979

The activities of Division II of IAGA over the past four years have been mainly in the areas of organizing scientific sessions and reporter reviews at the Seattle and Canberra meetings, and in the activities of several working groups. The relationship of the activities of Division II to those of other organizations, particularly URSI and IAMAP and to some extent COSPAR, has received considerable attention. URSI has an interest in the ionosphere because of its effect on radio transmissions and its susceptibility to study by incoherent scatter radar. Several joint working groups between IAGA and URSI have been active in promoting communication between scientists working in the areas of mutual interest, and have been involved in planning sessions of the relevant assemblies in such a way as to avoid duplication of topics. The scientific sessions at Canberra on "Dynamics of Thermosphere and Ionosphere and Effects on Composition" is cosponsored by COSPAR and URSI, and the scientific session on "Non Linear Waves in Geophysical Plasmas" is cosponsored by URSI.

The mutual interest of Division II and several IAMAP commissions in the physics and chemistry of the stratosphere and mesosphere was reflected in the joint assembly of the two Associations in Seattle which gave all attendees the opportunity to participate in the programs of both Associations. This mutual cooperation has been continued in the scheduling of an IUGG symposium "The Middle Atmosphere" for Canberra. In addition some papers were transferred between the programs for ICMUA, IAGA Div. II and the Middle Atmosphere Symposium to ensure a better grouping of subject material. In this Transactions, the Report of the Working Group "Wave Instabilities in Space Plasmas" is included in the Division III activity report, as is the report of the working group "The Auroral Oval and Its Extension into Space". The reports from other working groups follow here.

#### REPORTER REVIEW SESSION

The following reports of the Division II Topics were presented during the second morning session and the first afternoon session on 4 December, 1979 in the Copland Theatre. This reporter review session was chaired by B. A. Tinsley.

- Topic II-1. Structure and Dynamics of the Thermosphere, Ionosphere and Exosphere (by H. Rishbeth).
- Topic II-2. Neutral and Ion Chemistry and Solar Fluxes (by L. Thomas and A. D. Danilov)
- Topic II-3. Atmospheric Quantal Emissions, Including Auroral Processes and Airglow (by J. C. Gérard and M. H. Rees)
- Topic II-4. Ionospheric Irregularities, Including Small Scale Auroral Structure (by P. L. Dyson and R. S. Unwin).
- Topic II-5. Ionosphere-Magnetosphere Interactions, Including Large Scale Auroral Structures (by L. P. Block).
- Topic II-6. Stratosphere-Mesosphere-Ionosphere Interactions (by J. B. Gregory and C. F. Sechrist, Jr.)
- Topic II-7. Aeronomy of Other Planetary Atmospheres (by D. M. Hunten and M. Yu. Marov).
- Topic II-8. Laboratory Experiments of Aeronomical Interest (by D. C. Cartwright and H. I. Schiff)

#### BUSINESS MEETING OF DIVISION II

(4 December, 1979, 4:00-6:15 p.m. Chairman: B. A. Tinsley)

1. A list of the incoming Division officers,

H. Rishbeth, Chairman

P. Bauer, A. D. Danilov, M. H. Rees, Co-chairmen

was announced.

2. The first item of the agenda was a discussion of the duties of Topic Reporters and Working Group Leaders. After some discussion a set of job descriptions written by H. Rishbeth was adopted which is shown in Appendix I.

3. The second agenda item was a discussion of the structure of the Division (i.e. list of topics and working groups). A proposal from the British National Committee to include the study of Sq and L magnetic variations as a topic was considered. It was felt that the aeronomic aspects of Sq and L are already included in Topic II-1. However, a reporter should be appointed who was involved in this field, and this and the other topic titles should be amplified by a short descriptive statement.

Since Topic II-1 was considered large, it was agreed that the exosphere be treated as a separate topic, II-9.

Topic II-6 was considered unnecessarily narrow, and it was agreed that electromagnetic coupling between the stratosphere—mesosphere—ionosphere be included in it.

A list of revised topics and their descriptions is shown in Appendix II.

- 4. A report was received from the Joint Division II-III Working Group on the Auroral Oval and Its Extension into Space, with proposed officers and a set of scientific symposia for the Edinburgh Assembly. An additional vice-chairman was proposed by the meeting and the list, later accepted by Division III, is C. T. Russell (Chairman), A. Egeland, A. D. Johnstone and M. H. Rees.
- 5. A discussion of the status and possible new officers for the several **Joint Working Groups with URSI** was held, and it was decided that any changes at the present time should be intiated by the working groups themselves. Furthermore it was agreed that all such Joint Working Groups should lapse in 1981 unless a strong recommendation is made for their continuation.
- 6. Nominations for reporters for the various topics were called for. A large number were recorded and it was left to the Division leaders to make appointments to ensure good geographical distribution and to ascertain the willingness of prospective reporters to serve according to the job description. (The final results are shown in Appendix II.)
- 7. Two **resolutions** were submitted to the meeting and with some modifications were accepted for transmission to the IAGA resolutions committee.
- 8. Suggestions for symposia topics for the next IAGA meeting in Edinburgh were discussed. From these a list has been prepared by the Division leadership and is currently being developed taking into account plans of Division III and the MAP Commission. The provisional session titles and proposed convenors are as follows.

Dynamics of Thermospheres and Exospheres of the Earth and Planets (3 or 4 half-days)

Cosponsorship by URSI and COSPAR to be requested;

Must be in Week 1 to avoid clash with URSI;

Convenors: P. Bauer, A. Nagy, C. A. Reddy, COSPAR nominee.

Small-scale Ionospheric and Auroral Structures (2 half-days)

To be coordinated with Div III;

Must be in Week 1 to avoid clash with URSI;

Convenors from Division II: S. M. Ossakow, A. Brekke.

Atmospheric Phenomena linked with Polar Cusps (1 half-day)

Sponsored by Div. II/III WG on Auroral Oval, and coordinated with Div. III; Division II Convenor: M. H. Rees.

Auroral Emissions: X rays, Ultraviolet, Visible, Infrared (1 half-day)

Convenors: A. Vallance-Jones, R. R. Meier, N. N. Shefov.

Middle Atmosphere Scientific Session I (up to 8 half-days)

Items to be included: (a) Neutral and ion chemistry, airglow, (b) Solar fluxes,

- (c) Noctilucent clouds, (d) Mesospheric water vapour, (e) Electrodynamic coupling,
- (f) Energetic particle effects, (g) Laboratory aeronomy.

Must be in Week 2 of IAGA; M.A.S.S. II at IAMAP will cover other middle atmosphere topics.

IAGA members of Joint Committee for M.A.S.S. I & II:

L. R. Megill, M. H. Rees, L. Thomas.

General Contributions to Division II (1 half-day)

Convenors: H. Rishbeth, A. D. Danilov

# Appendix I. JOB DESCRIPTIONS FOR TOPIC REPORTERS AND WORKING GROUP LEADERS

Job Description for Topic Reporters

- To contribute Division II Reporter Review Sessions at the two-yearly IAGA Assemblies;
- To provide occasional brief 'highlight' reports on their topic for IAGA publications, as requested;
- 3. To serve as need arises on the programme committees for IAGA-sponsored symposia;
- 4. To represent IAGA Division II as need arises on interdivisional bodies of IAGA, interassociation bodies of IUGG, and interunion bodies:
- To bring to the notice of the IAGA leadership any scientific matters that might be made the subject of IAGA symposia, or might require administrative action by IAGA.

Of these, 1 and 2 are the joint responsibility of the three reporters on each topic, who should arrange among themselves as to how they are discharged. 3 and 4 will be arranged individually with those concerned, generally (but not necessarily) the Topic Reporters, as occasion arises. 5 is largely a matter for the initiative of the individual Topic Reporters. Job Description for Working Group Leaders

Working Group Leaders are responsible for ensuring that the working group carries out its appointed function.

The functions of the Working Groups are in general one or more of the following:

- 1. To carry out some specific task such as specifying standards for instrumentation, data formats, or preparation of geophysical indices;
- 2. To coordinate or implement a specific observing programme;
- 3. To provide a channel for communication between members of the scientific community and the leadership of IAGA and other bodies on scientific matters within

their field of competence. In practice this is likely to include advising on the coordination between bodies of programming of symposia.

# Appendix II. TOPICS AND THEIR DESCRIPTIONS, AND PROPOSED REPORTERS

II-1 Structure and Dynamics of the Thermosphere:

Includes descriptive and physical models; atmospheric solar and lunar tides and waves; electrodynamics of the plasma and interaction of the plasma and neutral air.

N. Matuura (Japan), C. A. Reddy (India), A. D. Richmond (USA)

II-2 Neutral and Ion Chemistry and Solar Fluxes:

Includes observations and models of the composition of the thermosphere, mesosphere and stratosphere; solar fluxes from X-rays to infrared.

J. H. Carver (Australia), P. C. Simon (Belgium), M. R. Torr (USA)

II-3 Atmospheric Quantal Emissions:

Includes observations and theory of auroral and airglow emissions, from X-rays to infrared; excitation mechanisms; applications to studies of upper atmosphere composition, dynamics and energetics.

R. R. Meier (USA), N. N. Shefov (USSR), A. Vallance-Jones (Canada)

II-4 Ionospheric Small-Scale Structures:

Includes structures at all ionosphere heights and all latitudes, especially phenomena in the aurora and equatorial regions.

S. L. Ossakow (USA), R. Raghavarao (India), A. V. Shirochkov (USSR)

II-5 Ionosphere-Magnetosphere Interactions:

Includes large-scale electrodynamic and energetic particle effects of the magnetosphere on the ionosphere (to be coordinated with the corresponding Div. III topic). M. Blanc (France), A. Brekke (Norway), R. A. Wolf (USA)

II-6 Stratosphere-Mesosphere-Ionosphere Interactions

Includes electrodynamic and other coupling; atmospheric turbulence and waves and their effects on circulation and energy balance; noctilucent clouds.

B. R. Clemesha (Brazil), M. Gadsden (UK), H. Volland (Fed. Rep. Germany)

II-7 Aeronomy of Other Planetary Atmospheres:

Includes the aeronomy of planets and their satellites in the solar system.

A F. Nagy (USA), V. I. Moroz (USSR), U. Von Zahn (FRG)

II-8 Laboratory Experiments of Aeronomic Interest:

Includes cross-sections for photoionization and impact processes, rates of neutral and ionic reactions of relevance to the exosphere, thermosphere, mesosphere and stratosphere.

K. C. Clark (USA), D. Smith (UK), S. Trajmer (USA)

II-9 Planetary Exospheres:

Includes dynamics and composition of exospheres of the earth and planets; interactions between neutral and ionized constituents.

B. A. Tinsley (USA), A. Vidal-Madjar (France), M. K. Wallis (UK)

#### **Division II Nominees**

Div. II—Div. III Working Group on the Auroral Oval and Its Extension into Space: M. H. Rees (USA)

Interdivisional Working Group on Relations between Internal and External Magnetic Variations: A. D. Richmond (USA)

Interdivisional Commission on the Middle Atmosphere: P. C. Simon (Belgium)

Joint IAGA/URSI Working Group on Wave Instabilities in Space Plasmas: S. L.

Ossakow (USA)

For information (not appointed by Division II):

- IAGA/URSI Joint Working Group on Structure and Dynamics of the Thermosphere, Ionosphere and Exosphere: Chairman: J. V. Evans (USA), Vice-Chairmen: G. Kockarts (Belgium), H. Kohl (Fed. Rep. Germany).
- IAGA/URSI Joint Working Group on Neutral and Ion Chemistry and Solar Fluxes: Chairman: L. Thomas (UK), Vice-Chairmen: A. D. Danilov (USSR), D. G. Torr (USA).

# IAGA/URSI JOINT WORKING GROUP ON STRUCTURE & DYNAMICS OF THE THERMOSPHERE, IONOSPHERE & EXOSPHERE

An open meeting of the Group was held at the Australian National University, Canberra, on 5 December 1979, lasting from 2000 to 2145. The JWG Chairman, J. V. Evans, was unable to be in Canberra and the meeting was conducted by H. Rishbeth.

- H. Rishbeth outlined the group's activities as reported in circular TIE-5 (June 1978). Furthermore, the joint URSI-IAGA-COSPAR Symposium II-1 on 'Dynamics of the Thermosphere and Ionosphere and Effects on Composition', which covered the JWG's field, had attracted a good crop of papers and was drawing a good audience, within the current IAGA Assembly. Symposia of this type represented the principal activity carried out under the general aegis of the JWG.
- M. Blanc, Vice-Chairman of the URSI Incoherent Scatter Working Group, reported on the group's successful coordination of electric field measurements by incoherent scatter radars, the arrangements for data exchange and collation, and the progress of electric field modelling. Future developments would include high-latitude studies using three radars (Millstone Hill, EISCAT and Chatanika—later Greenland).
- R. G. Roper described the operation of the coordinated meteor radar network. (Report available from NSF). It is planned to archive the data in a common format. Future observing plans include a long period in northern spring. It was noted that VHF MST radars can serve as meteor radars.
- J. D. Whitehead described some conclusions of the Report of the Australian National Committee on Radio Science on "Ionospheric Research Policy". The report stresses the important role of Australia, as a major Southern Hemisphere country, in ionospheric sciences and stresses practical applications of the subject. Future US plans in the JWG's field were discussed by J. R. Doupnik, specifically regarding incoherent scatter and the projected move of the Chatanika radar to Greenland; and also by S. A. Bowhill who particularly dealt with MST radars and possibilities for Lidar facilities, especially on Spacelab/Shuttle. Indian, Japanese and UK plans were also briefly discussed. The question was raised as to whether any equipment from the former Malvern incoherent scatter radar would be available for use elsewhere.
- J. A. Gledhill described current thinking regarding the Southern Hemisphere Incoherent Scatter concept (SHISCAT). The relative merits of a site conjugate to an existing Northern Hemisphere observatory, of a site in the polar cap, and of a movable (shipboard?) system need critical examination. A report is to be made to the URSI Assembly in 1981.

Regarding the future of the JWG: although the meeting produced some good discussion,

it was difficult to identify any essential role for the JWG. Some suggestions were however made that the JWG leadership could consider as potential activities for promotion by the Group:

- (1) Considering that sophisticated 3-dimensional dynamical models of the Thermosphere are being developed (e.g. those described in Symposium II-1 by R. E. Dickinson and by D. Rees), experimental tests of these models by a variety of techniques should be planned (S. A. Bowhill). (In this connection, the importance of providing adequate computer time for the development of such models was stressed by others).
- (2) Coordinated studies of the midnight equatorial temperature bulge and of high latitude/low latitude electrodynamic coupling should be encouraged (R. Raghavarao).

Some opinions were expressed that the pursuit of objectives such as (1) and (2) did not require the JWG. In any case, it was noted that the IAGA Division II Business Meeting has recommended that the JWG should lapse after the URSI and IAGA Assemblies in August 1981, unless a strong case for its continuation was made.

(Report by H. Rishbeth based on notes taken by J. R. Dudeney).

# REPORT ON ACTIVITIES OF THE JOINT IAGA/URSI WORKING GROUP ON "NEUTRAL AND ION CHEMISTRY AND SOLAR FLUXES"

The initial membership of the Working Group was based on members previously involved with the URSI Commission 3 Working Group 3.5 on "Production and loss of ionization including flare effects" and IAGA Division II Topic 2 on "Solar fluxes and photochemistry of ionized and neutral constituents, including excited species". Since the IUGG General Assembly at Grenoble additional members have been chosen to introduce particular expertise.

The membership suffered a tragic loss in the untimely death of Professor Takao Tohmatsu on 19 November 1977. He will be sorely missed by his friends within IAGA and URSI and by the international aeronomical community generally.

Members of the Working Group helped organise the joint COSPAR/IAGA Symposium on "Minor Constituents and Excited Species" which formed part of the 19th meeting of COSPAR, held in Philadelphia during 1976, and the Symposium on "Ions in the Middle Atmosphere" held as part of the IAGA/IAMAP Joint Assembly at Seattle during August/September 1977. In addition, active parts have been played in organising and participating in the planning meeting for MAP held at Urbana in June 1976.

Informal meetings have been held by groups of members at times of international symposia and other business of the Working Group has been performed by correspondence.

(L. Thomas, Chairman)

#### DIVISION III ON MAGNETOSPHERIC PHENOMENA

#### REPORTER REVIEWS

- (5 December 1979, a.m. and p.m., Room: Copland Theatre, Chairman: C.-G. Fälthammar)
  - Topic III-1. Magnetic field, electric fields and current systems including ground observations (by G. Rostoker)
  - Topic III-2. Magnetosheath, magnetospheric boundary and plasma penetration (by G. Haerendel)

- Topic III-3. Distribution and properties of magnetospheric plasmas (by V. M. Vasyliunas)
- Topic III-4. Energetic particle populations including cosmic ray entry (by L. J. Lanzerotti and M. Schultz)
- Topic III-5. Magnetic oscillations, waves and wave-particle interactions (by D. J. Southwood)
- Topic III-6. Magnetic storms and substorms, including aurora-magnetospheric relations (by S.-I. Akasofu and Y. Kamide)
- Topic III-7. Magnetosphere-ionosphere interactions (by L. P. Block)
- Topic III-8. Magnetospheres of other planets (by A. J. Dessler)
- Topic III-9. Laboratory experiments of magnetospheric interest (by N. Kawashima)

Editors Note: The Chairman of IAGA Division III, Prof. C.-G. Fälthammar, prepared an activity report 1975–1979 of IAGA Division III in September 1979 for the IAGA Executive Committee. The report summarizes the topic reporters' efforts and the activity of internal Working Groups (including the Joint Working Groups with Division II and URSI). The report on these Working Group activities is introduced elsewhere in this Transactions. Division III initiated the Reporter Reviews in 1975 for the Grenoble Assembly, and this system has now been applied to all IAGA Divisions since the Seattle Assembly. In Division III, in addition to oral presentations, topic reporters prepared more comprehensive written reports for distribution to interested scientists. At each Assembly a list of the available Reports has been circulated by the Division Chairman to all Members-at-Large of the Division, with an invitation to request copies. After the 1975 Grenoble Assembly several hundred requested copies were distributed by the Division Chairman. After the 1977 Seattle Assembly the actual distribution was handled by the Reporters themselves.

#### BUSINESS MEETING OF DIVISION III

(5 December 1979, 1600-1830 h)

#### 1. Information about the New Division Leadership

It was announced that in accordance with By-Law 3, the Executive Committee had appointed (and the Conference of Delegates ratified) the following Division III leadership for the period 1979–1983.

Chairman:

G. Rostoker (Canada)

Co-Chairmen:

A. Nishida (Japan)

M. I. Pudovkin (U.S.S.R.)

R. G. Rastogi (India)

#### 2. Revision of Division III Reporter Topics

In accordance with By-Law 2 the structure of Reported Topics was discussed, and it was decided to propose to the Executive Committee that the following changes be made:

- a) Divide the present Topic III-5, "Magnetic Oscillations, Waves and Wave-Particle Interactions" into two topics, namely "ULF Waves" and "Plasma Waves and Wave Particle Interactions".
- b) Change the present Topic III-9, "Laboratory Experiments of Magnetospheric Interest" to "Active Space Experiments, Laboratory Experiments and Computer Simulation".
- c) Combine the present Topics III-1 "Magnetic Field, Electric Fields and Current

Systems, Including Ground Observations" and III-7 "Magnetosphere-Ionosphere Interactions" into a single Topic numbered III-1 and called "Magnetosphere-Ionosphere Interactions".

The proposed revised list of Topics is given below.

- III-1 Magnetosphere-Ionosphere Interactions
- III-2 Magnetosheath, Magnetospheric Boundary and Plasma Penetration
- III-3 Distribution and Properties of Magnetospheric Plasmas
- III-4 Energetic Particle Populations Including Cosmic Ray Entry
- III-5 ULF Waves
- III-6 Plasma Waves and Wave Particle Interactions
- III-7 Magnetic Storms and Substorms, Including Aurora-Magnetosphere Relations
- III-8 Magnetospheres of Other Planets
- III-9 Active Space Experiments, Laboratory Experiments and Computer Simulation

#### 3. Appointment of New Reporters

In accordance with By-Laws 4 and 5 new Reporters were appointed for the time period 1979–1983. At an early time all Div. III Members-at-large had been informed that the Division Leadership intended to appoint new Reporters for all Topics and had been invited to submit nominations. Based on these nominations and additional nominations made at the Business Meeting, a secret ballot was taken as a guide for the appointments. Based on the outcome of the ballot the Division Leadership appointed the Reporters for each Topic. In cases where the preferred candidate could not be reached for confirmation of acceptance, a second and third appointee was selected. The Division Chairman will contact the appointees for confirmation and inform the Executive Committee of the final list of Reporters.

(see pp. 154-155)

#### 4. Review of Division III Working Group Structure

In accordance with By-Law 2, the Working Group structure (including both internal and joint Working Groups) was reviewed and discussed. It was decided to propose to the Executive Committee that no change of the Working Group Structure be made at this time.

#### 5. Appointment of Working Group Leaders

In accordance with By-Laws 4 and 5, Leaders of Division III internal Working Groups and Division III Co-Leaders of Joint Working Groups were appointed for the time period 1979–1983 as follows (In most cases, marked by asterisks, the Leaders were reappointed).

WG III-1 Magnetic Pulsations

Co-Chairmen: B. J. Fraser\* (Australia) and F. Glangeaud\* (France)

WG III-2 Composition of the Hot Magnetospheric Plasma

Co-Chairmen: R. G. Johnson\* (U.S.A.), G. Haerendel\* (Fed. Rep. Germany)

WG III-3 Quantitative Magnetospheric Models

Chairman: W. P. Olson\* (U.S.A.)

Joint Division II/Division III WG on the Auroral Oval and Its Extension into Space

Chairman: C. T. Russell (U.S.A.)

Vice-Chairmen: A. Egeland (Norway), A. D. Johstone (U.K.),

M. H. Rees (U.S.A.)

IAGA/URSI WG on Passive Electromagnetic Probing of the Magnetosphere

Co-Chairman for IAGA Div III: M. J. Rycroft\* (U.K.)

IAGA/URSI WG on Wave Instabilities in Space Plasmas

Co-Chairman for IAGA Div III: R. L. Dowden (New Zealand)

# 6. Planning of Div. III Scientific Sessions for the 1981 IAGA Assembly

Proposed symposium topics had been received from the various Working Groups and from individual scientists. Thus the Business Meeting had a total of 16 topics to consider, in addition to Reporter Reviews and General Contributions.

A selected list of topics had been prepared by the Division Chairman and Co-Chairmen as a basis for discussion of the very difficult choices to be made.

After thorough discussion the proposed list was adopted with minor modifications. The adopted list, given below implies a total of 16 half days. This number reflects a general feeling at the Business Meeting that the recommended number of 10–14 half days was somewhat small considering the total number of working days during the Assembly.

Based on indications that the Program Committee, when having access to the total picture including all Divisions might or might not relax the constraint on the number of half day sessions a given Division may use, four additional half-day sessions were placed on a "waiting list". These are also given below.

Reporter Review (2 half-days)

General Contributions (3 half-day sessions; parallel sessions may be needed)

Acceleration Processes and Wave Particle Interactions (2 half-days; Proposed by JWG on Wave Instabilities in Plasmas to be the IAGA Div. III part of a Wave and Instabilities symposium held partly at URSI and partly at IAGA)

The Role of Ion Composition in Understanding Magnetospheric Processes (2 half-days) Characteristics and Large Scale Structure of *Pi2* Pulsations (1 half-day)

The Physics of Pulsation Resonance Regions (1 half-day)

Quantitative Comparisons of Magnetospheric Event Data and Models (2 half-days)

Polar Cusp and Magnetopause Boundary Layers (3 half-days)

Additional sessions if time allocation allows (not in order of priority)

- 1. Polar Cap Phenomena (2 half-days)
- Mapping of Hydromagnetic Waves between the Magnetosphere and the Ground (1 half-day)
- 3. Hydromagnetic Wave Particle Interactions (1 half-day)

#### 7. Resolutions

The following three proposals were endorsed, i.e.

1. Noting that many IAGA member countries are now formulating plans and programs for solar-terrestrial research in the 1985–1990 period, and

recognizing that early coordination of programs was a key in the success of the IMS program,

IAGA urges that member nations now take steps to ensure international coordination to develop an International Solar Terrestrial Physics Program in the 1985–1990 time frame.

(Originator: D. J. Williams)

#### 2. Noting

i) the success of radar techniques in providing new information of dynamic and spatial

structure of electric fields, and

ii) the importance of such information for increasing the present understanding of ionosphere-magnetosphere coupling and global energy dissipation in the ionosphere through Joule heating,

IAGA *urges* that member nations collaborate in establishing additional radar systems over as wide a longitude range as possible and in both hemispheres.

(Originator: A. D. M. Walker)

#### 3. Resolution of thanks

IAGA expresses its gratitude to those member countries that hosted in recent years, successful international conferences in the fields of IAGA's interest, including IMS and other projects.

(Originator: N. Fukushima)

#### 8. Any Other Business

On a motion from the Chairman-elect, G. Rostoker, the meeting passed a vote of thanks to the outgoing Chairman C.-G. Fälthammar and Co-Chairmen R. Gendrin, T. Obayashi, and D. J. Williams in recognition of their highly valued service to the Division.

Although a second Business Meeting was scheduled originally in the evening of 7 December 1979, it turned out not to be needed and it was hence cancelled.

# Working Group III-1: Magnetic Pulsations

- 1) Name: The Working Group prefers to have a new name "ULF Pulsations" not restricted to magnetic variations.
- 2) Preparations for Next Meeting: Dr. D. J. Southwood is thanked for his good preparations for the present meeting in Canberra. For the next one in Edinburgh it will be W. J. Hughes' job. Two or three half-day sessions are planned for IAGA. Another one devoted to wave particle interaction will be included in a joint session URSI-IAGA. For the first session on Pi2 and polar pulsations we will try to have a suitable room to hold an active poster session. The second one, resonances in the magnetosphere including mapping in the ionosphere, will be classical. In both sessions, review papers will be delivered.
- 3) A motion asking observatory and network stations to continue recording ULF has been transmitted. If any laboratory has some unused instruments for observations, it is kindly requested to make an announcement in the newsletter.
- 4) Newsletter: Dr. B. J. Fraser has done a good job with the newsletter. It has been very helpful these last four years. To assist the newsletter additional proposals have been made:
  - a) W. F. Stuart has to prepare an up-to-date list of observatories and networks, and detail the instruments used. A special map of Scandinavia will be helpful.
  - b) P. F. Fougere will choose a special interval of Pi2 already recorded in order to prepare a world study of individual events.
  - c) F. Glangeaud will make a list of signal processes available for ULF Studies. It is sometimes difficult to choose which day should be studied in more detail. The newsletter is the right place to let people know which day is already being studied by colleagues. Please send a list. Let us know your latest references. Information will be distributed in the Newsletter.

The ULF Symposium has presented the interesting progress made in Pc3-4, Pi2 and Pi1 (in measurement and theory) and relations with other phenomena. Boundary effects (magnetosphere and ionosphere) have been studied but there are still more problems to solve. We are looking forward with anticipation to solutions being found in the near future.

(B. J. Fraser and F. Glangeaud, Co-Chairmen)

# Working Group III-2 on Composition of the Hot Magnetospheric Plasma

Working Group III-2 met as scheduled on 5 December 1979 at the XVII IUGG/IAGA General Assembly.

The activities of the past two years were discussed. These activities included the planning and implementation of coordinated satellite data acquisition for 7 satellites containing hot plasma composition instrumentation. The contributions of the plasma composition observations to the Coordinated Data Analysis Workshop II were reviewed. Efforts to encourage an international organization to assist in planning and coordinating the IMS-Data Analysis Phase were discussed.

Group activities for the next two years were reviewed. These included the analysis efforts for coordinated satellite data on plasma composition that have been required. WG III-2 endorsed and plans to support a symposium on "The Role of Ion Composition in Understanding Magnetospheric Processes" at the IAGA meeting in Edinburgh in 1981 and a second Coordinated Data Analysis Workshop on "Quantitative Comparisons of Magnetospheric Models and Data" for selected periods of geomagnetic activity.

(R. G. Johnson, Chairman)

# Working Group III-3 on Quantitative Magnetospheric Models

Current activities include the following:

- 1) With tentative Division approval—will select ad hoc committee to plan 1 or 2 workshops to be held before next IAGA meeting at which time workshop results will be the subject of a symposium on the quantitative comparison of data and models for specific magnetospheric events.
- 2) WG agrees to help IAGA representative to IUGG "Project Earth" (headed by Shebalin). The IAGA input on a magnetospheric description will emphasize its variability and control by solar and interplanetary processes.
- 3) Discussed results from recent Chapman conference on quantitative modeling and the current status of modeling generally.
- 4) Held symposium at Canberra on the quantitative understanding of magnetospheric processes.
- 5) Agreed that our newsletter will be published at irregular intervals—2 or 3 times annually. We will coordinate our letter closely with the IMS newsletter which will continue publications through the data analysis phase.
- 6) WG will correspond with national committees on IMS data analysis and provide vehicle for continued international exchange of IMS related business.
- 7) Work with Division II to obtain support for symposium on the quantitative specification sources of variability in the earth's surface magnetic field.

(W. P. Olson, Chairman)

# Divs. II and III Joint Working Group on the Auroral Oval and Its Extension into Space (WGAO)

WGAO was set up as a joint IAGA-URSI working group in 1974. Because of the reorganization of URSI and the elimination of the geophysical aspects of the ionospheric research from its program, WGAO was transformed into a IAGA working group in 1977.

The main task of the working group is to stimulate cooperation and information exchange within the large number of scientists who are working with different aspects of the auroral phenomena in different regions of the magnetosphere. WGAO has carried out its work by means of a Newsletter and by organizing meetings, mainly during the IAGA Assemblies. Both at Grenoble and at Seattle WGAO planned and organized a number of sessions on high latitude phenomena.

The intense international collaboration within the framework of IMS has had the effect that temporarily the need of distributing information of interest to the auroral physics community is being filled by the IMS-Newsletter which quickly and efficiently brings such information that earlier was contained in the WGAO Newletters and much additional information to all members of the Working Group. The WGAO Newsletter is, therefore, used during the IMS only for distribution of information of interest only for the restricted group of WGAO members.

In connection with the IUGG General Assembly in Canberra, Australia, a special IMS Symposium was organized in Melbourne in the last week of November 1979. The IMS Symposium covered all fields of interest of the WGAO membership. The program of the symposium had been planned and organized by a special Program Committee. WGAO has, therefore, not been directly involved in the organization of scientific sessions during the Canberra IUGG Assembly but it has been represented on the Program Committee of the IMS Symposium by its Vice-Chairman.

WGAO has about 160 members. If anyone who is not yet a member wants to join WGAO or if any information about the working group and its activities is needed, please contact the Chairman or Vice-Chairman. The WGAO held its business meeting on the morning of 4 December 1979 during the Canberra Assembly, and discussed the leadership for the period 1979–1983 and the proposals for session topics for the 1981 Edinburgh Assembly to be presented to Division II and III Business Meetings.

After the Canberra Assembly, the leadership of WGAO is

Chairman: C. T. Russell (U.S.A.)

Vice-Chairmen: A. Egeland (Norway), A. D. Johnstone (U.K.), M. H. Rees (U.S.A.)

(Bengt Hultqvist, Outgoing Chairman of WGAO)

# IAGA/URSI Joint Working Group on Wave Instabilities in Space Plasmas

Meeting was held in the evening of 4 December 1979. Present: P. L. Dyson (Co-Chairman, IAGA Division II), P. J. Palmadesso (Co-Chairman, URSI), R. L. Dowden, S. Grzedzielski, D. Nunn, H. Oya, L. Zelenyi.

## Symposium on Wave Instabilities in Space Plasmas

Since the next URSI General Assembly will be held in Washington, D.C. just before the

next IAGA Symposium in Edinburgh, the JWG decided that it should organize a Symposium on Wave Instabilities in Space Plasmas, part of which will be held at the end of the URSI meeting and part held at the beginning of the IAGA meeting. There are two main reasons for suggesting this, viz.

- 1) 1981 is an appropriate time to hold another symposium along the lines of the very successful symposium organized by the JWG at the Helsinki URSI meeting held in 1978.
- 2) because of the strong interest in both URSI and IAGA, such a symposium should not be held within just URSI or IAGA when this meeting will be held so close in time. Having the JWG organize part of the symposium at URSI and part at IAGA will ensure a minimum of overlap in topics and ensure the most efficient use of the time available at each meeting.

The Symposium on Wave Instabilities in Space Plasmas will require two full days at both URSI and IAGA. At the IAGA meeting, this could be accomplished by Division II asking the JWG to organize two half-day sessions on Ionospheric Irregularities and Small Scale Auroral Structures; and by Division III asking the JWG to organize two half-day sessions on Acceleration Processes and Wave-Particle Interaction at 3000–10000 km altitude and on (say) plasma aspects of reconnection.

The JWG would like to be able to change the above session titles if it seemed appropriate at a later date. However, it would guarantee to include the above topics within any new topic titles. Topics which the JWG wants to include in the Symposium are:

Ionosphere irregularities;

Acceleration processes and wave particle interaction at 3000–10000 km. (to include anomalous resistivity, double layers, electrostatic shocks);

Plasma aspects of reconnection;

Terrestrial kilometric radiation:

Ionosphere heating experiments;

Interaction of newly ionized particles with the plasma background (kinetic instabilities)

It is also intended to organize an informal discussion on numerical methods—D. Nunn to organize.

Co-Chairmen: If the Symposium on Wave Instabilities in Space Plasmas is suggested by IAGA, it should appoint Co-Chairmen who are willing and able to immediately begin planning the Symposium. We nominate R. L. Dowden to be the representative of Division III and he, together with P. J. Palmadesso (representing URSI) will accept overall responsibility for planning the Symposium.

It is appropriate for one of the resporters for Ionospheric Irregularities to represent Division II on the JWG. Since *P. L. Dyson* has completed his term as a reporter for Ionospheric Irregularities, it is recommended that one of the new reporters be a person willing and able to assist with the planning of the Symposium on Wave Instabilities in Space Plasmas. This person should be appointed as soon as possible. *S. Ossakow* has expressed his willingness to be available and the JWG nominates him as Division II representative and a reporter on Ionospheric Irregularities.

(P. L. Dyson, Co-chairman)

# IAGA/URSI Joint Working Group on Passive Electromagnetic Probing of the Magnetosphere

The meeting was held in the evening of 5 December 1979. Present: R. L. Dowden (New Zealand), Chairman; M. K. Andrews (New Zealand), T. R. Kaiser (U.K.), N. G. Kleimenova (U.S.S.R.), F. B. Knox (New Zealand), O. M. Raspopov (U.S.S.R.), A. J. Smith (U.K.), A. D. M. Walker (South Africa), I. A. Zhulin (U.S.S.R.).

Unfortuantely, neither of the co-chairmen of the Working Group were able to be present, and there was no representative of the Stanford group, as *U. S. Inan* had to return to the U.S.A. However, *D. L. Carpenter* had written a letter suggesting topics which could be considered, and these were discussed in turn.

#### 1. Session on Ray Tracing for 1981 URSI Assembly

Kimura had suggested that such a session be held. Walker thought that there were not enough people involved in ray-tracing work present at the meeting to assess the value of such a session and suggested that Kimura send a circular to canvass opinions. Dowden expressed the view that ray-tracing was a more or less standard technique and wondered whether there would be sufficient new development by 1981 to merit a special session. Zhulin said that his group would definitely be interested in attending an contributing (probably two or three papers) to such a session.

It was suggested, and generally approved, that the topic would be suitable for a workshop to be held at the URSI Assembly, and it was recommended that the Co-Chairmen (*Carpenter* and *Rycroft*) should send a circular to the working group members to get opinions on this.

#### 2. IMS Data Sets

Carpenter had requested all groups to send him lists of their 1972–79 data sets, i.e. lists of dates and times for which they have data from their various stations. He would then compile and circulate a master list. The meeting agreed that this would be a very useful project—it would be possible then to see at a glance, which stations had simultaneous data for a particular period of interest. It was recognized that there were practical problems, e.g. man hours required in preparing such lists, but groups were urged to do so and send to Carpenter. Type of recording, e.g. 'continuous', one minute in five, 'DF", etc. should be indicated in the list.

#### 3. Future Directions in Direction Finding and Related VLF Imaging

A number of different d.f. systems had been developed over the years, e.g. goniometer, Leavitt tracker/d.f., Japanese system. Compared to the goniometer, the latter two systems have the advantage of an essentially instantaneous direction reading but the disadvantage of being unable to process more than one simultaneously observed signal. The Japanese groups were experimenting with a special station, interferometer approach. *Dowden* stated that his group was no longer doing DF work although he had experimented with goniometers in earlier years.

Walker said that the emphasis should be placed on developing improved techniques for analyzing the data. His group were at present experimenting with a minicomputer based system. This applied to all VLF recordings—not just DF. Smith commented that much work was still to be done in comparing simultaneous DF recordings made during the IMS (e.g. Palmer, Hulles, Seal, Sanae) and it was hoped to proceed rapidly with this.

Kaiser pointed out the advances in VLF data processing capability made possible by the Sheffield University semi-automatic analyzer—speeding up analysis by a factor of at least 50

compared to the hard copy sonagram method. Smith added that the Sheffield system was also being upgraded by the addition of a micro-computer.

Walker commented that the VLF beacon to be flown on the Space Shuttle would open up new opportunities, for example in South Africa, for direction finding experiments. Because of the Shuttle's near equatorial orbit, the Antarctic network of stations would not be able to see the beacon.

There was some discussion about the compatibility of data exchanged between various groups. At present this was by means of analog tape recordings or film spectrograms and there was little problem. However, the exhange of data in digital form may become desirable in the future, and some thought should be given to the definition of a standardized format for such data. It was also mentioned that digital recording may be a possibility in the not so distant future, as this seems to be the way in which commercial hi-fi systems are moving.

#### 4. VLF Radiometry

The Stanford Group is interested in developing a standardized radiometer system. This would presumably be similar in principle to the old hiss recorder (*Dowden*), or the Sheffield multi-channel receiver, but with digital outputs.

There was some discussion about methods of calibrating VLF receiving systems. *Dowden* said he uses two methods—one with a coil carrying a large oscillating current, situated some distance from the loop aerials and one using a dummy aerial. In the latter case either a monochromatic or a noise signal may be used for calibration depending on the application. Such a calibration signal was recorded on all data tapes. The Sheffield method was similar except that a coil at the centre of the loop aerial was used. The Russian group (*Kleimenova*) used a method involving a mu-metal cored aerial.

Smith mentioned that he had prepared a report on the Sheffield receiving equipment as used at Halley Bay, detailing brief system description, calibration methods, amplitude sensitivities, frequency response, and typical signal strengths of various types of signals observed (e.g. whistlers, Omega transmitters, hiss etc.) relative to receiver noise. (A copy of that report will be sent to anyone interested.) This was circulated to the various groups with a request for reciprocation, as this would be a guide in interpreting simultaneous signals seen at different stations (e.g. If a signal is seen at Sanae, say, and not at Halley, is that due to a real intensity difference or a difference in equipment response?) So far corresponding information has only been received from Stanford.

#### 5. Future of the Working Group

It was reported that the IAGA Division III Business Meeting had reappointed M.J. Rycroft to serve as the IAGA Co-Chairman for another term. D. L. Carpenter will probably wish to step down as co-chairman at the time of the 1981 URSI Assembly so a new co-chairman will be needed then if the Working Group is to continue in its present form.

It was generally agreed that the Working Group has served a useful purpose and could continue to do so. Through the newsletter, it has helped contact with some groups (e.g. Brazilian workers—Walker) which would not otherwise have been made, and assisted exchange of information. The good response to the whistler propagation and direction finding symposium (organized by Tsuruda & Walker) at Helsinki was thought to be largely due to contacts via the Working Group. It also acted as a channel through which to suggest new ideas and experiments.

The newsletter was generally thought by the meeting to be valuable, and members were

urged to exchange information through it by submitting material to *Carpenter* for inclusion. This might include lists of especially interesting events (e.g. during the IMS period) which were being studied, and news of new experiments, particularly active experiments.

#### 6. Future Work

The meeting felt strongly that the emphasis in the next few years should be placed on detailed study of the data sets which had been gathered during the IMS. This would include the development of more sophisticated processing and analysis techniques mentioned earlier. This general theme was also strongly emphasized at the IMS symposium in Melbourne. It is the only data gathering phase of the IMS which is now over. In order to obtain the maximum benefit from the great experimental efforts which have been made, we should concentrate on making the best use of the data which has been collected.

Meanwhile, experimental programs will continue and will be improved with perhaps a new experimental effort in mind for the second half of the new decade—the OPEN era.

(A. J. Smith)

# Recent Activities of the URSI-IAGA Working Group on Passive EM Probing of the Magnetosphere

Newletters circulated to a working group membership of approximately 55 scientists have been the principal way of conducting business within the working group since its inception in 1975, and in the lifetime of the preceding group, which actually came into being in 1969. Newsletters have been circulated through the cooperation of World Data Center A at Boulder, Colorado, U.S.A. They have been issued on at least an annual basis with the purpose of notifying participating groups about experimental campaigns, proposing future activities, identifying new research opportunities, discussing certain problems of data analysis and so forth. A valuable adjunct to the main working group newsletters have been specialized communications and newsletters issued by reporters within the working group. These reporters were assigned to particular topics of wide interest such as direction finding, raytracing, propagation between conjugate ground points, and curve fitting. Reporters on these topics who have assisted valuably are K. Tsuruda, I. Kimura, A. D. M. Walker and Y. Corcuff.

At the suggestion of *K. Tsuruda*, a special session on whistler mode propagation with emhasis on VLF direction finding was held at the XIXth URSI Assembly in 1978. The meeting was convened by *K. Tsuruda* and *A. D. M. Walker*. Informal meetings of the working group were held at the IAGA meeting at Seattle in 1977, and also at Helsinki in 1978.

Special international IMS plasmapause and/or direction finding campaigns have been held in each of the IMS years 1976 through 1979. These have been partially coordinated and publicized through the working group. At the Helsinki meeting some of the initial results of direction finding during these campaigns were reported. Currently, there are multi-group efforts underway to intercompare signal amplitudes at spaced stations and to investigate plasmapause-plasmasphere dynamics using the IMS campaign data.

(D. L. Carpenter, Co-Chairman)

# DIVISION IV ON SOLAR WIND AND INTERPLANETARY MAGNETIC FIELD

#### REPORTER REVIEWS

(6 December 1979, p.m., Room: Copland G7, Chairman: K. I. Gringauz)

- Topic IV-1. Large-scale characteristics of the interplanetary medium (Feldman et al., presented by D. N. Baker)
- Topic IV-2. Waves, discontinuities and shocks in the interplanetary plasma (by F. M. Neubauer)
- Topic IV-3. Solar wind interactions with unmagnetized or weakly magnetized bodies (by C. T. Russell)
- Topic IV-5. Evolution of the sun and solar system as deduced from solar wind observations (by C. P. Sonett)

## BUSINESS MEETING OF DIVISION IV

The business Meeting of IAGA Division IV was held after the Reporter Review on 6 December 1979 in the Copland G7 room, presided over by the chairman, K. I. Gringauz. The main results of the meeting were as follows.

# 1. Leadership in the 1979-1983 period.

The following nominations were approved:

Chairman:

H. Rosenbauer (Fed. Rep. Germany)

Co-Chairmen:

L. F. Burlaga (USA) and T. Gombosi (Hungary)

#### 2. Revision of Internal Structure in Division IV.

It was agreed to add a new topic (topic IV-6) in addition to five existing topics. The candidates of reporters for each topic were proposed, although some of them are to be confirmed. The proposed internal structure and reporters were as follows:

Topic IV-1. Large-Scale Characteristics of the Interplanetary Medium Reporters: W. C. Feldman (USA), F. Mariani (Italy),

J. Scudder (USA), E. J. Smith (USA).

- Topic IV-2. Waves, Discontinuities and Shocks in the Interplanetary Plasma Reporters: M. Dobrowolny (Italy), F. M. Neubauer (FRG), S. Pinter (Czechoslovakia), O. Vaisberg (USSR)
- Topic IV-3. Solar Wind Interaction with Unmagnetized or Weakly Magnetized Bodies Reporters: T. K. Breus (USSR), C. T. Russell (USA).
- Topic IV-4. Solar Activity, Interplanetary Dynamics and Terrestrial Disturbances
  Reporters: S. M. Mansurov (USSR), M. Scherrer (Belgium),
  R. Schwenn (FRG), N. R. Sheeley (USA)
- Topic IV-5. Evolution of the Sun and Solar System as Deduced from Solar Wind Observations

  Reporters: J. Geiss (Switzerland), C. P. Sonett (USA).
- Topic IV-6. Interaction of the Interplanetary Neutral Gases and the Solar Wind Plasma Reporters: T. E. Holzer (USA), S. Grzedzielski (Poland)

### 3. Proposed Sessions for the Edinburgh Assembly

In addition to Reporter Review Sessions, the following four sessions were proposed for the next IAGA Assembly in Edinburgh in August 1981.

- 1) Large-scale structure and evolution of the solar wind (2 half-days; Proposed conveners: D. S. Intriligator and R. Schwenn)
- 2) Kinetic physics and plasma turbulence in the solar wind (2 half-days; Proposed conveners: D. A. Gurnett and M. Dobrowolny)
- 3) Solar wind during solar maximum (1 half-day; Proposed conveners: M. H. Acuna and F. Mariani)
- Origin and composition of the solar wind (1 half-day; Proposed conveners: M. Neugebauer and W. I. Axford)

The report by W. Coles and W. C. Feldman on International Workshop on Solar Wind Studies sponsored by IAGA, which was carried out in Moscow in April 1979, was presented by the chairman. The resolution of thanks to Soviet Geophysical Committee for organization of this workshop was adopted.

The business meeting closed with thanks to the outgoing chairman, co-chairmen and topic reporters or correspondents for their devotion to the activity of Division IV.

(K. I. Gringauz and L. F. Burlaga)

# Activity Report of IAGA Topic IV-5 Group

Research in the group directed by the undersigned during the past four years has consisted of three major areas of study:

- a) The magnetohydrodynamic structure of the solar wind,
- b) Physical models of the terrestrial planets and Moon with emphasis upon the very early thermal profiles, and
- c) Electromagnetism in the primordial solar system including remanent magnetization.

Under (a), we have been investigating the wave structure, expecially looking at the relationship between propagation direction determined from minimum variance analyses and the average IMF direction and also examining dual spacecraft cross-correlations of large amplitude Alfvén waves. Extension of this work from Explorers 33 and 35 (presently used) to Pioneers 9, 10, and 11 is planned. A key problem is the disparity between theoretical predictions of radial propagation of waves in the solar wind and the apparent steeply peaked clustering of minimum variance directions about the direction of the mean magnetic field.

Under (b), we are engaged in the problem of detection of a metallized core in the Moon using sounding data from Apollo magnetometers. This problem is complicated by the presence of a second source of excitation seated in the time variations of the diamagnetic cavity downstream of the Moon. Theory and experiment carried out jointly with Podgorny in Moscow provides the evidence for this second source. A better overall electrical profile of the Moon is also sought in trying to answer whether the putative conductivity "spike" is real, and also to attempt a globally averaged and improved heat flux determination. The properties of k in the solar wind are also connected with inversion of lunar electrical conductivity data, because for short wavelengths compared to lunar radius higher order magnitude multipoles are excited in the Moon; this excitation is strongly dependent upon the angle of arrival of waves (formally similar to Mie scattering).

The third area of research (c) encompasses improved magnetic maps of the Moon with the

end desire of finding the true source of permanent magnetization. The magnetization of meteorites has also been investigated in trying to determine the source(s) of the background field responsible for the thermoremanence. Early solar system field candidates are an enhanced field of the early Sun and nebular dynamo. Both have problems of geometry related to the need for a stationary field as seen from the frame of reference fixed in a meteorite parent object or the Moon.

In connection with early solar system electromagnetics, we have continued calculations of the model of heating seated in electrical induction with application especially to asteroidal parent objects. A possibility for channelled heating arises from instabilities associated with the heating process. This provides an explanation for the strong variation of spectral types of asteroids where evidence for thermal metamorphosis appears distance dependent (from the Sun) and qualitatively consistent with the electrical induction heating hypothesis.

Lastly, some work has been started on the magnetosphere of Saturn using Pioneer 11 data, and also on theoretical considerations regarding electrical induction in the Galilean satellites of Jupiter with special emphasis on Io.

(C. P. Sonett)

# DIVISION V ON OBSERVATORIES, INSTRUMENTS, INDICES AND DATA

During the IUGG/IAGA General Assembly, Canberra, 2–15 December 1979, the IAGA Division V had the following activities:

All Working Groups held their business meetings.

Reporter Review Session, chaired by C. Sucksdorff (Co-chairman)

Business Meeting, chaired by C. Sucksdorff (Co-chairman)

Workshop on Observatory Practice and the Reduction of Secular Variation (11-12 December 1979)

"Mayaud" Symposium on Use of Geophysical Indices (13 December 1979)

### REPORTER REVIEWS

(7 December 1979, a.m. Room: Copland G5)

Working Group V-1.	Magnetic Observatories (by C. Sucksdorff)
Working Group V-2.	Meteor Observatories (by R. G. Roper)

Working Group V-3. Geomagnetic Instruments and Standards (by F. W. Stuart)

Working Group V-4. Optical Calibration Standards (by R. A. Pastiels)
Working Group V-5. Magnetic Surveys and Charts (by P. M. McGregor)

Working Group V-6. Geophysical Indices (by J. V. Lincoln)

Working Group V-7. Collection and Dissemination of Data (by H. Maeda)

Working Group V-10. Ground-Based Measurements for Satellite Geomagnetic Surveys (by E. B. Fabiano)

The reports from these Working Groups are shown after the report from the Division Business Meeting.

#### BUSINESS MEETING OF DIVISION V

The meeting in the afternoon of 7 December was presided over by C. G. Sucksdorff in the

absence of Chairman P. H. Serson.

# 1. New Division V Leaders for 1979-1983

The following nominations were approved:

Chairman: C. G. Sucksdorff (Finland)

Co-chairmen: R. G. Roper (USA), W. F. Stuart (UK) and H. Maeda (Japan)

# 2. Change in Working Group Leaders for 1979-1983

The Working Groups suggested new chairmen and co-chairmen for themselves for the next 4-year period. These suggestions were discussed in this business meeting and passed to the Executive Committee, which adopted them in their original form. The names of the new Working Group leaders are shown elsewhere in the Transactions.

### 3. Modification of Internal Structure

To avoid overlapping in work, the WG's 1 and 3 were joined into one new WG 1, Geomagnetic Observatories, Instruments and Standards. The numbering of the Working Groups is kept unaltered, because of the convenience of keeping historical numbers in other WG's.

#### 4. Resolutions

Division V deals with production of scientific data for different programs, and, especially with coordination and improvement of the production of data. The most important results of the work of the working groups therefore often are recommendations. The recommendations worked out in Division V WG's in Canberra are to be found in the IAGA resolutions elsewhere in the Transactions. Half of the resolutions were originated from Division V. Programs suggested by Division for the coming Edinburgh-meeting are shown below.

# 5. Proposal for the Edinburgh Assembly

The following sessions were decided for proposal to the Executive Committee for consideration.:

- 1. Workshop on observatory and repeat station practice (2 half-days)
- 2. Use of secular variation data from surface and satellite measurements (2 half-days)
- 3. Comparison of analytical techniques for national and regional magnetic charts (2 half-days)
- 4. The use of recent satellite data for regional magnetic charts (2 half-days)
  In addition it was decided that IAGA sponsor an "Optical Calibration Workshop" at Aberdeen University in Scotland in connection with the IAGA Edinburgh Assembly.

#### 6. Items of General Interest

A variety of items were discussed in each Working Group in IAGA Division V. The following might be of general interest to the IAGA community.

- 1) A new list of permanent magnetic observatories was prepared by WG 1 and published by World Data Center A for Solid Earth Geophysics (Report SE-21, 87 pages). The list has been sent to every observatory and is available from WDC-A.
- 2) The need of an Information Bank of IMS data was found very necessary. The plans for such a bank in WDC-A was welcomed. To begin with, only a rough idea will be given about what was recorded, where, when and by whom. Also some information about the quality of the data was found important, if it is possible to describe.

- 3) Modernization of the instruments of magnetic observatories was found desirable. Discussions and presentations showed, that modern digital equipment can be very reliable, but one has to select the best available components, which seem to be also the cheapest solution in the long run.
- 4) Computer controlled radiometer wind stations have been a success and will probably contribute essentially to the Middle Atmosphere Program (MAP).
- 5) The new practice of IAGA News to publish short articles about instruments and observatory practice was welcomed with thanks. There is no other forum for these notes, which are essential for the basic production of data. New ideas in observational technique seems to be often more elaborate and rare than the so called scientific ideas.
- 6) The importance of international calibration of optical standards was stressed and a workshop for calibration was suggested to be held in connection with the Edinburgh-meeting of IAGA.
- 7) Bibliographies about older magnetic charts and field measurements were found valuable and important. Coordinators were nominated to collect information about old measurements and charts.
- 8) Dr. P. N. Mayaud was reported having visited all magnetic observatories which produce  $K_m$  indices. This has led to an improvement in homogeneity of these indices, which was noted with satisfaction. Dr. Mayaud made this important contribution after his retirement from his regular work.
- 9) The use of geophysical alerts and forecasts has been a great success both for scientists and also, more and more, for practical purposes like telecommunications, jet flights, etc. Satellites used for telecommunication between magnetic stations and central computer systems and new satellites measuring sun-earth relations have improved the alerts.

# Working Group V-1: Magnetic Observatories

WGV-1 held its meeting on Dec. 5, 1979 from 0900 to 1120 in Copland G8. 33 persons from 19 countries were present, two of them members of the working group. The following items were discussed and decided upon.

- 1. The list of magnetic observatories: Kendall Svendsen reported that the list is in press and will probably reach Canberra before the end of the meeting. Virginia Lincoln urged observatories to send these data for the new edition of MONSEE list of stations.
- 2. The worldwide network of observatories: The working group promised its help in cases where observatories will be established in areas now scarce in observatories and in cases where existing observatories are in danger. The resolution was suggested to be discussed also in WGV-3 upon this matter.
- 3. The usefulness and need of magnetic observatory data: The need for observatory data for different purposes was discussed and realized to be very wide. It is partly coupled with the need for more modern data (next item).
- 4. The modernization of magnetic observatories: To meet the requirements of scientists of today and the sophisticated data handling systems the instruments of the observatories should be able to produce data in digital form and with sufficiently short intervals. A recommendation about this was decided upon (next item).
- 5. The production of one-minute values, should they be means, how centered, how distributed and in which format: Long discussions about this item led to the following conclusions:

- Observatories recording in digital form should be prepared to record with a sampling rate
  of 10 sec which is desirable in disturbed conditions and for special studies.
- The archive data should be one minute values, which should represent the mean of the minute and be centered at the middle of the minute. The first minute of the day should be the mean of the time interval 00 h00 m00s to 00 h01 m00s. (This was changed in the Business meeting)
- 6. The control of the absolute level of the observatories: The discussion led to a conclusion that IAGA News should have an article about different possibilities to control the absolute level of the observatories by comparison with e.g. nearby observatories. In the discussion the importance of keeping the level of an observatory also in case a difference was found in the absolute level, was strongly stressed. In this connection the WDC representatives, speaking for users, strongly preferred having raw data and information about possible changes in standards rather than making the corrections at observatories. Observatory people preferred to apply the corrections.
- 7. The induced part of the recorded magnetic variations: Attention was directed to the possible anomalies in conductivity and also in the magnetic field at the observatories. Observatories should study their recordings in this sense.
- 8. The change of absolute level when starting PVM measurements: The importance of informing about the change of standards was strongly stressed. In this connection the importance of giving all the data within one year referring to one standard was stressed. Also in this connection, the WDC people liked to have the raw data and information about the change e.g. as a result of starting absolute measurement at a new pier with PVM.
  - 9. Joining V-1 with V-3 was discussed and got the support of all present.
- 10. New chairmen and members of the WG were discussed. The importance of having active members was stressed.

#### 11. Resolutions

The following resolutions were decided to be suggested for IAGA:

- (from WG V-1) Considering the importance of Auroral Electrojet (AE) indices and the importance of early determination of these indices, IAGA urges all nations operating magnetic observatories in the northern hemisphere whose records are now used in derivation of these indices to begin recording digitally magnetic variations at these sites within the next 5 years.
- (from WG V-1) Considering the importance of proper evaluation of data from the magnetic satellite (MAGSAT), IAGA recommends that until the end of 1980, observatories send hourly values, preliminary if necessary, to the World Data Centres as soon as possible, preferably not later than two months after the end of the recording period.
- (from WG V-1, 3) Considering the importance of establishing and maintaining an adequate geographical distribution of magnetic observatories, especially in remote regions and ocean areas, the IAGA expresses the hope that
  - (a) the responsible authorities in Chile will find the means to construct a new observatory on Easter Island,
  - (b) the responsible authorities in Tahiti, being aware of the deterioration of conditions around Pamatai because of nearby urban

development, will make every effort to maintain an appropriate area of protection around the observatory site,

(c) the effort that has been initiated to open a permanent magnetic observatory at New Amsterdam Island will be supported by the responsible authorities.

(from WG V-1, 3) Noting that many magnetic observatories are adopting digital methods of recording, the IAGA draws attention to the desirability of producing data at sampling rates higher than once per minute and refers all observatories to the special recommendations given by Division V at the Canberra Assembly. (C. Sucksdorff)

# **Working Group V-2: Meteor Observatories**

The meeting was held at the XVIIth General Assembly, Canberra, December 7, 1979, 2002–2150 h. Present were 6 members of the working group, and 13 other interested scientists.

At the request of the chairman, those present stood in silence in memory of Dr. V. V. Fedynsky (USSR), a valued working group member who passed away last year.

Additions to the GRMWSP-CTOP calendar for 1980 were requested by Dr. Kaiser (a minimum of July 20 through August 3; January 10 to January 31 in the Southern Hemisphere), and by Dr. Kascheyev (USSR) (March 1 to April 30). The summer period suggested would allow better delineation of the 2 day wave, and the spring interval the reversal from winter to summer circulation. A revised calendar will be circulated by the chairman.

Several points were raised during a discussion of the limitations of radio meteor wind data—in particular, the consistency of winds measured at different locations. Comparisons with other techniques were also mentioned. The chairman informed the meeting that a resolution had been passed at the Division V business meeting that very afternoon which would encourage the Meteor Section of the Soviet Geophysical Committee to set up a subcommittee of Working Group 2 to further investigate these matters. The chairman apologized to those working group members who had not seen the resolution before submission, but pointed out that having the working group meeting after the Divisional meeting necessitated this irregular procedure.

Next came a discussion of data archiving. It was decided that hour by hour winds, at 2 km height intervals, should be written on magnetic tape to, preferrably, ASCII or EBCDIC standards, with the USSR sending their data to WDC-B2; the chairman agreed to check with the Ashville Meteorological Data Center as a possible depository for the rest of the world, with WDC-A in Boulder as a possible alternative. Suggestions from working group members on data format are to be obtained by the chairman, and a proposed format circularized prior to adoption. It was suggested that, once the format is decided upon, interested parties exchange tapes on a trial basis before submission to the Data Centers.

Support for the Middle Atmosphere Program (MAP) at the working scientist level was solicited by the chairman. Drs. *Elford* (Australia), *Kaiser* (UK), *Baggaley* (NZ), *Kascheyev* (USSR), all spoke of firm plans for the MAP period, 1982–85.

*Dr. Portmyagin* emphasized the importance of monthly mean winds and tides for use in climatological studies.

*Dr. Vincent* suggested the inclusion of partial reflection drift station representatives in the working group. The meeting concurred that this was certainly in the interests of GRMWSP and CTOP.

The chairman noted that a prior polling of working group members had resulted in *Drs. Elford* (Australia) and *Kasheyev* (USSR) being recommended to the Division as new co-chairmen.

(R. G. Roper, Chairman)

# Working Group V-3: Geomagnetic Instruments and Standards

The Business Meeting of WG V-3 was attended by 21 delegates from 15 countries.

The chairman remarked that a mailing list of individuals interested in the various aspects of instrumentation had been compiled over the past four years. In addition an attempt had been made in response to the wish of the Seattle meeting, to compose a file of instruments in use in observatory and survey work. This attempt was not successful. The meeting indicated that such a file was desirable and some further attempts to compose it should be made by the corresponding members of the working group.

The WG noted with satisfaction the publication of short papers on instrument and observatory practice in the IAGA News and expressed its gratitude to the Secretary General for being so helpful in a matter which the WG regards as very important. It was decided that a paper on "Available ways of comparing observatory baselines and standards" would be useful for a future issue of IAGA News and a suitable author would be invited to make such a contribution. For the future it was considered that papers on anomalous effects at observatories, either in the main field or due to induction, would be valuable contributions.

The meeting felt that observatories should be reminded about the existing ways of checking standards and encouraged to join with them or establish local arrangements of a similar nature. The WG is to send a circular letter to the observatories inviting them to update or check their standard comparison.

It was felt that the facilities offered by the Danish Meteorological Institute should be used much more fully by the observatories of the world. It was further recommended that, if the Danish authorities agreed to the added responsibility, IAGA should obtain some Proton magnetometers (total field) which could be sent out with the QHM's. Meanwhile the corresponding members of the WG should consider if it could be possible to devise other instrumental techniques which could usefully be adopted for the international standardization of observatory instruments.

It was agreed that the 'Workshop on Observatory Practices' offered a valuable opportunity to present information and exchange views on aspects of routine work which are not normally covered by other Symposia or Scientific Sessions at IAGA meetings. A three-session workshop was recommended for the Edinburgh meeting, to include invited papers from some 'users' of observatory recordings, particularly interested in the short period end of the 'observatory' spectrum.

The WG agreed that because its activity in the specific interest of instruments and standards was low, and because much of its business overlapped with that of WG V-1. the two groups should be combined, at least temporarily, into one with responsibility for Observatories, Instruments and Standards.

(W. F. Stuart, Chairman)

# Working Group V-5: Magnetic Surveys and Charts

The WG met on Tuesday, 4 December 1979, 2000–2200 h. In the absence of Chairman Barraclough, the meeting was convened by McGregor, Co-Chairman. The meeting was

attended by 18 persons including Working Group members H. G. Barsczus, E. B. Fabiano, W. Mundt and A. N. Pushkov.

Agenda items included topics proposed by members in correspondence, reports on matters carried forward from previous Assemblies, and the composition of the Working Group for the next period.

Barsczus presented a compilation of references to magnetic observations made in the African region which he has prepared over several years. The value of this document was noted, and it was recommended that it be published as part of the proceedings of the Canberra Assembly.

It was agreed that similar compilations should be made for other regions and 'regional compilers' were nominated as follows: America, north—E. B. Fabiano; America, south—K. L. Svendsen to arrange; Australia—P. M. McGregor; Asia—B. N. Bhargava; Europe, eastern—W. Mundt; New Zealand—R. S. Unwin; Pacific—H. G. Barsczus; United Kingdom—S. R. C. Malin; USSR—A. N. Pushkov.

Mundt reported that the compilation of a bibliography on chart production was nearly completed and it was planned to produce the material in three parts as publications of the UK Institue of Geological Sciences before the next Scientific Assembly. The meeting acknowledged with gratification the work of Barraclough, Dawson, Fabiano and Mundt in finalizing this matter.

As a consequence of this work, Mundt recommended that the re-issue of a guide on how to produce charts, as adopted at Seattle, be not proceeded with. He drew attention to the existence of at least three relevant documents: the paper by Sucksdorff and Serson, Wienert's book on observatories and surveys, and a paper produced by eastern European workers in the 1960s.

Fabiano and Svendsen drew attention to problems encountered with present data bases. It was agreed that information on corrections and adjustments made to the data should always be included, that two sets of data were necessary, namely: original observations with time-of-day and elevation; and data adjusted to 'station level' or epoch. It is important that it be indicated whether the data were derived from absolute observations or from calibrated recordings made over several days.

Opinions on the value of definitive (that is retrospective) regional charts were divided; but there was agreement that predictive charts were essential.

It was noted that most of the spheres of interest of Working Group V-5 were common with those of Working Group V-10 and, in particular, the possibility of future 'Magsat'-type projects had a significant bearing on plans for regional or global land surveys. Close coordination of the activities of the two Working Groups (and of related Working Groups in Division I) was essential.

Noting the importance of maintaining long-standing series of data from repeat stations, it was strongly recommended that every repeat station should comprise at least two observing sites, so that the loss or pollution of one site would not terminate the data-series.

The questions of setting criteria for selecting a sub-set from the regional network (e.g. in times of limited resources) was discussed. It was agreed that no all-embracing criteria could be set. Features such as the local geology, proximity to oceans, proximity to atmospheric current systems, the need for uniform systems, the need for uniform geographic distribution, the history of the station, are some of the factors to be taken into account. It was noted for example that Canada intended to halve its number of repeat stations, but that it has a relatively high number of permanent observatories.

The meeting noted that many countries were modernizing their equipment, and recommended that they lend their superseded equipment to those countries having a need and desire to make observations. This should be accompanied, whenever practicable, by training in techniques of observing and reduction of data.

The meeting submitted the following draft resolution for consideration:

"Considering the need for secular change data from the remote ocean areas of the world and the possibilities for achieving this on certain specified islands, the IAGA expresses the hope that the responsible authorities will find the means to establish repeat stations and to reobserve on them, at intervals of not more than 5 years, on the following islands or island groups:

Atlantic Ocean: Ascension, St. Helena, Cape Verde, Trista- da Cunha, Trindade,

Falkland, Gough, Bermuda

Pacific Ocean: Clipperton, Galapagos, Juan Fernandez, Line, Marquesas,

Gambier, Austral, Marshalls, Carolines, Wake, Baker, Adak, Raoul, Auckland, Campbell, Snares, Cooks, Fiji, Niue, Chatham,

Bounty, Antipodes, Tonga, Solomons, Naurn

Indian Ocean: Heard, Diego Garcia, Seychelles, Maldines, Cocos, Christmas."

Discussion on the future membership of the Working Group resulted in the recommendation that it remain unaltered except for the addition of Dr. Pastor of Portugal.

It was agreed that a topic for discussion at the next Scientific Assembly would be the comparison of charts produced by manual and by automatic methods, with examples of each.

(P. M. McGregor, Co-Chairman)

# Working Group V-6: Geophysical Indices

At the Canberra Assembly two meetings of the Working Group were held with eight of the twelve members of the WG present or represented by alternates. In all, 28 from 10 countries attended.

The "Report on Km-Observatory Visits" by P. N. Mayaud and M. Menvielle was approved with slight modifications. It will be distributed to all Km Observatories with a request that they follow the recommendations and procedures covered in the report. Resolution 14 of IAGA at Canberra is a result of this report urging that each country appoint a qualified scientist within that country to check regularly the K-indices in order to maintain the K-scaling standards and requests that observatory directors notify the Central Km Bureau of any changes of the Chief Observer to allow the central Km Bureau to be alert to possible systematic index changes due to changes in K-scaling technique.

The Working Group calls to the attention of scientists the value of using the Kn and Ks indices as hemispheric indices, and the Km indices as planetary indices, noting their now routine preparation and the fact that the indices are based on data from observatories at sub-auroral latitudes, covering all longitudes with as even a spacing as possible in both the northern and southern hemispheres.

The new 3-letter codes prepared by Dr. van Sabben for geomagnetic observatories and special magnetometer stations was discussed. The final list appeared in IAGA Bulletin No. 32 h (1977-data). In the future only corrections or additions will be published in IAGA Bulletin No. 32-series. World Data Center A for Solar-terrestrial Physics will assign the codes hereafter to new observatories and the World Data Centers can make the lists available in alphabetical code order, alphabetical station order or by geographic latitude to anyone on request.

It was decided to postone publishing a list of geomagnetic coordinates for all observatories or stations, past and present, until IGRF 1980 is available and results are available from the MAGSAT data analysis.

It was decided that observatories no longer need to report 'unusual events' to the Rapid Variation Service at Ebro, since in recent years, there has been no consistency in these reports.

Observatories are again reminded that they no longer need to scale K-figures from the Z-component. Even for Kp-observatories the Z-component is no longer used when preparing the K-figure.

The Working Group reported that the semi-monthly Göttingen Bulletins were found useful and should continue.

The International Service of Geomagnetic Indices has reserved money to publish the definitive *Dst*-indices from 1957 to date. However, if these indices cannot be available in the near future, the funds will have to be used for other publications.

At the next time the mailing list is revised for the IAGA Bulletin 32, recipients should be asked to evaluate the contents, in particular the desirability of continuing the data for the ten selected events for the year.

World Data Center A for Solar-Terrestrial Physics made two trips, in connection with Resolution 11, IAGA Seattle 1977, photographing magnetograms at observatories throughout the world and thus making many additional station years of data available through the World Data Center system.

The status of preparation of AE-indices was given. With the assistance of World Data Center C2 for Geomagnetism, Kyoto, Japan in cooperation with World Data Center A for Solar-Terrestrial Physics, it is hoped that preparation of these indices will become more current. Values now exist through 1975, as well as preliminary indices for January through April 1976, and a still more limited version for the ten selected disturbed intervals published in IAGA Bulletin No. 32 for times in 1977 and 1978. IAGA Resolution 13 is concerned with the continuation of the publication of AE-indices.

An evening was spent discussing possible new geophysical indices. Before such new indices can be recommended it is necessary that the data necessary be readily available and that some scientist or institution be willing to undertake the routine preparation of the index. If the Observatories included in indices operate digital magnetometers, it greatly facilitates and speeds the preparation of these indices.

Sodankylä reported the continuation of the magnetic *Q*-index. The Air Force Geophysics Laboratory has been experimenting with an auroral index based on the latitude of the equatorial edge of diffuse aurora using precipitating electron measurements. A new *Pc3* amplitude pulsation index prepared by Troitskaya was reported.

The solar wind principal investigators are encouraged to prepare for archiving, indices based on solar wind velocity and the southward component of the interplanetary magnetic field.

Raymond A. Greenwald of the Johns Hopkins University, Applied Physics Laboratory, Laurel, MD, 20810, U.S.A. is interested in developing an *E*-field index in collaboration with interested scientists.

Dan Baker, LASL, reported indirectly that they are preparing an *E*-field index from measurements at geostationary satellites for use in forecasting magnetic disturbances at the earth's surface.

H. E. Hinteregger of the Air Force Geophysics Laboratory continues to work on

appropriate EUV-indices.

The International Ursigram and World Days Service in the near future will publish a coronal hole index for which they will be interested in receiving comments from the scientific community.

The Working Group thanked Dr. M. Siebert for the preparation of Kp, Ap, Cp and quiet and disturbed days; M. Menvielle for Kn, Ks, Km and 'aa'; Dr. M. Sugiura for Dst; J. H. Allen for AE; and Dr. A. Romañá for the tables of ssc and sfe. Special thanks were given to Dr. van Sabben as Director of the International Service of Geomagnetic Indices for his continued editorship of IAGA Bulletin No. 32.

The "Mayaud" Symposium on Use of Geophysical Indices was held on December 13, 1979 with 13 papers presented covering auroral zone, sub-auroral and low latitude indices and their interpretation.

Miss J. Virginia Lincoln of the U.S.A. continues as Working Group Chairman with Dr. T. Saito of Japan as Co-Chairman.

(J. V. Lincoln, Chairman)

# Working Group V-7: Collection and Dissemination of Data

Collection and dissemination of data are mainly made by the World Data Centers. It seems that the geomagnetic and aeronomical data collected at these centers are frequently used by scientists and scientific institutions. However, there are still difficulties for the effective use of the data, and the following problems have been discussed by the working group members since the Grenoble meeting.

# 1. Digitization of Analogue Data

Recently, requests for digital data have been increasing rapidly because of data processing by computers. Even though some observatories are taking digital data directly, many of the observatories are still taking analogue data alone. Thus the digitization of these data is an urgent problem. The Working Group is expecting cooperation from every observatory or institute for the digitization of analogue data.

## 2. Exchange of Digital Data on Magnetic Tape

In connection with the first problem, we often meet difficulties in the exchange of digital data on magnetic tape. This is because digital data are recorded in different formats by different computers. The Working Group discussed in length the standardization of magnetic type format and agreed to publish a brief note on the format in the IAGA News.

### 3. Data Collection for Special Programs

Even though every observatory is making efforts to send observed data to the WDC's as early as possible, the Working Group discussed the problem of early supply of data for special programs. This problem has also been discussed by WG V-1, and so we agree to support a resolution provided by the WG I-1 for MAGSAT data.

We have other problems also on collection and dissemination of data, list of data that are not held in WDC's, etc. However, these problems are common in every field. So they should be discussed at the ICSU Panel on WDC's meeting.

The World Data Centers have recently received some geophysical data from the People's Republic of China. We are much obliged for the cooperation of China in the international data exchange, and are hopeful of continuous supply of data to the World Data Centers.

(H. Maeda, Co-chairman)

# Working Group V-10: Ground-Based Measurements for Satellite Geomagnetic Surveys

- 1. WG V-10 met on 10 December at 2000–2115 h. The attendants were: E. B. Fabiano (USA), H. G. Barsczus (Tahiti), B. Theile (FRG), G. R. Small (Australia), T. A. Rodgers (NZ), I. D. Ripper (PNG), and D. F. Smart (USA). The WG Chairman D. Voppel could not attend, and the meeting was chaired by E. B. Fabiano.
- 2. The chairman read Dr. Voppel's report and reviewed for the WG the activities since Grenoble, Specifically:
  - (a) Some 50 replies were received from the 200 questionaires mailed to agencies and institutions involved in geomagnetic observatory and repeat station measurements.
  - (b) A summary of replies has been prepared which explains the plans of various countries to establish and occupy repeat stations and observatories during the second half of MAGSAT.
  - (c) Forms have been prepared to be used in the forwarding of data to the World Data Center.
  - (d) It had been noted that although some countries are interested in participating, specific agencies have mentioned difficulties in obtaining funding or adequate instrumentation.
- 3. Barsczus reported on the occupation of stations in French Polynesia; additional reports were made on station measurements by New Zealand (Rodgers) and Australia (Small).
- 4. Since the resolution for magnetic measurements desired by WG V-10 is included in the WG V-5 resolution, it was decided not to submit an additional resolution.
- 5. Fabiano and the WG recommended that agencies that have gone on record to occupy specific stations, be contacted within 2 or 3 months to verify their commitment. In addition it was considered desirable to update frequently the station and participating agency list which was originally prepared by Voppel.
- 6. The WG agreed to ask E. B. Fabiano to be the chairman during the next period of 1979–1983, and H. G. Barsczus and D. Voppel to be the Co-chairmen. Thelma Rodgers is added as a member to WG V-10.

(E. B. Fabiano and H. G. Barsczus)

# INTERDIVISIONAL COMMISSION ON ANTARCTIC RESEARCH

The meeting of the IAGA Interdivisional Commission on Antarctic Research was held in the evening of 7 December 1979 in Copland G5 room, chaired by T. Nagata. Present were: M. Keller (Argentina), K. D. Cole (Australia), O. Gonzales-Ferran (Chile), J. Bannister (Chile), H. Volland (FR Germany), H. G. Fournier (France), T. Nagata (Japan), H. Oya (Japan), T. Obayashi (Japan), N. Matuura (Japan), S. Kokubun (Japan), E. Kaneda (Japan), T. Hirasawa (Japan), R. S. Unwin (New Zealand), T. A. Rodgers (New Zealand), J. A. Gledhill (South Africa), R. Haggard (South Africa), V. A. Troitskaya (USSR), A. N. Pushkov (USSR), O. M. Raspopov (USSR), N. G. Kleimenova (USSR), J.W. King (UK), J. R. Dudeney (UK), A. J. Smith (UK), T. R. Kaiser (UK), E. A. Bering (USA).

1. The chairman briefly reported the history of the Interdivisional Commission on Antarctic Research which was set up in IAGA at the IAGA Scientific Assembly in Kyoto in 1973, and the past activities in the 16th Assembly in Grenoble in 1975 and in the Scientific Assembly in Seattle in 1977. It was reported by the Chairman that the scientific activities of this

Commission after 1977 were presented to the SCOSTEP/IAGA Symposium on IMS in Melbourne by 9 Antarctic IMS reports, in accordance with the commission recommendation adopted in 1977.

2. It was then suggested by the chairman that an urgent problem to be discussed in the meeting was whether this Commission should be terminated in this Assembly at the opportunity of the end of the observation phase of the IMS, or whether it should be further continued because of the MAP and other new international research programs on upper atmosphere physics, in which Antarctic observations are significantly important, because this Interdivisional Commission was set up in IAGA in order to effectively promote the coordinated upper atmosphere physics researches in the Antarctic region, in particular, in connection with the IMS.

In this regard, all comments coming from the floor emphasized a continuation of this Commission and a further strengthening of its function and structure in order to meet the scientific and technical requirements to promote the MAP and the other scientific programs in Antarctica. Then, the chairman asked all attendants to vote on whether this Commission is to be continued or to be terminated. The result was all in favour, with no objections, to continuing and strengthening this Commission in the future.

3. The Chairman then expressed his wish to resign from the position after his six-year service to this Commission. After discussions on this matter, the resignation of the present Chairman was accepted, and the names of candidates for 2 Co-Chairman and a Secretary were unanimously agreed upon.

Those names are:

J. A. Gledhill (South Africa), Co-Chairman

A. N. Pushkov (USSR), Co-Chairman

T. Hirasawa (Japan), Secretary

The other membership of this Commission for the new term will be carefully considered by the new officers in the near future in consultation with several leading scientists in IAGA by taking into consideration the geographical and disciplinary distributions of the Commission members.

(Takesi Nagata, Chairman)

### INTERDIVISIONAL COMMISSION ON HISTORY

This meeting was convened at 2015 hours on December 7th at the Canberra meeting. Conflicting meetings and the report that the chairman would not arrive on time resulted in a limited attendance of less than 10 persons.

**Changes in the organization and leadership** were discussed. The nominations for the next period 1979–1983 were:

Chairman: H. B. Garrett (USA)

Co-chairmen: S. R. C. Malin (UK) and later also H. G. Barsczus (France)

The present regional groups were not to be reactivated, but the Working Group on "Development of Research" remains.

A Senior Executive Panel comprised of retired leaders of geophysical reasearch was discussed. This Panel would include such persons as

N. V. Pushkov (USSR), G. Fanselau (GDR), L. Gama (Brazil), M. Nicolet (Belgium),

E. C. Bullard (UK), W. Dieminger (FRG), K. Ramanathan (India), E. J. Chernosky

(USA, chairman),

and others who could through informal correspondence contribute from their knowledge, facts of history otherwise lost with time or from formal papers. Copies could be provided for the IAGA History group or Secretary General. The suggestion is made here that some suitable stationery be provided as a possible incentive, particularly to members not having other organizational responsibilities.

Observations of Note was taken of Professor Terada's "Death of Professor B" and that correspondence delays interferred with Professor R. W. Home's plans to present his paper on "F. U. T. Alpenus (1972–1802) mid 18th-Century theories of geomagnetism". It was also noted that this was the 60th anniversary of IUGG and IAGA formed in 1919 and that the 50th anniversary of the Second Polar year would occur in 1982. Correspondence from W. Schröder who is active in auroral and noctilucent date history indicated his interest in presenting papers at Edinburgh on 100 years "Das Polarlicht" by Fritz and also Auroral Frequency in the 17/18 centuries. A report was received that the Stonyhurst observatory operated since 1865 has terminated its magnetic observations.

In concluding about twelve years of chairing the Interdivisional Commission on History, I wish to thank former Working Group Reporter and now Secretary General, N. Fukushima for his appreciated efforts and patience, Working Group Reporter G. Fanselau for arrangements for the Genoble meeting, Reporter C. S. Gillmor for his liaison with the professional historians and interesting speakers he has been able to secure, and to many others who have contributed suggestions when I was not able to devote the needed effort to the affairs of our Interdivisional Commission on History.

(E. J. Chernosky, Chairman)

### INTERDIVISIONAL COMMISSION ON THE MIDDLE ATMOSPHERE

Two meetings have been held (in the morning of 7 December and in the evening of 11 December 1979) to discuss the role of this commission in IAGA. The conclusions are that an increased visibility for MAP activities is desirable, and that a committee should be formed.

Because of the very strong interest of Division II in these activities, it is recommended that, where possible, planning should include the chairman of that Division. Where the interests of other Divisions, e.g. Div. III or Div. V are impacted, similar arrangements will be made.

A working group on Solar U.V. Irradiance to consider the spectral irradiance in the middle atmosphere in the wavelength range from 180–450 nm is being formed under the leadership of Dr. Paul Simon.

Tentative plans for the representation of IAGA on the Interassociation Coordinating Committee for the Edinburgh meetings have been made. There will be a set of sessions joint between Div. II and IDCMA dealing with the middle atmosphere. These will be designated Middle Atmosphere Science Sessions or MASS I; MASS II will be given in Hamburg. Dr. Rishbeth has designated Dr. Lance Thomas to represent Div. II and Dr. M. H. Rees is currently representing Div. III. It will be necessary to contact Dr. Rostoker to complete these plans.

There has been considerable interest in the initiation of a working group on mesopheric ion and neutral chemistry. This will either be a new working group or an expansion of existing groups in Div. II.

(L. R. Megill, Chairman)

# INTERDIVISIONAL WORKING GROUP ON RELATIONS BETWEEN EXTERNAL AND INTERNAL MAGNETIC VARIATIONS

The Business Meeting of this Working Group was held on Monday December 10, 1979, 20.00–22.00, in Copland G7 room. At the request of the W. G. chairman, Prof. A. A. Ashour (who was unable to attend), Dr. V. R. S. Hutton chaired the meeting. Twenty-four delegates attended.

- 1. **Previous Activities.** Dr. Hutton read the report prepared by the Chairman, which is shown below.
- 2. Officers. Although there was no formal requirement for a change of officers, Prof. Ashour wished to retire as Chairman, and had invited suggestions for a successor by post. It was the view of the Executive Committee that insufficient replies had been received to represent a consensus of opinion, so the working group was invited to make nominations. These were: Chairman Dr. S. R. C. Malin (proposed by Dr. W. H. Campbell, seconded by Prof. D. I. Gough); Co-Chairman: Prof. S. Matsushita (proposed by Prof. Gough, seconded by Dr. Campbell); Dr. E. Oni (proposed by Dr. Campbell, seconded by Dr. Matsushita). In the absence of other nominations, these names were accepted for recommendation to the Executive Committee.
- 3. Terms of Reference. Following consideration of the request from the British National Committee that an appropriate place be found in the IAGA structure for studies of Sq and L, the Executive Committee had requested that the working group should expand its terms of reference to include these, and possibly other topics. After some discussion in which concern was expresssed that the W.G. should avoid trespassing on the preserves of other W.G's, in particular WG I-3, it was agreed that the W.G. should provide a forum for the interchange of ideas between those primarily interested in induction and those primarily interested in morphology, with particular emphasis on the following:
  - (i) Sq and L
  - (ii) Interactions between internal and external contributions
  - (iii) Magnetic disturbance effects on man-made structures
  - (iv) Dynamo effects in the ocean
- 4. Name of the Working Group. While it was felt that it might be desirable to re-word the name of the working group to reflect its somewhat expanded terms of reference, difficulty was found in producing an acceptable title, and it was finally decided to retain the present name by a majority of 9 votes to 3, with several abstentions.
- 5. **Programme for Edinburgh IAGA meeting.** One symposium and three scientific sessions are proposed for Edinburgh, as follows:

Symposium: Representation of magnetospheric and ionospheric source fields and their induction effects (Convenors: S. Matsushita and W. P. Olson). Scientific Sessions: (i) Source effects in induction studies (Convenor: J. Hermance), (ii) Induction risk (Convenor: W. H. Campbell), (iii) Morphology of Sq and L (Convenors: J. C. Gupta and D. E. Winch).

(V. R. S. Hutton)

# ACTIVITY OF THE INTERDIVISIONAL WORKING GROUP ON RELATIONS BETWEEN EXTERNAL AND INTERNAL MAGNETIC VARIATIONS DURING 1975–1979

In the four years since the XVI IUGG General Assembly in 1975 the Interdivisional Working Group on Relations between External and Internal Magnetic Variations has continued in its main task of co-ordinating research work in those aspects of magnetic variations not specifically covered by the IAGA divisional structure. It has done this by organising three scientific sessions to provide a stimulus to the publication and discussion of the most recent results in the subject and to concentrate attention on the most actively developing areas of the subject and those requiring further study.

The first of these sessions was held at the Third General Scientific Assembly, Seattle, 1977, as scientific session SE/I entitled "Relations between External and Internal Magnetic Variations." The aim of this session was to focus attention on (1) the problems of the separation of the external and internal parts of the variation fields, and on (2) source field studies. Thirteen papers were accepted for the session, of which nine were presented by their authors, and two were made available as written papers by authors unable to attend. Of the eleven papers ten were concerned with external and internal fields, and of these five were devoted to local and three to global studies, while two papers were of a theoretical nature. Only one paper was a source field study indicating that this is a difficult problem area requiring more attention.

Following this successful scientific session the Business Meeting of the Interdivisional Working Group proposed two scientific sessions for 1979. These two scientific sessions EI-1 "Internal Contributions of Ionospheric Electrojets" (Convenors: S. Matsushita and W. H. Campbell), and EI-2 "External and Internal Magnetic Variations for Sq, L and Related Phenomena" (Convenors: S. R. C. Malin and V. R. S. Hutton) have now been organised for the XVII General Assembly, Canberra. The objective of EI-1 is to focus attention on the special induced current effects at regions beneath the auroral and equatorial electrojet currents of the ionosphere, while EI-2 seeks to further our understanding of the nature and reasons for the many departures from the main world-wide features of the average Sq and L fields.

The Interdivisional Working Group maintains a circulation list of members and scientists interested in this subject, together with their fields of study. This list is based on two questionnaires circulated in 1974 and 1976 and is up-dated every two years. In August 1977 it contained 73 names.

(A. A. Ashour, Chairman)

# SUMMARIES OF THE IUGG INTERDISCIPLINARY SYMPOSIA SPONSORED BY IAGA

The XVII General Assembly of IUGG was held in Canberra, Australia during 2–15 December 1979. The assembly organized the following 20 interdisciplinary symposia.

- No. 1 Chemical evolution of the atmosphere, oceans and crust (4-5 December 1979).
- No. 2 Sea level, ice sheets and climatic variation (7-8 December 1979).
- No. 3 New technologies in geophysical instrumentation (4 December 1979).
- No. 4 Problems of coastal and estuarine zones (10-11 December 1979).
- No. 5 Origin and structure of the southern oceans (13-14 December 1979).
- No. 6 Relationships between variations in the Earth's rotation and geophysical phenomena (4-5 December 1979).
- No. 7 Geophysical implications of planetary studies (6-7-8 December 1979).
- No. 8 Evolution of the upper mantle (7-8 December 1979).
- No. 9 Recent crustal movements (13-14 December 1979).
- No. 10 Dynamics of core mantle (7-8 December 1979).
- No. 11 Physico-chemical properties of mantle materials at high pressure (13–14 December 1979).
- No. 12 Volcanism and climate (6 December 1979).
- No. 13 Ocean and atmospheric boundary layers (12-13 December 1979).
- No. 14 Heat production and generation of magmas (12 December 1979).
- No. 15 Quantitative methods of assessing plate motions (5–6 December 1979).
- No. 16 Global reconstruction and geomagnetic field during the Paleozoic (10-11 December 1979)
- No. 17 Electrical conductivity and characteristics of the asthenosphere (12 December 1979).
- No. 18 The middle atmosphere (10-11 December 1979).
- No. 19 Geodetic applications to oceanography (6 December 1979).
- No. 20 Tidal interactions (11-12-13 December 1979).

IAGA was the leading Association for organizing Symposia Nos. 7, 16, 17 (with IASPEI), and 18 (with IAMAP); IAGA cosponsored the symposia Nos. 1, 3, 6, 8, 10, 14 and 15. The reviews of these IAGA-sponsored IUGG Interdisciplinary symposia are summarized below. The Abstracts of all 20 symposia have been published in book form (655 pages) and are available from the IUGG Publications Office (39 ter, rue Gay-Lussac, 75005 Paris, France) at the price of US \$24. Handling, packing and mailing charges are to be added.

# No. 1. CHEMICAL EVOLUTION OF THE ATMOSPHERE, OCEANS AND CRUST

Review of the composition and constitution of the mantle seems to lead to the conclusion that its composition is fairly uniform and similar to pyrolite. Compared with primordial element

abundances, it is depleted in volatile elements. It is unlikely that the mantle was ever extensively melted and differentiated during accretion. Densities of the core are most likely explained by FeO dissolved in molten iron. The mantle material was derived from a mixture of high and low condensate meteoritic material during accretion and iron oxidation occurred by an intermediate atmosphere containing  $H_2O$  with  $H_2$  escaping. (Ringwood)

Important for the formation of the Earth's lithosphere are also later cratering processes due to the decreasing rate of bombardment which broke up any early crust separation and resulted in partial melting and degassing. The chronology of these events can be estimated from studies of the Moon, Mercury and Mars. These processes are likely to have played an important role in the evolution of the global crust, and the onset of plate tectonics. (*Lal*)

Of great importance for the question of the formation process of the earth crust including the oceans and the atmosphere is the degassing history of the Earth's interior. Two possibilities are discussed: Instantaneous degassing during accretion associated with melting and continuous gradual degassing due to heat production by radioactive decay. The behavior of the rare gases provide important information on this question and several papers summarized our present knowledge (*Tolstikhin, Ozima and Nakazawa, Fisher, Rao*). As a result of recent studies it seems to be established that primordial <sup>3</sup>He is still being released from the Earth's interior, the observed fluxes also provide a handle for estimating the discharge rate of other juvenile volatiles (including CO<sub>2</sub>) whose degassing rates are less amenable for direct assessment. These findings weaken the concept of an early catastrophic degassing event widely believed to have occurred during the Earth's early history. Although degassing rates during the first 10<sup>9</sup> years after the Earth's formation were probably much higher than in later times, it nevertheless appears that the catastrophic degassing model in its extreme form has to be abandoned and relaced by a concept of continuous degassing.

It is an established concept in geochemistry that the sedimentary shell including the oceans and the atmosphere was formed by a gigantic titration process in which the acidic volatiles together with water decomposed igneous rocks resulted in the present composition of sediments, the ocean water and the atmosphere. A first approximation of this concept envisions a sedimentary mass increasing as degassing proceeded and constant recycling by weathering processes. The relative success of this model seems to imply that gains and losses of crust material e.g., by plate tectonics or sea water circulation through ocean ridges may be of secondary importance. With recycling times being relatively short, increasingly small fractions of older sediments are preserved as we go back in time. The oldest known sediments are  $3.8 \times 10^9$  years old and were formed only  $0.7 \times 10^9$  after the Earth's accretion was completed. They show already the same basic types of sediments as in later times. (Garrels)

Of special importance are new findings from composition studies of old sediments showing that the sea water composition has apparently not changed much over more than  $3\times10^9$  years, except for Mg which is apparently exchanged with the ocean crust and for reduced Fe content. The oldest sediments clearly prove that  $CO_2$  was present in the atmosphere in concentrations at least as high as today, showing that a methane-ammonia-hydrogen atmosphere—if it ever existed—was already replaced by a more oxidizing atmosphere at this early time. We have only very little information on the slow rise of atmospheric  $O_2$  but the interpretation of uraninite and pyrite conglomerates about  $2\times10^9$  years ago is still valid which indicate low  $O_2$  contents, perhaps 1% PAL. (Holland)

It is now clear that formation of new oceanic crust and loss due to subduction results in large scale and long term geochemical cycles of such materials as H<sub>2</sub>O, Cl, CO<sub>2</sub>, Ca, and Mg,

and others. First quantitative data presented seem to indicate, however, that the corresponding geochemical fluxes are much smaller than those due to weathering. (Anderson, Harris and Ito, Gieskes)

The microfossil record in old sediments is still debated because of the poor state of preservation as we go back into the early precambrium. But the evidence is becoming stronger that microfossils have existed even  $3.8 \times 10^9$  years ago and this is supported by carbon isotope data and the presence of organic compounds similar to those found in later sediments. (*Muir*)

Before life developed, any  $O_2$  in the atmosphere could have been produced only by photo-dissociation of  $H_2O$  by UV radiation and escape of H into space. Photochemical models clearly show that in the presence of volcanic production of  $H_2$  and CO the  $O_2$  level during this period must have been exceedingly low, even if the assumptions are varied within wide ranges. After the appearance of early life and oxygen evolving photo synthesis, reduced iron and sulphur were substantial sinks for oxygen. The free oxygen in the atmosphere may have increased somewhat but remained still very low ( $\approx 1\%$  PAL?) until about  $2\times 10^9$  years ago. (Walker) There are also many lines of biological evidence which support this low level of oxygen in the presence of early life: The many forms of anaerobic procaryotes, the process of anaerobic photosynthesis in bacteria, the invention of oxygen breathing at some later stage requiring higher levels of oxygen, etc. Model calculations based on the growth characteristics of modern blue-green-algae seem to indicate that in view of the vast amounts of reduced Fe and S present in the crust the buildup of free  $O_2$  in the atmosphere must have been only gradual and of long duration. These new calculations contradict older geochemical models which predict rapid rise after photosynthesis was invented. (Schopf, Carver)

Already very low levels of  $\rm O_2$  at  $10^{-5}$  PAL would result in an ozone screen similar to the present one, so that life on the solid earth surface would have been protected against damaging solar ultraviolet radiation at an early time. Questions were also raised about the average earth temperature due to possible changes of the luminosity of the sun and possible higher  $\rm CO_2$  levels. The biological evidence favors no great temperature changes. (*Carver*)

The rise of atmospheric oxygen from about  $2 \times 10^9$  years ago is certainly one of the most interesting questions. Geochemical models indicate that most  $O_2$  produced in the early stages of life development were irreversibly locked up by  $So_4$  and  $Fe_2O_3$  formation until some new biological events occurred. A very likely event is the development of sulphate reducing bacteria and this is indeed strongly suggested by sulphur isotope data. (Garrels)

The last papers were concerned with post-Cambrian times. Much improved <sup>13</sup>C data for the last 500 × 10<sup>6</sup> years are presented (Veizer, Holser, Wilgus). Their quantitative interpretation with respect to the global oxygen budget strongly suggests that the total organic carbon equivalent of oxygen varied rather parallel to the So<sub>4</sub>-oxygen reservoir which is to be expected from geochemical considerations (*Schidlowski*, *Junge*). New data were also presented for the atmospheric CO<sub>2</sub> level during the last glaciation, derived from ice cores from Greenland by new, much improved methods. The data indicate CO<sub>2</sub> levels during the maximum of glaciations which are lower than present levels by factors of 0.5 to 0.7. This technique obviously opens up new possibilities for studying the chemical composition of the past atmosphere (*Delmas*, *Ascencio*, *LeGrand*, *Raynand*)

(C. Junge, Convenor)

# No. 3. NEW TECHNOLOGIES IN GEOPHYSICAL INSTRUMENTATION

This Symposium was designed to present the latest developments in instrumentation, in each branch of geophysics, to workers in other areas. All of the Associations responded extremely well in proposing speakers, and it was evident that the participants, approximately 175 in number, appreciated hearing of the many very exciting developments throughout geodesy and geophysics.

Smith (U.S.A.) described laser satellite techniques for position determination. Mobile ranging equipment has been developed, so that points other than permanent observatories can be located, to within a few centimetres. However, these systems are relatively expensive, and plans for the future include the development of a satellite-borne laser, which will determine ranges to reflectors fixed on the ground. With a distribution of these simple devices, over an area such as that adjacent to the San Andreas fault, a satellite could determine relative crustal deformation, both horizontal and vertical, to an accuracy of 1 or 2 cm, in a few days. Anderle (U.S.A.) described the radar altimeter mapping of the ocean surface from satellites. The latest satellite has covered the ocean to a density of about 0.6° in latitude and longitude. It is estimated that, after correction for winds, tide and swell, the geoid over the oceans has been determined to about 0.5 metres. Where tests against geoid slopes (deflections of the vertical) computed from sea gravity observations are possible, the agreement is good. Morgan (Australia) discussed lunar laser ranging. Great advances have been made in the lasers, the detectors, and the timing systems, so that much smaller powers can be used than was previously the case. The importance of this is that smaller telescopes can be used, permitting the method to be applied to additional ground stations. Groten (Federal Republic of Germany) discussed the problems and applications of gravimetry to the microgal level, not with superconducting instruments but with the simultaneous use of up to 10 conventional, but high quality, gravimeters. Applications include the study of groundwater movement, and the relation to vertical crustal motion.

A paper on the measurement of forces of a satellite for meteorological purposes was given by *Walch* (France). A precision accelerometer on a satellite measures non-gravitational forces due to radiation balance, over both land and sea, to be directly measured. Some problems remain, because of the tendency of the satellite to acquire electric charge, which can influence the accelerometer (consisting of a small sphere within the satellite, and the satellite, and position-sensing devices for this sphere).

Joselyn and Williams (U.S.A.) described a real-time solar-terrestrial monitoring system. The new development here is less in the sensors than in the central computer, its software, and the real-time data transmission systems. It is now possible for alerts of solar disturbances to be issued immediately upon the appearance of a feature on the face of the Sun, or in a change in radiation or particle flux at satellite height or on the Earth's surface. The greatest difficulty has been in the transmission and processing of the optical data relating to the Sun.

Walton (Canada) discussed the use of superconducting magnetometers (SQUIDS) in archeomagnetism. The almost unbelievable sensitivity of the SQUID permits the use of samples of millimetre size, which may be drilled out of museum pieces of pottery without destroying the original—a capability of great importance.

Whitmarsh (U.K.) showed beautifuly detailed maps of critical areas of the ocean floor determined from side-scan SONAR mounted on a ship-towed vehicle. The scanner surveys the bottom up to 30 km on each side of the ship, so that coverage is possible at a rate enormously

greater than was the case with vertical sounders. Most interesting are the indications of fault scarps to either side of oceanic ridges, and the direct mapping of ridge offsets by transform faults. The greatest need is for more accurate ship navigation, through some of the techniques described earlier. In meteorological applications, *Tillman* (U.S.A.) described the instrumentation for measuring the parameters of the Martian atmosphere with 2 soft landings, and also the development of incredibly robust instrumentation for hard landings, instrumentation which will be attached to probes dropped into the Martian surface layer. Wind speed and direction, temperature and atmospheric pressure have already been acquired for a period of several months. *Suomi* (U.S.A.) eloquently described the great advances in instrumentation required for, and achieved during, GARP. He pointed out that GARP was a bargain, because previously much data, collected by conventional means, was lost or transmitted very late.

de Leeuw (Netherlands) discussed the impact of solid-state transducers and minicomputers in hydrology, including both improved geophysical exploration for groundwater, and the evaluation of water reservoirs from well tests.

In volcanology, Lo Guidice and Tonelli (Italy) described the remote sensing of geothermal areas. Interesting results have been obtained on the change with time of the surface conditions, related probably to the migration of volcanic gases through the surface layers. Interpretation of the imagery requires a very complete knowledge of the spectral reflection and emission characteristics of various rocks and vegetation covers, on which research is continuing.

It will be seen that the Symposium did indeed cover the entire range of interest of IUGG, and there is no doubt that useful ideas were obtained from presentations in fields outside one's own.

(G. D. Garland, Convenor)

# No. 6. RELATIONSHIPS BETWEEN VARIATIONS IN THE EARTH'S ROTATION AND GEOPHYSICAL PHENOMENA

The Symposium comprised papers in three major subject areas; (i) changes in the spin rate or length of day, (ii) changes in the orientation of the rotation axis within the Earth and in space, and (iii) results from new techniques of measuring the rotation.

#### Papers in areas (i)

Sundermann computed, by means of numerical modelling, the tidal elevations and currents in ancient oceans and the resulting tidal friction and torque. The results point to significant variation in dissipation throughout geologic time.

Mörner proposed a complex but qualitative system of geophysical interactions and correlations with the rotation for the late Cenozoic and also a modern correlation between the decreases in the length of day and seismicity in Fennoscandia at the beginning of the present century.

Courtillot et al. showed some striking accelerations in the secular variation measured at a number of geomagnetic observatories which appear to be related to minima in the rotation rate. These secular variations would appear to limit the lower mantle conductivity to 100 s/m.

Currie showed the results from a two channel maximum entropy spectral analysis of the length of day and sunspot numbers for the period 1838–1970. An amplitude for the 11 year cycle in the length of day data of 0.16 ms was obtained with a period between 10.5 and 11.4 yr

while the length of day signal lags the sunspot signal by 3 to 3.5 yr.

Merriam presented an anlysis of the zonal tidal signals in the length of day data arguing that the weak coupling between the core and the mantle meant that only changes in mantle moment of inertia affected the observed rotation. This brings theory and observation into close agreement (within 2%) and yields a zonal response coefficient R = 0.315.

Runcorn reviewed the evidence for a correlation between secular variation changes and length of day variations. He argued that strong fluctuations in the field could be propagated to the core surface via hydromagnetic waves and these might considerably tighten core-mantle coupling with the result that some of the more sudden length of day episodes might be explained. Quantitative models were not attempted.

Lambeck reported on some further extension of previous calculations of zonal angular momentum exchange to the period 1963 to 1973. Improved estimates of seasonal terms were obtained along with higher frequency and irregular terms and an indication that zonal winds contribute to variations in l.o.d. from 2–5 years.

Hide talked of the importance of new series of meteorological and rotation observations in both geophysics and in understanding the general circulation. While meteorologists wish to monitor the angular momentum of atmospheric motions, geophysicists would like to subtract off atmospheric effects on the rotation to see if core-mantle angular momentum was made for two periods of the FGGE.

Nakiboglu showed calculations of the viscoelastic response of the Earth to deglaciation and the resultant effects on polar motion and the length of day. Results agree well with Stoyko's secular shift path, and Newtonian viscosity estimates based on polar motion and length of day give a consistent value of 10<sup>22</sup> Pa. sec for the average over the mantle.

#### Papers in area (ii)

*Vicente* discussed the pole coordinate results from the re-reduction of International Latitude Service observations for the period 1899–1977. The new pole paths bear little resemblance to the old coordinates although the period of the Chandler motion is not much changed.

Mansinha reviewed the seismic excitation hypothesis of Chandler wobble excitation comparing a wide variety of conclusions drawn at different times by authors in the field. He also reported on some new modelling studies of the build up of the global strain field prior to earthquakes which might enhance the effect on wobble and make it premonitory.

Dickman reported on an extensive study of the pole tide. He showed results which indicate that the oceans through departure from equilibrium response are capable of damping the Chandler wobble in from 2 to 80 years and lengthening the period by up to 3 months if the tide is globally enhanced. This would pose a problem for core response as it would have to be very different from present conceptions.

*Merriam* presented a review of calculations of the meteorological annual excitation pole including an improved theory for the inverse barometer response of the oceans.

Melchior urged the adoption of an improved model of core response in the construction of luni-solar nutation tables. In particular he advocated the Wahr model which is the first to take account of both rotation and ellipticity throughout the Earth. A member of the audience pointed out that this model still suffers from uncertainty of the degree of the effects of the severe truncation required, but agreed that at the moment it is the best available.

### Papers in area (iii)

Anderle reviewed Doppler satellite determination of pole position and UT1. At present error levels of several centiseconds of arc are realized but future Navy Navigation Satellites with on board drag compensating device might permit subcentisecond determinations.

Tapley showed determinations of pole coordinates and UT- based on laser ranging to LAGEOS which are in good agreement with smoothed BIH-results after the annual term in the latter is corrected.

Bender reported on an investigation of the apparent irregular change in the polar motion in late 1974 previously manifested in the BIH, IPMS and DPMS paths, using lunar laser ranging results from the McDonald Observatory in Texas. This appeared to be presented in the ranging data as well.

*Melbourne* described the programme of Earth rotation mesurement by VLBI using the NASA deep space network being carried out at JPL.

Councilman described some recent VLBI measurements made on the Haystack, Massachusetts to Owens Valley, California baseline. Agreement with smoothed DPMS results to 0.9 centisecond of arc for the x component of polar motion was obtained while UT1 determinations were within about 1 msec of BIH and lunar laser ranging results.

Cannon spoke on the satellite phase link LBI rotation experiment currently under way in Canada. Early results indicate good resolution of UT1 will be possible.

(K. Lambeck and D. Smylie, Convenors)

# No. 7. GEOPHYSICAL IMPLICATIONS OF PLANETARY STUDIES

SYNOPSIS: The general theme of this symposium was the results of recent planetary studies, their mutual relationships, and their implications for the undertanding of the Earth and its environment. Since 1979 has been a banner year for planetary encounters, there were papers representing the latest results from Venus, Jupiter, and Saturn, as well as the broader and more mature comparative and interpretive summaries. The three days of the program were devoted respectively to solid planets, atmospheres, and magnetospheres. The spectacular Voyager imaging results on Jupiter's clouds and the four Galilean satellites were presented in evening sessions.

SURFACES AND INTERIORS: Radar altimetry from Pioneer Venus Orbiter has disclosed two raised areas, one the size of Australia. Imagery also suggests a considerable number of circular areas reminiscent of impact craters. Small features are well correlated with gravity anomalies, but the large ones are almost entirely compensated. A study of the Mars gravity field was described. Several Australian impact craters were described, and a survey of the geochemistry of the solar systems was presented.

Three papers on planetary magnetism discussed the dipole moments of the planets from Mercury to Saturn, and the remarkable evidence of fields near 1 Gauss early in the history of the Moon and meteorite parent bodies. Use of solar-wind magnetic fields to sound the interior of the Moon was described.

An evening session was devoted to a description of the surfaces of the four Galilean satellites, which exhibit a huge range of novel geological processes.

**ATMOSPHERES:** The aeronomy of the Venus ionosphere and thermosphere was described and contrasted with that of Earth. Electron and ion temperatures are high, and neutral temperatures low, especially on the night side. The strong implication is that important

terms need to be added to the heat-balance equations. A re-assessment of radio-occultation data in light of recent direct measurements showed that thermospheric temperatures for both Mars and Venus have been greatly overestimated in the past.

Motions in the Venus stratosphere were described; a major difference with the Earth is the absence of significant Coriolis forces. In the lower atmosphere the observed winds are remarkably uniform at similar northern and southern latitudes and are almost entirely zonal.

An explanation was proposed for the remarkably large content of nonradiogenic argon on Venus. Rotation of Jupiter's visible atmosphere and interior were discussed. In the evening session, the motions revealed by the pictures from Voyagers 1 and 2 were described and analyzed.

A paper on sulfur chemistry discussed the analogies and differences between Venus and Earth, both of which have H<sub>2</sub>SO<sub>4</sub> clouds. The rest of the evening session consisted of papers on the Voyager observations of the Jovian upper atmosphere and aurora, and on Martian meteorology and its implications for theories of atmospheric motion.

MAGNETOSPHERES: After an introduction on the classification and comparison of magnetospheres, the first group of papers was devoted to the magnetosphere and tail of Jupiter. Perhaps the most striking discovery of Voyager is that much of the plasma in the inner Jovian magnetosphere is composed of heavy ions (S, O, Na), with an obvious but not fully explained connection with the Io plasma torus.

Venus, with its negligible magnetic field, is the best-explored object in this class, which includes comets and possibly Mars; its interaction with the solar wind was described.

Several papers were devoted to Io's plasma torus and direct interaction with the Jovian magnetic field. Extreme ultraviolet measurements indicate the presence of ions of S and O and a temperature in the  $10^{5\circ}$ K range. This plasma has a major effect on the generation and propagation of plasma waves, including striking shadow effects. Although Voyager 1 did not penetrate the Io flux tube, a strong magnetic signature of its currents was observed. The Jovian aurora seems to be connected to the torus, and a mechanism for precipitating  $\sim 100\,\text{keV}$  electrons from the torus was described.

Three papers described the results of the Pioneer 11 encounter with Saturn. The magnetic field is highly dipolar and aligned with the rotation axis. The magnetosphere is much less distorted than that of Jupiter; the magnetopause (on average) is near Titan's orbit. Plasma observations again suggest substantial populations of heavy ions, probably  $0^+$ .

**COMMENTS:** It is unfortunate that the four Soviet papers on the program could not be presented. Even more unfortunate is the extremely small audiences, which never greatly exceeded 100 and fell to 20–30 in one evening session and the last day. Scientifically the symposium was otherwise excellent.

(D. Hunten, Convenor)

### No. 8. EVOLUTION OF THE UPPER MANTLE

The symposium discussed recent progress toward understanding the geochemical and geophysical evolution of the upper mantle and its relationship to the crust and deeper mantle. Five sessions covering different approaches to the problems of structure and composition gave an opportunity to compare and confront interpretations and conclusions arising from various fields of investigation. A final summary session reviewed and synthesized the findings of the symposium, and focused attention on areas both of general agreement and of unresolved

controversies. Attendance was good throughout all of the sessions. We estimate the peak audience to have been about 300 people.

Speakers in the first session, "Thermal Evolution and Mantle Convection," were: G. F. Davies, D. L. Turcotte and E. A. Lubimowa.

The first session was on the thermal evolution and mantle convection (speakers: Davies, Turcotte and Lubimowa). Most thermal models now recognize convection as the principal mechanism of heat transfer, but questions of an initially hot or cold accreted Earth, fast or slow core formation, whole-mantle or confined convection regimes, and the relative contributions from gravitational and radioactive heat sources remain unresolved. Davies and Lubimowa also addressed the subject of chemical heterogeneities in a convecting mantle and concluded that their models could accommodate reasonable variabilities of up to 100 km in dimension in the upper mantle.

Session II dealt with the evidence for mantle composition derived from the analysis of ultramafic xenoliths. *Irving* Presented data for major and trace elements for 32 spinel lherzolite and garnet lherzolite xenoliths and showed that the data were consistent with metasomatic enrichment for the incompatible elements. *Keays* presented new analytical data for the abundances of Pd, Au and Ir in minerals separated from nodules, and showed that the bulk of the precious metals were not constrained in the major mineral phases, but appeared to be associated with sulfide phases in interstitial glass along grain boundaries. This information sets strong constraints on attempts to estimate upper mantle abundances for the elements.

Morgan provided new sets of data for trace volatile and siderophile elements in ultramafic nodules, and showed that their abundances were parallel to those in carbonaceous chondrites. He interpreted this observation to as consistent with derivation of these elements from a terminal meteoritic bombardment, thus accounting for the apparent over-abundance of these elements in the upper mantle.

Seismology and Geophysical models was the theme of the third session, which provided a look at mantle structure from three rather different perspectives. Anderson presented a differentiation model in which a 20% partial melting of the primitive mantle resulted in a thick basaltic crust that subsequently reverted to ecologite and now occupies the volume between the 220 km and 670 km discontinuities. Complete melting of this layer can provide new MORB crust while an overlying layer of 'displaced' garnet peridotite serves as a source for other volcanic rock types. Aki carried out inversion analyses on several sets of seismic travel time data, which revealed interesting 3-D structures extending well into the mantle (e.g. an elliptical pipe of low velocity rock underlying the Yellowstone caldera; a linear belt of low velocity rocks paralleling the Pacific coast of California interpreted to be the boundary between the Pacific and North American Plates; and the trace of the downgoing slab of subducted oceanic crust under Japan).

Buntebarth presented a mathematical formulation for relating cation distribution to seismic and density data. Verified by laboratory measurements, this relationship should allow us to further constrain the chemical composition of the crust and mantle.

The fourth session of the symposium discussed the evidence which basaltic lavas provide for the composition of the upper mantle. *Subbarao* showed that the mantle beneath the Indian Ocean was heterogeneous with respect to trace element and Sr isotopes. *Sun* outlined the trace element and isotopic distinctions between basalts from mid-ocean ridges, oceanic islands and island arcs showing that mantle heterogeneity and metasometic effects were involved. *Tarney* presented the results of detailed studies of basalts from the Atlantic ocean. He showed that the

ratios of incompatible refractory elements (e.g. Nb/Ta) which do not change during partial melting processes, showed regional differences, implying mantle heterogeneity. *Aswathanarayana* presented a paper which showed that some of the Deccan Traps had trace element concentrations similar to mid-ocean ridge basalts and suggested that the Deccan Traps may have been erupted in a tectonic environment similar to Iceland.

Session V dealt with geochemical and isotopic models. Arculus gave a summary paper on island are volcanic rocks in relation to the evolution of the mantle and the crust. He presented arguments against the direct involvement of the down-going slab in the genesis of island-arc rocks and suggested their derivation from LIL enriched mantle above the slab. Zartman discussed his plumbotectonic model relating lead isotopes to a dynamically evolving crustmantle system, which took into account bidirectional transport of U, Th, and Pb among upper crustal, lower crustal, and upper mantle reservoirs. According to this model, lead entered the crust rather early and is now largely being recycled in the formation of young crustal segments. The mantle maintains chemical heterogeneities with mean life-times of about 1 b.y., which may be established by subduction processes and destroyed by MORB and hot-spot melting. Jacobsen used the coupled Nd and Sr isotopic systematics to argue for crustal development from a chondritic mantle with the corresponding buildup of a separate depleted mantle layer. He estimates a mean crustal age of ~1.8 b.y. and the involvement of about 30% of the original mantle to produce the present reservoir configuration. MORB is derived during later melting of the depleted layer, and continental basalts and ocean island volcanics tap original mantle sources.

The Synthesis and Review session began with *Bence* and *Oxburgh* providing summaries of the earlier sessions. Highlighted in these summaries were a number of topics that had received particular attention during the symposium. The character and scale of chemical heterogeneity, evidence for mantle metasomatism, and the nature of subduction zones from the field of geochemistry and the implications of non-steady state heat flow, manifestations of lower crustal and mantle anisotropy, and isotopic modelling of residence times from the field of geophysics served as examples of concentrated research effort.

The remainder of the session was thrown open to a question and answer period, which produced vigorous discussions among the various speakers and the audience. While being made acutely aware of fundamental unresolved questions, all participants in the symposium undoubtedly came away with a broader view of upper mantle composition and structure. The papers given at this meeting will be published in a special issue of TECTONOPHYSICS.

(S. R. Taylor and R. E. Zartman, Convenors)

# No. 10. DYNAMICS OF THE CORE AND MANTLE

The papers presented in this sympsoium covered an extremely broad range of ideas relating to motions in the Earth's core and mantle and several directly addressed issues involving the physical interconnections between these two major divisions of the planet. If any one idea emerged during the proceedings as providing a link between the various contributions it was probably the re-emphasis of the importance of the thermal and mechanical coupling of the core to the mantle in a wide variety of geophysical problems.

The first session was devoted to a discussion of constraints upon motions in the core provided by paleomagnetic and geomagnetic observations. One paper of particluar interest in this sequence was the updated analysis by *Courtillot et al.* of the 1967 impulse in the

geomagnetic secular variation, the timescale of which appears to require a very low value for lower mantle electrical conductivity. Such secular variation data may provide a means of inferring the velocity field in the outermost reaches of the core, an idea which was also discussed by Benton, while Creer described the space-time signature of the secular variation through the Holocene period. Other papers on motions in the core included contributions concerning its possible hydrodynamic free oscillations by Smyllie and Rochester and by Crossley and an interesting discussion by Loper and Roberts on their non-thermal (gravitational) convection model of the source of the motions responsible for the geodynamo. Yukutake explored some of the geomagnetic consequences of a convection inhibiting stable density stratification in the outer regions of the core and there was discussion of geomagnetic field reversals from both the theoretical and observational points of view. Malin gave a delightful (and informative) review of his work with Hyde concerning the estimation of the topography on the core-mantle interface using gravity and geomagnetic data and concerning their novel method of determining the radius of the core by downward continuation of the surface geomagnetic field.

One of the most difficult and topical questions which is currently at issue in the ongoing debate concerning mantle convection involves the source of energy which maintains the circulation against dissipation. It is interesting to note that this question also continues to plague dynamo theorists, as discussed above. Insofar as mantle convection is concerned the circulation is almost certainly thermal in origin but it is not yet understood the extent to which the thermal energy is supplied by radioactive heating as opposed to that derivable by cooling of the planet in bulk. If the whole mantle is convecting, a possibility which is now considered quite likely, then heating from below implies the existence of a substantial heat flux across the core mantle interface and the existence of a pronounced thermal boundary layer in the immediately adjacent mantle. Several of the papers, in this symposium reflected interest in these issues such as that by Sacks et al. concerning seismic observations of lateral heterogeneity at the base of the mantle as indicative of the presence of small (150 km) scale thermal fluctuations. It was interesting to note that this is on the order of the thickness of the D" layer which might be interpreted as the lower thermal boundary layer of a mantle wide convective circulation. On the subject of mantle convection itself, Busse read a paper which contained one suggestion as to how the upper mantle model of convection might be saved from the difficulty connected with the difference between the horizontal scale of convection expected in such geometry and the observed scale of surface plates. His linear stability argument suggested that the length scale of the upper mantle flow could be governed by the scale of a separate circulation in the lower mantle beneath the transition zone. Other papers on mantle convection included that by Hager and O'Connel on plate "driven" flows and one by Schuber et al. in which the parameterized convection idea was employed to attempt to infer the radiogenic heat source contents of the Earth and Moon. Their calculations reinforce the earlier conclusions of Sharpe and Peltier to the effect that mantle convection may be driven substantially by heating from below. Jones' paper dealt with the possibility that substantial heat flow from the core might be realized only episodically while the paper by Yinting and Dexiang dealt with the relation between upwelling flows in the mantle and seafloor spreading.

Several articles were presented concerning the inference of various physical properties which are important to questions of mantle and core dynamics including presentations by *Stevenson* on the deduction of some thermodynamic properties of the outer core, such as the melting curve, using results from the statistical theory of liquids. These results seem to suggest quite strongly that the melting point gradient in the outer core at constant composition is

steeper than adiabatic and thus provides additional evidence against a stably stratified core. A very interesting paper in the sequence by *Sommerville* and *Ahrens* reported recent shock wave results pertinent to the hypothesis of potassium in the core which strongly suggests, according to the authors, that the hypothesis is unlikely to be correct. These results seem to be rather important both to the question of the energy source for the convective circulation in the mantle and that for the geodynamo. If the whole mantle is convecting and there is a substantial heat flow across the core mantle boundary the planet must be cooling since the heat withdrawn from the core could not be replenished by radioactive decay processes. The cooling of the planet could contribute very substantially to the motions in both core and mantle, a fact which emphasizes the importance of the thermal history to the way in which the two units interact.

(W. R. Peltier, Acting Convenor)

# No. 15. QUANTITATIVE METHODS OF ASSESSING PLATE MOTIONS

The Symposium focused on the latest work in the quantitative determination of present and past plate motions, including relative and absolute plate velocities and finite plate rotations. The subject drew together workers in paleomagnetism, geodesy, seismology, geology and theoretical tectonophysics.

From the work of *Minster* and *Jordan*, of *Chase*, and of others, the present-day relative motions of the major plates averaged over the last 3–5 m.y. are fairly well known. The principal outstanding problems in the field of plate motions, and the topics addressed during this Symposium, are (1) the relative motions of plates in the past, (2) the motions of plates with respect to a plate-independent reference frame, (3) the relationship of regional displacements and strain near plate boundaries to the average motion of major plates, (4) the motion of plates over time scales much shorter than  $10^6$  yr, and (5) the nature of the forces maintaining plate motions.

Several global and regional plate reconstructions were presented for the geologic past. A major problem, yet unsolved, for the determination of a global set of relative plate velocities prior to 30 m.y. ago is the specification of the sense and amount of relative motion, if any, between west and east Antarctica. The Antarctic plates link the oceanic plates in the Pacific (Pacific, Farallon and Kula plates) to the rest of the world. In spite of such problems, however, there is growing evidence for large and yet unexplained past accelerations and decelerations of many of the plates.

A concensus remains to be reached on a suitable reference frame, if any exists, for determining the absolute motions of the plates. The Earth's rotation axis provides a good reference for plate rotations about axes other than the geographic (or mean geomagnetic) pole. *Jurdy* demonstrated that the lithosphere has not *wandered* with respect to the mean magnetic pole during the Cenozoic. An ensemble of hot spots provides a reasonable reference frame for individual plates and perhaps for sets of plates, but some hotspots move slowly with respect to one another and the set of hotspots may move with respect to the rotation axis. Finally, a force balance for each plate or for the entire lithosphere may provide a reference frame for plate motion with respect to the asthenosphere, but the asthenospheric flow must be taken into account.

Plate displacements near plate boundaries need not bear a close similarity to the predictions of rigid-plate tectonics. Clearly plate motions are time-dependent near boundaries,

reflecting episodic strain release by earthquakes. *Bibby* and *Walcott* presented evidence from strain data that plate motion in New Zealand occurs principally by lithospheric deformation distributed across a 100 km wide zone and only secondarily by earthquake slip on plate boundary faults.

Relatively new, ultra-precise geodetic techniques such as satellite laser ranging and very long baseline interferometry (VLBI) offer the promise of measuring directly both the motion between the stable interiors of adjacent plates and the time-dependent deformation near plate boundaries (and perhaps within plates). *Herring* and others reported the measurement by VLBI of a baseline between Europe and North America to a subdecimeter precision, heralding the imminent direct observation of continental drift.

The nature of the forces moving the plates remains a fundamental topic of current research. The plate motions themselves, the state of stress in the lithosphere, and the Earth's gravity field are all potentially important contraints on the driving mechanism. Temperature contrasts associated with convergence zones and spreading ridges and sublithospheric convection are all likely elements of the driving force system. Proposed force models must be capable of explaining past plate motions as well as those of the present.

Progress on understanding plate motions is likely to come in the near term from new measurements of displacements and strains between plates and along plate boundary zones from more detailed reconstructions of past plate positions and motions, from further determinations of lithospheric stress, and from an integration of the new data into existing theoretical models for the driving mechanism.

(S. Solomon and J. Luck, Convenors)

# No. 16. GLOBAL RECONSTRUCTIONS AND THE GEOMAGNETIC FIELD DURING THE PALEOZOIC

The Symposium occupied five sessions covering Monday 10th and Tuesday 11th December, 1979. The opening session was clearly the highlight of the Symposium. *Irving* (Canada) presented his view of the rearrangement of Pangea from form A to form B during the late Paleozoic. *Van der Voo* (U.S.A.) and *Bucha* (Czechoslovakia) analysing the same data presented an alternative interpretation. These differences immediately highlighed the problems of data analysis and the basic philosophy that ought to be followed. Considerable debate centred around this point. Later *Smith* and *Briden* (U.K.) presented their versions of Paleozoic World Maps, with a philosophy that followed the line of *Irving* in the earlier paper. *Scotese* presented a film covering continental drift during the Phanerozoic.

During subsequent sessions, aspects of the overall problem of global reconstructions were presented. The former separation of the Siberian and Russian platforms was discussed by Khramov. The development of the Appalachians during the early Paleozoic was discussed by Haworth (Canada). Contrasting views of the unity of the Australian plate and of Gondwanaland in late Precambrian-Cambrian times were presented by McElhinny and Klootwijk (Australia). These papers presented some of the problems in the interpretation of multicomponents in rocks with overprinted magnetizations. Which is primary and which is secondary?

Session 4 presented three very interesting papers. *Klootwijk* described his work on the Nepal Himalaya. Very careful work made it possible to measure the extent of the Indian plate beneath Asia and the extent of Greater India in a Gondwana reconstruction.

The place of Iran in Gondwanaland was discussed by Soffel (Germany) who concluded it was most likely previously a microcontinent that broke off Gondwanaland during the Paleozoic and had a much earlier collision with Eurasia than India. Irving then presented a discussion of the problem of Pacifica and the displaced terranes now situated along the west coast of North America. Results from this region make it clear that they were not originally part of Gondwana but came from more equatorial latitudes.

The final session was devoted to aspects of the late Paleozoic magnetic field. Reversal time-scales were discussed by *Khramov* (U.S.S.R.) and *Valencio* (Argentina). A new look at geological palaeointensity determinations was described by *Senanayake* (Australia) and finally *Embleton* (Australia) described the difficulties of locating the late Paleozoic Illawarra reversal in southeast Australia, usually regarded as the type section for the close of the Kiaman interval.

The Symposium celebrated the 25th Anniversary of paleomagnetism in Australia and highlighted new problems for the analysis and interpretation of paleomagnetic data. Perhaps the most important of these is deciding whether or not the age of the characteristic magnetization is the known age of the rock unit under study. The variable introduced by allowing for these not necessarily to be identical can cause markedly different interpretations of the same data. This is clearly the most important problem that needs to be resolved in specific cases in the future.

Nineteen papers were presented, most of which will be published in a special edition of the Journal of Geomagnetism and Geoelectricity to be edited by M. Ozima.

(M. W. McElhinny, Convenor)

# No. 17. ELECTRICAL CONDUCTIVITY AND THE CHARACTERISTICS OF THE ASTHENOSPHERE

Much interest attaches to the question of whether a maximum (or maxima) of electrical conductivity occur at depths ≈ 100 km, and how universal such extrema may be along radii beneath difference geological provinces. While there is still a tendency to see the average mantle conductivity depth profile as monotonically increasing with depth, there seems to be considerable confusion whether this is the best choice against which to define local anomalies, or indeed whether it serves any useful purpose to have a reference distribution for such a geophysically variable distribution. A continuously increasing function seems to represent the situation, according to Vanyan, under ancient continental shields, but both he and Lilley made reference to the much higher conductivities and its lateral variations under the younger and more active continental areas. Our whole concept of a global average may well begin to look absurd when more data have been collected from oceanic regions. The novel techniques of E.M. sounding in deep water, described by Filloux, have now been deployed in several locations of the Pacific and Atlantic, and it seems that in a high proportion of cases, the conductivity at depths  $\sim 100 \, \mathrm{km}$  is  $\sim 0.1 \, \mathrm{ohm^{-1}} \, \mathrm{m^{-1}}$  and significantly higher than the values taken as a norm for such depths only on the evidence of continental studies. The minimum in shear wave velocity and Q is definite beneath the oceans; more definite than under the continents. So far logistic difficulties have prevented the detection of as definite a maximum in conductivity, but this remains an exciting objective for the future.

Theoretical interest in conductivities  $\sim 0.1$  ohm<sup>-1</sup> m<sup>-1</sup> and conductivity maxima stems from the fact that they have no tenable explanation in terms of the effect of temperature on the conductivity of solid mineral phases. It is generally thought that a liquid phase must be

involved, but opinion is divided as to whether it is basically siliceous and the lowest melting point fraction of the mantle rocks (Shankland & Waff) or an aqueous solution produced by dehydration (Tozer). The first explanation appears to rely on conventional methods and estimates of finding the temperature in the Upper mantle with heat conduction theory, whereas the dehydration model was introduced specifically to deal with the consequences of the Earth now being seen as a dynamically evolving object to which a convective rather than conductive theory of heat transfer applies. Any explanation involving liquids demands a degree of convectivity in the melt fraction and this raised some interesting questions of stability and permanence of liquid networks in a gravitational field. Probably the resolution of these controversies await further developments in heat transfer theory, laboratory observation of partially molten systems and further field observations, but it seems that conductivity studies relevant to asthenospheric depths may be the most valuable contribution geomagnetic sounding can make to general geophysical studies.

(W. D. Parkinson, IAGA Convenor)

Electrical conductivity can now claim to be one of the measurable physical variables in the upper mantle. A substantial number of measurements are summarised by a "normal curve" relating conductivity to depth by a monotonically increasing function. This applies to shield areas and agrees well with global results from widely scattered ovservatories.

Two significant departures from this normal curve are often found. Where porous sediments occur at the surface a conductivity maximum is commonly observed. Also in many places a second conductivity maximum or highly conducting layer (HCL) is found at a depth of about 80 km. The depth is well controlled by magneto-telluric measurements as is the product of thickness and conductivity. Separate estimates of conductivity and thickness can be more precisely obtained from controlled source experiments.

Evidence from isostasy, tectonics and seismology requires a zone of low viscosity at a depth of the order of 100 km. This has been called the "asthenosphere". On the basis of the similarity between the temperature dependence of viscosity and conductivity, it is generally assumed that the highly conducting layer and the asthenosphere are the same thing. The correlation of conductivity with seismic and heat flow results in western U.S.A. strongly supports this assumption. However the relation between viscosity and conductivity in silicates can be quite complicated, especially when the Fermi energy level is far removed from available electron energy levels.

The asthenosphere is present under the oceans. According to plate tectonic models it should be at a shallower depth under younger parts of the ocean floor. This is beautifully confirmed by sea floor measurements which show a HCL varying from a depth of 20 km for 2 My old ocean floor to 130 km for 30 My old ocean floor.

A commonly assumed explanation of the low viscosity and seismic velocity, and high conductivity layer is that, at a depth near 100 km in non shield areas, the temperature curve intersects the solidus, producing partial melting. However both mechanical and electrical properties are very sensitive to the aspect of the molten fraction. The conductivity requires a melt fraction of several per cent in a connected network; seismic attenuation requires a much smaller melt fraction in elongated voids. Thus it is difficult to find a single configuration that satisfies measurements of both properties. For this and other reasons alternative explanations of the HCL have been sought. Convection in the mantle is an efficient means of heat transfer. The mantle may be cooler than previously throught and its temperature may not approach the

solidus anywhere. A possible "low temperature" explanation of the HCL involves the release of water by the hornblende-eclogite transformation.

Work in Iceland, where the extent of partial melting is unusually well known, indicates that its effect may be dominant.

Many problems remain in this field. How normal is the "normal curve"? We need many more continental depth soundings to know how widespread the HCL really is. Also the ocean-continent contrast in mantle conductivity should be more thoroughly established. Strong lateral inhomogeneities in conductivity are common but their relation to the asthenosphere is not clear. The ability of electro-magnetic induction to trace rift zones beyond their surface expression (as shown in Africa) should be exploited.

Perhaps the biggest unknown at present is the cause of the HCL. Any explanation must be consistent with the absence of a HCL under at least some shield areas. The dehydration model envisages a "wet" sub-oceanic mantle and a "dry" sub-shield mantle. This must be reconciled with the conclusions of petrology.

An issue of P.E.P.I. will be devoted to the proceedings of this symposium.

(D. Tozer, IASPEI Convenor)

#### No. 18 THE MIDDLE ATMOSPHERE

The Symposium on the Middle Atmosphere was held on 10–11 December 1979, cosponsored by IAMAP, IAGA and SCOSTEP. The structure of the Symposium included 3 sessions dealing with the following general subjects:

- 1) Invited papers to set the background of the subject,
- Sessions in which developments of the pre-MAP programs and contributed papers were presented,
- 3) An evening session in which national plans for MAP were presented by the national representatives of eight countries.

There were many important papers in these sessions. The variety of these and the rapid progress since the Seattle IAGA/IAMAP meetings (1977) gives evidence of a growing maturity in middle atmosphere research. One especially noteworthy event is the appearance of several papers from the flight of NIMBUS 7 satellite. These data give promise of substantial advances in the understanding of the global patterns of temperature and a number of minor constituents. It was announced that these data will be placed in public archives early in 1981. The promise of mesospheric-stratospheric-tropospheric (MST) radar for wind measurements is being borne out by the substantial number of papers presented using radio techniques. New techniques are being developed for the application of these results to atmospheric quantities, including not only wind field measurements but the derivation of parameters relating to eddy diffusion coefficients.

It is apparent from the nature of a variety of papers presented that the interaction among theory, numerical modelling and experiment is progressing rapidly. There are increasingly large numbers of papers which indicate valuable contributions from several areas. Plans described in several sessions for cooperative programs indicate that there will be continued progress in this area. Additional papers were presented which indicated that substantial advances are being made in fields which utilize techniques such as LIDAR and balloons. New results from both of these areas indicate their promise for the future. These appears to be developing interest in the area of electrodynamics of the middle atmosphere. This area, which was largely missed in the

early planning, is beginning to demonstrate potential importance to a variety of atmospheric problems.

Subsequent international MAP symposia are currently planned to be held at Illinois in 1980 and at the IAGA-IAMAP meetings in 1981.

(I. Hirota and L. R. Megill, Convenors)

# PROGRAMS AND HIGHLIGHTS OF THE IAGA SESSIONS

# I-1. MATHEMATICAL AND PHYSICAL ASPECTS OF MODEL-LING THE GEOMAGNETIC FIELD AND ITS SECULAR VARIATION (Convenor: B. R. Leaton)

December 8 (Saturday) a.m. and p.m. Room: Copland G7 Chairmen: B. R. Leaton and A. N. Pushkov

- T. Yukutake: On derivation of the secular change term in the geomagnetic reference field (11.01).
- R. W. James: Some theoretical aspects of geomagnetic scalar intensity analysis (11.02).
- F. S. Barker: Domain partitioning for modeling spatially uniform geomagnetic vector data (11.03).
- G. I. Kolomijtseya, A. N. Pushkov, T. A. Chernova: The main geomagnetic field and its variations (I1.04).
- F. S. Barker: A main field model for the 1980 world declination charts (I1.07).
- D. R. Barraclough, B. R. Leaton, S. R. C. Malin: World declination charts for 1980—secular variation (I1.08).
- W. Webers, W. Mundt: On spectral analysis of geomagnetic time series (11.09).
- N. M. Rotanova, N. I. Papitashvili, A. N. Pushkov: Spectral and temporal analysis of the annual means of magnetic elements at the world magnetic observatories (I.1.10).
- D. H. Coupland, R. Van der Voo: Non-dipole components in the time-averaged geomagnetic field during the last 130 my. (I1.11).
- G. N. Petrova, S. P. Burlatskaya: Secular variations spectrum (I1.12).
- G. N. Petrova, V. N. Vadkovsky, G. Z. Gurary, M. P. Mamikonjan, G. V. Rassanova: Secular variations in Matuyama-Jaramillo reversal (11.13).
- E. R. Benton: Downward extrapolation of electro-magnetic fields through a nonuniform spherically symmetric mantle (I1.14).
- P. H. Roberts, D. R. Barraclough, S. R. C. Malin: More on core surface motions (11.15).
- C. G. A. Harrison, H. M. Carle: Core and crustal fields in oceanic basins, and the origin of intermediate wavelength magnetic anomalies (11.16).
- J. Ducruix, V. Courtillot, J. Le Mouel: A secular variation acceleration, the eleven year magnetic variation and their implications for deep mantle conductivity (I1.17).

The sessions were attended by approximately 60 delegates. The papers presented covered 3 broad topics.

- (a) Techniques and practical modelling of the present geomagnetic field and its recent secular change.
- (b) Spectral analysis of several geomagnetic time series and
- (c) Studies relating to the Earth's deep conductivity and motions at the core boundary.

Yukutake showed that higher frequency components remain after removal of trend and the solar cycle effect, and hence secular acceleration should be taken into account. In developing his simple method for evaluating models from scalar intensity data James showed that, for an infinite series, 2 models may be derived, having an arbitrary potential difference. Barker demonstrated that the uniform spatial converage expected of MAGSAT data will permit the compilation of models to a very high order and degree, computational problems being eased by appropriate partitioning which includes a large measure of orthogonalisation. He further reported on the joint USA/UK 12th order main field model for 1980 derived from angular data only. The corresponding secular change model, using observatory repeat station service survey and satellite data, was reported by Malin who also described the global morphology of the 1970 jerk.

There is now clear evidence that in many respects the pattern of the geomagnetic field and its changes is not random. For instance, spectral analyses of European observatory data, reported by *Mundt*, and archaeo- and palaeomagnetic data reported by *Petrova*, show that the secular change spectrum is discrete, and that there appear to be at least 2 classes of behaviour near reversals with distinctly different VGP topography. The secular change pattern, of course, shows large variations but *Pushkov* reported a marked persistence in the location of some non-dipole isoporic foci, which is apparent even in the Brunhes epoch. Studies of the stationary field, described by *Van der Voo*, show other evidence of durability. The axially symmetric quadrupole component has been important for the last 100 MY. Both the octupole and some marked regional features of the non-dipole anomaly pattern have existed for more than the past 50 MY.

From analysis of the European detail of the 1970 jerk, and the internal response to the 11 year cycle, Courtillot deduces an upper limit of macro-conductivity between 100 and 200 siemens per metre. Benton showed that mantle conductivity does not significantly affect extrapolation to the core of models to m=n=8. Applying such an extrapolation to the core boundary in tests of a proposed invariant Roberts showed for the first time how to derive motions along the magnetic equator. The product of wave number and velocity indicates that a lot of power is involved.

(B. R. Leaton)

# I-2. TECTONOMAGNETICS (Convenors: V. A. Shapiro, M. J. S. Johnston, and F. D. Stacey)

December 10 (Monday) a.m. and p.m. Room: Copland G5, Chairmen: T. Rikitake and F. D. Stacey

Seismomagnetic Effect: Observation and Interpretation

- T. Rikitake: Changes in the geomagnetic field associated with earthquakes in the Izu Peninsula, Japan (I2.01).
- A. M. Isikara, I. Özdogan, N. Orbay: Locally anomalous behaviour in Turkey (I2.03).
- N. Orbay, A. M. Isikara, I. Özdogan: Does secular variation obtained from long interval separated data give tectonic implications? (I2.04).
- M. Pantovic, A. M. Isikara: A study on revealing the seismotectonic pattern of Yugoslavia from geomagnetic data (12.05).

Seismomagnetic Effect: Observation and Interpretation

- R. L. McPherron, P. M. Davis, C. Searls, D. D. Jackson, P. J. Coleman Jr: Spectral characteristics of noise in proton magnetometer measurements for earthquake prediction (I2.07).
- P. M. Davis, D. D. Jackson: Detection of tectonomagnetic events using multichannel Wiener filtering of magnetic array data (12.08).

### Geomagnetic Field Variations Induced by Recent Processes in the Earth's Lithosphere

- W. Mundt, P. Bankwitz: Possible connections between secular variation anomalies and anomalies in recent horizontal movements of the earth's crust in the GDR (I2.09).
- B.R. Lienert, J. H. Whitcomb, R. J. Phillips: Long term variations in magnetotelluric apparent resistivities near the San Andreas fault (I2.11).
- K. Noritomi: Low electrical resistivity along an active fault, Yamasaki fault (I2.12).
- S. J. Pike, J. Revol, T. L. Henyey, M. Fuller: Pressure cell for use with cryogenic magnetometer to simulate shallow crustal conditions (12.14).
- J. Revol, R. Day, M. Fuller, S. J. Pike: Magnetization of polycrystalline magnetite and various rocks under stress: implications for tectonomagnetism (I2.15).

The limited offering of papers apparently reflected the rather slight advance in tectonomagnetism since the more extended symposium on the same subject at the Seattle Assembly. Observations continue, but are mostly of marginal or doubtful significance and even viewed retrospectively could not have been made the basis of earthquake predictions. The most promising development is evidently the numerical filtering of data under study at UCLA. This appears to offer hope of more convincing observations in the future.

(F. D. Stacey)

# I-3. PLANETARY DYNAMO THEORY (Convenor: F. H. Busse)

December 10 (Monday) a.m. and p.m. Room: Copland G4,

#### Chairmen: F. H. Busse and P. H. Roberts

- M. G. Rochester: Core properties and dynamics: Geophysical and astronomical evidence (invited review, 13.03).
- D. J. Stevenson, G. Schubert, P. Cassen, R. T. Reynolds: Core evolution of the terrestrial planets (13.04).
- P. H. Roberts, D. E. Loper: Speculations on the cause of reversal asymmetries (13.02).
- E. J. Smith: Planetary magnetic fields (invited paper, 13.05).
- M. H. Acuna, N. F. Ness: Pioneer II Saturn encounter: Preliminary results from the GSFC magnetometer experiment (13.06).
- D. J. Ivers, R. W. James: Generalized antidynamo theorems (13.08).
- F. H. Hibberd: A thermomagnetic generator for the geomagnetic field (13.09).
- M. W. McElhinny: Properties of the earth's dynamo inferred from paleomagnetic and archeomagnetic evidence (invited review, 13.01).
- I. A. Eltayeb: Hydromagnetic instabilities in rotating magnetic systems (invited review, I3.10).
- R. Hide: Dynamo theorems.
- R. G. Cuong, F. H. Busse: A numerical model of the geodynamo (I3.13).

Four invited and seven contributed papers were presented in this full-day session. The proceedings of the session can be conveniently divided into two parts: a first part dealing with

the observational constraints and the physical environment in which planetary dynamos operate, and a second part addressed to the theory of the dynamo process of the generation of magnetic fields by fluid motions.

The geophysical and astronomical evidence for the dynamical properties of the earth's core and for the coupling between core and mantle was reviewed by Rochester. The observed correlation between changes of the length of the day and the westward drift of the nondipole geomagnetic field indicate the importance of the core-mantle coupling process. But because of the uncertainty of the electrical conductivity in the lowermost mantle, it has not yet been possible to decide whether electromagnetic coupling is sufficiently strong to explain the observations or whether the inertial coupling mechanism by bumps on the core-mantle boundary is required as proposed by Hide. The increasing accuracy of seismic and other geophysical measurements suggests that detailed information about the bumps and about other dynamically important properties of the core will become available in the near future. The discovery of the Slichter mode of the inner core and perhaps even the measurement of subseismic internal modes of the outer core would greatly improve our knowledge of the physical conditions in this part of the earth. The interpretation of the more accurate measurements will require improved earth models and intimate cooperation between astronomers and geophysicists. Rochester expressed regret that the astronomical community has adopted the old model of Molodenskii instead of the recently improved models by Wahr and others, which are preferred by geophysicists.

Quite different constraints are provided by archeomagnetic and paleomagnetic data, which were reveiwed by McElhinny. He stressed the importance of a worldwide distribution of data, since continent size anomalies seem to be frequent in the history of the geomagnetic field. The often-reported  $10^4$  year period of the dipole intensity, for example, is a doubtful phenomenon, since little evidence for it is found from archeomagnetic measurements outside Europe. The question of asymmetries between normal and reversed state of the earth's magnetic field received particular attention, since they cannot be explained on the basis of dynamo theory alone. McElhinny presented new data confirming the earlier finding of a significant difference between the  $g_3^0/g_1^0$  ratio for normal and reversed state, while the  $g_3^0/g_1^0$  is nearly the same according to the more recent measurement. Roberts and Loper, in a contributed paper, emphasized the possible importance of thermoelectric effects, which were also mentioned by D. Stevenson in a different session of the IUGG General Assembly. The possibility of a purely thermomagnetic generator instead of a dynamo was resurrected by Hibberd. But it remains doubtful whether the magnitude of the Nernst effect is sufficiently large in the earth's core.

The exploration of the magnetic fields of other planets by space probe has strongly stimulated planetary dynamo theory. The results of this exploration were reviewed by *Smith*. The recent measurement of Saturn's magnetic field received particular attention. Saturn's field differs from those of other planets because of its small quadrupolar component and because of its perfect alignment (within about  $0.1^{\circ}$ ) with the axis of rotation. Extrapolation of the measured data yields an equatorial field strength of  $2.5 \times 10^{-5}$  tesla. The data reported by Smith were corroborated by the data obtained independently by the GSFC magnetometer on the Pioneer XI space probe and presented in this session by *Acuna*. The existence of a planetary dynamo has implications for the thermal history of a planet. The paper presented by *Stevenson* described thermal history models of the terrestrial planets and gave an explanation for the apparent absence of a dynamo process in Venus. As Stevenson pointed out convincingly, in

spite of the small difference in size between Earth and Venus, the latter probably does not possess a solid inner core, because of its lower pressure at the center of the planet. Thus the energy source of gravitational separation leading to the formation of an inner core is not available to drive a dynamo. In the case of Mercury, an active dynamo still seems to be possible even though the radius of inner core may have nearly reached the radius of the outer. Because of the low melting point of iron sulfur alloys, the existence of a liquid shell inside Mercury is plausible.

The mathematical theory of dynamos was less well represented at this meeting than at some earlier ones, partly because the speakers for some of the papers listed in the original program were unable to come to Canberra. In spite of this, the four theoretical papers presented in the session gave a good indication of recent progress in dynamo theory. Eltayeb reviewed the topic of convection instability in hydromagnetic systems. Although this problem does not involve the dynamo process directly, the understanding of the dynamics of convective motions in the presence of a magnetic field is a prerequisite for the understanding of the interaction taking place in the full magnetohydrodynamic dynamo problem. The generalization of Cowling's antidynamo theorem and of the toroidal theorem was the topic of the paper by Ivers and James. Although no new geometries for the application of antidynamo theorems were found, the generalization offers the potential for a deeper understanding for the absence of dynamo action under special conditions. A new look at dynamo theorems from a different point of view was presented by Hide. The method of surface integrals over regions of magnetic flux of the same sign introduced by Hide provides an attractive way for proofs of the classical theorems on the one hand, and for the investigation of new hypotheses on the other hand. Recent progress in the numerical solution of realistic magnetohydrodynamical dynamo problems was reported in the paper by Cuong and Busse. Results were obtained for the case of convection in a rotating spherical shell for certain values of the Taylor number and the azimuthal wave number. The fact that in the majority of the cases investigated dynamos could not be found suggests that dynamo action is rarer than many theoreticians have believed. A better understanding for the conditions under which dynamos occur in a finite domain such as a sphere will require more detailed computations.

(F. H. Busse)

# I-4. LITHOSPHERICAL MAPPING FROM LOCAL ANOMALY CHARTS (Convenors: C. C. Weber and P. J. Hood)

December 11 (Tuesday) a.m. Room: Copland G4 Chairmen: C. C. Weber and P. J. Hood

The objective of Session I-4 was to review recent advances in utilizing magnetic survey data to delineate the geological formations comprising the earth's crust and to provide information on their genesis. Several papers were not given due to non-attendance of the authors at the General Assembly; the actual papers that were presented in Session I-4 are as follows:

- P. J. Hood: Aeromagnetic surveys in Canada and their geological interpretation (14.02).
- D. W. Strangway, S. Letros, J. Bambrick, A. Tasillo: Aeromagnetic mapping and magnetic properties of a Precambrian greenstone belt in the Canadian Shield (14.04).
- C. C. Weber: Données sur la lithosphère en France: comparaison entre levés aéromagnétiques et autres informations géophysiques (14.05).

Hood commenced the session with a review of the national aeromagnetic survey which has been carried out by the Geological Survey of Canada since 1947 as an aid to both geological mapping and mineral exploration programs in Canada. Since that time some 8 million line kilometres of aeromagnetic survey data have been obtained and have resulted in the production of 8100 aeromagnetic maps at various scales. The specifications for aeromagnetic surveys in Canada have been continually improved upon over the years, mainly as a result of developmental work undertaken by the Geological Survey of Canada. This developmental work has also resulted in the fabrication of an inboard aeromagnetic gradiometer survey system which measures the vertical gradient of the earth's total field in addition to being a high resolution total field instrument. The main advantages of the aeromagnetic gradiometer as a geological mapping tool compared to the single sensor (total field) technique are a) superior resolution of anomalies produced by closely-spaced geological formations; b) anomalies produced by near-surface features are emphasized with respect to those resulting from more deeply-buried rock formations; c) regional gradient of the earth's magnetic field and diurnal variation are automatically removed; d) direct delineation of vertical contacts by the zero gradient contour value i.e. vertical contact mapper. In 1967, the first coloured Magnetic Anomaly Map (MAM) of Canada was produced at a scale of 1:5,000,000 in which the dominating effects of the main earth's field were removed. Two more editions of the map have been produced in the subsequent 10-year period. The main uses of such a magnetic anomaly map are threefold. Firstly, as an index map it presents an overview of the aeromagnetic survey coverage of Canada. Secondly, the map presents the major patterns produced by the continental rocks of the Canadian landmass and may be utilized both as an aid in the delineation of structural provinces and the interpretation of regional features in the basement rocks. Thirdly, the map stimulates comparisons of magnetic features with other geological and geophysical compilations on a regional scale. More recently commencement of coloured 1:1,000,000 MAM's has also begun and these are clearly superior to the 1:5,000,000 MAM in showing the finer details of the regional anomalies since short wavelength features especially dykes tend to be eliminated at the smaller scale.

Strangway continued the discussion of the results of the Canadian aeromagnetic survey program by describing the aeromagnetic mapping of a Precambrian greenstone belt in the Canadian Shield. Major gneissic belts of the Superior province are characterized on the 1:5 million Magnetic Anomaly Map of Canada by strongly banded zones and are consequently easily recognizable. In between the gneissic belts are a number of broad magnetically-low areas which correspond to the greenstone belts with which many base metal deposits are associated. Within the greenstone belts it is possible to study in detail a variety of volcanic rock types ranging from komatiites, to iron-rich tholeiites to magnesium-rich tholeiites to rhyolites and andesites. Frequently these represent piles of volcanic flows which are several kilometres thick. A detailed study of the magnetic properties of representative rock types from a region near the Ontario-Quebec border indicate that these rock types have a wide range of magnetic properties. By using high resolution airborne magnetic maps, equivalent susceptibility maps have been compiled that permit the delineation of the surface geology to a very high degree of accuracy. These maps outline the various stratigraphic units quite sharply and these can be identified from the measured magnetic properties. In this manner it is possible to derive detailed stratigraphic maps relating to the volcanic stratigraphy and hence use this in mapping. In addition, where major faults exist there appears to be a sharp drop in the equivalent susceptibiltiy suggesting the destruction of the magnetic minerals along the fault plane.

Weber discussed the results of the 1964 aeromagnetic survey of France (carried out by the National Centre for Scientific Research) which has permitted the production of a variety of anomaly maps at different scales. Using the aeromagnetic results the Bureau of Recherches Géologiques et Minières has recently prepared a detailed magnetic anomaly map of France. A comparison of the resultant aeromagnetic survey information with the gravimetric data, seismic profiles and the seismotectonic map of France has permitted the delineation of a number of large scale features of the continental crust. A number of distinct crustal blocks have been mapped which have a particular character with regard to their geological lithology, crustal thickness, tectonic history and present seismic activity. The block boundaries correspond in a number of cases to important zones of faulting, the most important of which are of late Hercynian age. Many of these faults have an associated seismicity which indicates their present activity. In concluding the paper, the large magnetic anomaly associated with the Paris Basin was interpreted as being due to a pre-Hercynian rift in the crustal rocks prior to the formation of the North Atlantic Ocean.

(P. J. Hood)

# I-5. ROCK MAGNETISM OF FINE PARTICLES (Convenors: E. R. Deutsch and H. C. Soffel)

December 11 (Tuesday) p.m. and 12 (Wednesday) a.m. Room: Copland G4, Chairmen: H. C. Soffel, E. R. Deutsch and D. J. Dunlop

- D. J. Dunlop: The rock magnetism of fine particles (Invited, 15.01).
- P. M. Davis: Hysteretic properties of interacting single domained magnetic particles (I5.02).
- E. R. Deutsch, R. R. Patzold, C. Radhakrishnamurty: Apparent superparamagnetic behaviour of some coarse-grained synthetic titanomagnetite (15.03).
- C. Radhakrishnamurty, S. D. Likhite, E. R. Deutsch, G. S. Murthy: A comparison of the magnetic properties of synthetic titanomagnetites and basalts (15.04).
- W. E. Senanayake, M. W. McElhinny: Hysteresis and susceptibility characteristics of magnetites and titanomagnetites: Interpretation of results from basaltic rocks (15.05).
- L. G. Parry: The influence of fine structures on the remanence of multidomain particles of magnetite and titanomagnetite (15.07).
- G. Murthy, R. Patzold, C. Brown: Source of stable remanence in certain intrusive rocks (15.08).
- D. Clauter, V. A. Schmidt: Shifts in the blocking temperature spectrum of magnetite powders as a function of grain size and applied field (15.09).
- S. Halgedahl, R. Day, M. Fuller: Domain patterns in titanomagnetites and pyrrhotite, dependence upon grain size and magnetization state (15.10).
- H. C. Soffel: Domain structure of fine grained pyrrhotite (I5.11).
- F. Oldfield, R. Thompson: Stream bedload tracing: a hydrological application of superparamagnetism and magnetic viscosity (I5.12).
- J. L. Kirschvink: Fine-grained biogenic magnetites and their use in rock magnetism (I5.13).
- J.-P. Pozzi: An interpretation of piezoremanence in fine grained hematite bearing rocks (I5.14).
- T. Nagata: Viscous magnetization and apparent coercive force caused by VRM for achondrites (I5.15).

The magnetization of rocks, though it has been studied for almost two centuries, is still not entirely understood. Research in this field has been intensified during the last 30 years, especially in connection with palaeomagnetism, the interpretation of continental and marine magnetic anomalies and the study of the physical properties of samples of extraterrestrial origin.

It is generally agreed that the stable components of remanent magnetization reside in fine particles of ferrimagnetic minerals of either single-domain size or in very small multidomain grains with pseudo single-domain behaviour.

In an invited paper (I5.01), Dunlop presented an introduction into the subject of fineparticle rock magnetism and discussed the present knowledge in this field as well as some future guidelines. The following paper (15.02) and a later paper (15.09) were devoted to the problem of the magnetostatic interaction of single-domain grains in exsolved titanomagnetites and of dispersed magnetite of various concentrations in a nonmagnetic matrix. The next three papers (15.03, 15.04, 15.05) dealt with the study of magnetic susceptibility and hysteresis properties of magnetite and titanomagnetites as dependent on temperature. The interpretation of the observed spin glass behaviour of many natural and synthetic samples is still controversial. Models for the experimentally observed unexpected stability of remanence and large coercive forces of multidomain grains of magnetite have been discussed in two papers (15.07, 15.08), while two other contributions (I5.10, I5.11) were devoted to the direct observation of the magnetic domains down to the multi-domain/single-domain threshold of titanomagnetites and pyrrhotite. A connection to biology appeared in the the report on biogenetic magnetism (I5.13) where the presence of single-domain magnetite in bees, mollusks and bacteria as a tool for their orientation was discussed. This was followed by a paper on the stress remanence of rocks (15.14) carrying fine-grained hematite, and another on the use of material with special magnetic properties as a tracer in river sediments. The session concluded with a contribution by one of the most merited scientists in rock magnetism, Prof. Takesi Nagata, on the viscous remanence of stony meteorites from Antarctica (I.5.15).

The contributions and the discussions during this session showed in a remarkably clear manner the numerous unsolved problems in rock magnetism. Most of them are of vital importance for various methods and techniques in palaeomagnetic research, such as: demagnetization procedures, palaeointensity studies, evaluation of the influence of structural and chemical changes on the magnetic properties of the ferrimagnetic minerals.

The papers of this IAGA session will be published in the near future in a special volume of Physics of the Earth and Planetary Interiors.

(E. R. Deutsch and H. C. Soffel)

# I-6. PALAEOMAGNETISM OF RECENT SEDIMENTS (Convenor: R. Thompson)

December 12 (Wednesday) p.m. Room: Copland G4, Chairman: R. Thomspon

- D. T. A. Symons, M. Stupavsky, C. P. Gravenor: Remanence resetting by shock induced thixotropy in the Seminary Till, Scarborough, Ontario (I6.01).
- S. Sasajima, Y. Otofuji: A new model of the post-DRM acquisition (I6.02).
- R. M. Clark: Comparison of palaeomagnetic records (16.03).
- K. Noritomi, R. Nakamura, Y. Matoba: Palaeomagnetic study of Miocene-Pliocene sediments in Akita Prefecture, Japan (16.04).

- V. A. Schmidt: Magnetostratigraphy of clastic sediments in the Flint-Mammoth cave system of Kentucky, USA—a new high resolution field record extending back to one million years (16.05).
- B. H. Keating, C. E. Helsley: Magnetization of the Cretaceous Lance formation (I6.06).
- R. M. Clark: Smoothing of directional data (I6.07).
- N. Abrahamsen, B. Fredskild, S. Funder: Holocene magnetostratigraphic investigations in Greenland. Preliminary results (I6.08).
- R. Thompson, G. M. Turner: Gemagnetic secular variations from European lake sediments (16.09).
- C. E. Barton, M. Barbetti: Survey of recent geomagnetic secular variation in South-Eastern Australia (I6.10).
- R. Dodson, J. R. Dunn, M. Fuller, W. Kean: Records of secular variation from lake sediments (16.11).
- K. M. Creer: Lake sediment records and computer models of the late Quaternary geomagnetic field of Europe, N America and some other localities (16.13).
- S. K. Runcorn: Theoretical aspects of geomagnetic secular variation and reversals (16.14).

Thirteen papers were presented and one film shown in this full afternoon session. Topics discussed covered the origin of magnetic remanence, secular variation and geomagnetic reversal stratigraphy, statistical analysis of palaeomagnetic data, secondary magnetizations and theoretical aspects of the recent geomagnetic field. The use of cryogenic magnetometers in palaeomagnetic research has greatly expanded the range of sediments which can provide useful geomagnetic information. Carbonate rich cave, lake and deep sea sediments can now be analysed in detail. The IAGA resolution number 7 of the Canberra Assembly concerning a comprehensive study along an east-west profile of secular variation recorded in lake sediments grew out of the session discussions.

(R. Thomspon)

# I-7. MULTICOMPONENT NATURAL REMANENT MAGNETIZATION (Convenors: H. C. Halls and K. M. Storetvedt)

December 13 (Thursday) a.m. and p.m. Room: Copland G7, Chairmen: H. C. Halls, J. C. Briden, K. M. Storetvedt

- H. C. Halls: The analysis of superimposed component of remanent magnetization (I7.01).
- J. L. Kirschvink: Principal component analysis and other linear least-squares techniques for paleomagnetic data (invited, 17.02).
- P. L. Mc Fadden: An analysis of the effect of individual single domain grain anisotropy in alternating field demagnetization, with particular reference to multicomponent remanence (17.03).
- J. C. Briden, G. R. Arthur, C. A. Foss: Precision of measurement of remanent magnetization and its implications for multicomponent NRM analysis (invited, I7.04).
- K. M. Storetvedt: Problems of decomposing multicomponent magnetizations (17.05).
- P. W. Schmidt, B. J. J. Embleton: Multicomponent natural remanent magnetisation: Imprints, overprints and reprints (17.06).
- B. A. Duff: Multicomponent magnetizations in Cambro-Ordovician red beds from the Armorican massif (France and the Channel Islands) (17.07).
- M. Barbetti: Multicomponent magnetizations in archaeological samples (17.09).
- D. T. A. Symons, H. I. Hutcheson, M. Stupavsky: Positive test of the paleomagnetic method for estimating burial depth using a dike contact (I7.10).
- D. J. Dunlop, D. York, G. W. Berger: Resolving and dating multicomponent NRM in some Canadian

Precambrian rocks (I7.11).

- M. K.-Seguin: Palaeomagnetism of the Winslow intrusive and associated hornfels (I7.12).
- N. Abrahamsen, J. R. Wilson, N. Ø. Olesen, P. Thy, K. H. Esbensen: Palaeomagnetism of the Fongen-Hyllingen gabbro complex, Southern Scandinavian Caledonides (17.13).
- L. D. Schutts, D. J. Dunlop: Multicomponent NRM in Precambrian rocks of the Abitibi Subprovince, Canada (17.14).
- J. E. T. Channell, F. Heller, W. Lowrie, R. Kligfield: Magnetization components of widely differing ages in Mesozoic limestones (17.15).
- W. Lowrie, J. E. T. Channell, F. Horner: Evidence for the rotation of Sardinia derived from multicomponent magnetizations in Mesozoic limestones (I7.16).
- J. C. Briden, B. A. Duff, A. Kröner: Palaeomagnetism of the Koras Group, Northern Cape Province, South Africa (17.18).

The symposium on multicomponent NRM at the Canberra Assembly constituted the second international meeting concerned with this topic. A total of 16 papers were presented covering two broad areas of the field: a) methods of multicomponent analysis (5 papers), and b) application of these methods to geological problems (11 papers).

After an initial summary of current techniques by *Halls* an automatic least squares method based on Principal Component Analysis was outlined by *Kirschvink* who showed that vector subtraction, remagnetization circles and Hoffman-Day (1978) directions can all be obtained by fitting either lines or planes to points defined by the ends of vectors in 3-D space. *Briden, Arthur* and *Foss* demonstrated how one could assess the reliability in the position of such points obtained for single specimens on stepwise demagnetization. Papers followed that presented words of caution concerning particular techniques used to resolve components. One by *McFadden* suggested that certain errors that broaden component spectra, can occur if a single axis demagnetizer is used instead of a tumbler. *Storetvedt* showed that volcanic rocks may possess a considerably more complex magnetization than that revealed by the AF technique.

The second section included some excellent examples of the use of multicomponent techniques. They demonstrated that composite magnetizations are frequent phenomena. It was also well illustrated that there is no single experimental procedure or analytical technique that can successfully separate all components in a rock formation: each specimen has to be individually analysed rather than being subjected to blanket treatment.

In summary, substantial progress was made in the estimate of component directions and in the statistical treatment of demagnetization paths. The symposium was very well attended. From the considerable interest shown by the participants rapid progress can be anticipated in this perhaps most fundamental area of palaeomagnetic research.

(H. C. Halls and K. M. Storetvedt)

# I-8. GEOLOGICAL APPLICATIONS OF THE MAGNETIC ANISOTROPY OF ROCKS (Convenors: E. A. Hailwood and J.-J. Wagner)

December 13 (Thursday) a.m. Room: Copland G4, Chairman: J.-J. Wagner

B. B. Ellwood: Controls on the development of magnetic fabric in deep-sea sediments (I8.01).
M. Stupavsky, D. T. A. Symons, D. S. Walley: Anomaly interpretation and age of magnetism of the Algoman iron formations at the Sherman and Moose Mountain Mines (I8.02).

- R. Kligfield, W. Lowrie, A. Pfiffner: Magnetic susceptibility anisotropy and strain in folded oolitic limestones from the Swiss Alps (I8.03).
- J.-J. Wagner, I. G. Hedley, D. Steen, C. Tinkler, M. Vuagnat: Magnetic anisotropy and fabric of some progressively deformed ophiolite gabbros (I8.04).
- B. B. Ellwood: Genetic implications of some igneous and metamorphic rocks as inferred from magnetic fabric measurements (18.05).

This session presented three different applications of the method.

The first related to the use of the orientation of the anisotropy axes to determine flow directions in sediments and in magmas. This aspect was presented in great detail by *Ellwood*; many examples were discussed to give an idea under which conditions the method can be useful.

The second type of application is the relation between the magnetic anisotropy and the deformation. One of the main interests is to correlate the anisotropy to the finite strain. *Lowrie* showed with an analysis of oolitic limestones how the flattening of the anisotropy ellipsoids reflects the flattening of folds.

Wagner gave evidence for magneto-crystalline anisotropy in deformed gabbros from an ophiolite.

Finally the third topic concerned the effect of anisotropy on magnetic field anomalies. *Symons* illustrated this by the modification of the expected anomalies for both airborne and ground-based surveys of the Algoman Iron formations.

(J.-J. Wagner)

# I-9. CORRELATION BETWEEN ANOMALIES OF POTENTIAL FIELDS (Convenor: R. D. Regan)

December 14 (Friday) a.m. Room: Copland G7, Chairman: P. J. Hood

- M. H. A. Hassan, I. A. Eltayeb: On the correlation between the gravitational and magnetic potentials of the earth (19.01).
- D. H. Eckhardt: Correlations between global features of terrestrial harmonic fields (19.02).
- R. R. B. Von Frese, L. W. Braile, W. J. Hinze: Correlation of long wavelength gravity and magnetic anomalies of North America (19.04).
- J. C. Dooley: A geophysical profile across the Australian continent (19.06).
- A. Malahoff, B. M. Larue: Origin of the Southwest Pacific geoidal high (19.07).
- R. T. Haworth: The combined interpretation of gravity and magnetic anomalies over ophiolites using an interactive computer graphics system (I9.08).

The convener of the session was R. D. Regan of Phoenix Corporation, McLean, Virginia, U.S.A. who unfortunately because of a schedule conflict could not himself attend the Canberra meeting. Accordingly he asked P. J. Hood of the Geological Survey of Canada, Ottawa to chair the session for him. The objective of the session was to examine the correlation between potential field anomalies and to this end papers were invited which dealt with the theoretical and/or practical aspects of the correlation of local, regional and planetary gravity and magnetic field anomalies.

The first paper presented was a theoretical paper by *Hassan and Eltayeb* who, motivated by the suggestion that the high degree of correlation between the gravitational and magnetic potentials of the Earth discovered by Hide and Malin (1971) using harmonic analysis, may be due to the presence of small topographical irregularities on the core-mantle interface, investigated the motion of an incompressible fluid flowing over a corrugated solid surface in the presence of a uniform poloidal magnetic field and a toroidal magnetic field which increased from zero in the solid to large values deep into the fluid. The system was rotated uniformly and it was found that the motions set up by the topography travelled deep into the fluid. The gravitational disturbances produced by the discontinuity in density at the fluid-solid interface correlated with the magnetic perturbations (due to the motion of the fluid) far into the solid. The highest degree of correlation was shown to be approximately +0.79 and corresponded to a situation in which the magnetic potential was displaced both longitudinally and latitudinally relative to the gravitational one.

Eckhardt has investigated the correlation coefficients between the global features of terrestrial harmonic fields and has determined angular phase orientations which result in high correlations between the dominant low degree spherical harmonics of the geomagnetic and terrestrial gravity fields, but has also found angular phase orientations which result in equally high, yet meaningless, correlations if the lunar gravity field is substituted for the terrestrial gravity field. To explain such high correlations, he derived and verified the theoretical correlation distribution function between Gaussian-distributed component harmonics for low degree harmonics by using a Monte Carlo technique which took into account the three-dimensional rotation group. Some curious properties surfaced as follows: 1. the correlation distribution function for all possible relative orientations was almost the same betwen identical and uncorrelated fields; and 2. the correlation distribution function was almost ergodic for randomly oriented fields. Eckhardt concluded that such studies demonstrated that there is no significant correlation between global geomagnetic and terrestrial gravity fields.

Von Frese, Braile and Hinze have studied the regional correlation of gravity and magnetic data for North America in which one-degree averaged free-air gravity anomaly data were lowpass filtered and spherically upward continued to 450 km elevation for comparison with POGO satellite magnetic data differentially reduced to radial polarization. An inverse relationship was generally observed between gravity and magnetic anomalies over the continent. In particular, regions of large relative crustal thickness correlated with negative free-air gravity and positive magnetic anomalies. For instance, a prominent east-west magnetic high across the mid-continent corresponded to a zone of gravity minima that extended from western Texas to the Cincinnati Arch. Negative magnetic and positive gravity anomalies, on the other hand, were associated with areas of thinner crust and higher heat flow such as the Cordillera of North and Central America and the Yellowstone geothermal region. Over oceanic areas a comparison between gravity and magnetic anomalies indicated limited correlation.

The long wavelength components of the gravity and magnetic fields, topography and heat flow were examined by *Dooley* along a profile at approximately 29°S extending across Australia. He was able to divide the profile into three distinctive zones and these corresponded to the Archean Shield in the west, a central region from 135° to 150°E and the eastern highlands in New England forming the Permian geosyncline. The depth to the Moho, mean crustal density, temperatures at 40 km depth and at the base of the crust were determined from the profile. It was found that the depth to the Moho was greatest (37 km) in the central region with the greatest crustal density (2.92 gm/cc) and heat flow (80 mW/m²). The values of the foregoing

parameters for the other two reas were generally quite close but were generally lower.

The paper by *Malahoff and Larue* described the airborne magnetic surveys, shipboard gravity and satellite altimeter data (GEOS-3) which were used to determine a possible source of the +70 meter geoidal high centered in the North Fiji Basin to the east of the New Hebrides Islands in the southwest Pacific. Magnetic lineations located over the site of the geoidal high have been identified as extending from anomaly 1 to 3 (present day to 5 million years before present). Seismic refraction data suggests the presence of a thin (3 kilometers thick) oceanic crust and low mantle velocities of 7.6 km/sec. Gravity models of the lithosphere of the North Fiji Basin based on the seismic sections show an excess of +20 to +50 milligals over models drawn over "normal" (zero Free Air Observed Anomaly) lithosphere section of the surrounding Pacific Ocean and the Tasman Sea. Analysis of the magnetic lineations suggest that the sources of the geoidal high to be the youthful elevated crustal blocks of the South Fiji and Lau Basins as well as the Bismarck Sea. Longevity of the geoidal highs associated with developing marginal basins appears to be about 8 million years.

The final paper by *Haworth* described an interactive computer graphics modelling technique for the combined interpretation of gravity and magnetic anomalies in which the susceptibility, density and dimensions of prismatic blocks could be varied to obtain best-fit solutions. The technique has been applied to the ophiolite rocks of Newfoundland and it was deduced that the source of the allochthonous ophiolites was a zone extending over 100 km at the edge of which the ophiolites lie in imbricate thrust sheets less than 1 km thick.

(P. J. Hood)

# GC-I. GENERAL CONTRIBUTIONS TO DIVISION I (Convenor: K. M. Creer)

December 14 (Friday) a.m. Room: Copland G5, Chairman: K. M. Creer

- P.-A. Schnegg, G. Fischer: On-line determination of apparent resistivities in magnetotelluric measurements (GI.03).
- M. Barbetti: Geomagnetic strength over the last 50,000 years (GI.07).
- W. Lowrie, J. E. T. Channell: Magnetic stratigraphy in Mesozoic pelagic limestones (GI.09).
- C. Liu: On the paleomagnetic studies of deposits of the Sinanthropus locality at Zhoukoudian (Choukoutien) (GI.10).
- J. E. T. Channell, F. Heller, R. Freeman, W. Lowrie: Magnetic properties of Swiss flysh (GI.13).
- I. G. Pacca, U. G. Cordani: Contribution for the South American Precambrian apparent polar wandering path (GI-15).
- D. A. Valencio: Palaeomagnetism and the hypothesis of oroclinal bending of the Antarctic Peninsula (GI.17).
- B. J. J. Embleton, P. W. Schmidt: Global distribution of sialic crust during the Lower Proterozoic (GI.18).

Of the eight papers presented one dealt with magnetotelluric measurements while the remaining seven dealt with palaeomagnetic topics ranging geographically across S. America, Antarctica, Europe and China in epoch from the Pre-cambrian through to the Quaternary. The session was well attended especially by palaeomagnetists who were particulary happy to

(K. M. Creer)

# II-1. DYNAMICS OF THE THERMOSPHERE AND IONOSPHERE AND EFFECTS ON COMPOSITION (Cosponsored by COSPAR and URSI; Convenors: H. Rishbeth, A. F. Nagy, K. S. W. Champion, P. Bauer)

December 5 (Wednesday) a.m. Room: Copland G5, Chairman: H. Rishbeth

Thermospheric Circulation: Measurements and Theory

R. Dickinson: Thermospheric dynamics—a review (invited, 21.02).

T. J. Fuller-Rowell, D. Rees: Three-dimensional time-dependent global models of thermospheric dynamics: 1. Seasonal and solar activity variations of tides and prevailing winds (21.03).

J. W. Meriwether, Jr., J. H. Yee, P. B. Hays: High resolution observations of the 7320 Å and 7330 Å doublets of O<sup>+</sup> in twilight (21.04).

Waves and Effects on Composition

J. M. Straus: Effects of acoustic-gravity waves on composition in the thermosphere (invited review, 21.05).

Tides

A. D. Richmond: Upper atmosphere tides: A review (invited, 21.06).

P. Rutter, N. Kaiser, T. R. Kaiser: The semi-diurnal tide in the mesosphere (21.07).

G. Muller, S. P. Kingsley: Quasi 2-day oscillations in the wind at meteor altitudes (21.08).

B. L. Kashcheyev: Meteor trail drifts research under the GRMWSP program (with poster, 21.09).

December 5 (Wednesday) p.m. Room: Copland G5, Chairman: A. F. Nagy

Models Compared with Data

C. J. Rice, L. R. Sharp: Thermospheric density over land and ocean (21.10).

R. H. Wand: Models of lower thermospheric temperature from incoherent scatter radar measurements at Millstone Hill and Arecibo (21.11).

G. Schmidtke, N. Börsken: Variability of solar EUV flux and exospheric temperatures (21.12).

#### Low Latitudes

G. Haerendel, D. N. Anderson: Dynamics of the equatorial ionosphere (invited review, 21.13).

F. A. Herrero, J. W. Meriwether, Jr.: Airglow meridional intensity gradients in disturbed conditions (21.14).

#### High Latitudes

J. R. Doupnik: Ionospheric convection at high latitudes (invited review, 21.15).

W. Kofman, V. Wickwar: Plasma line measurements at Chatanika in 1978 (with poster, 21.16).

M. H. Rees, R. G. Roble, J. M. Gary: The effects of thermospheric winds on auroral atmospheric composition and spectral emissions (21.17).

G. F. Tulinov, M. L. Chanin: Time-varying structured sodium layers over Heiss Island.

J. R. Dudeney: The structure and dynamics of the F2-region over Antarctica (invited review, 21.19).

### December 6 (Thursday) a.m. Room: Copland G5, Chairman: P. Bauer

### High-to-Low Latitude Coupling

- M. Blanc: Coupling of high and middle latitudes in the thermosphere and ionosphere (invited review, 21.20).
- D. Rees, T. J. Fuller-Rowell: Three-dimensional time-dependent global models of thermospheric dynamics: 2. Models of the propagation of thermospheric disturbances initiated by geomagnetic substorms (21.21).
- K. D. Cole, P. F. B. Williams: Distances from the auroral zones to the magnetic and geographic equators (21.22).
- Y. Suzuki: Auroral infrasonic wave generation and propagation (21.23).

### Current Systems

- M. Blanc, A. D. Richmond: The ionospheric disturbance dynamo (21.24).
- C. Mazaudier: The circulation of electric currents above Saint-Santin: A preliminary study (21.25).
- M. Takeda, H. Maeda: A model of ionospheric dynamo current system including three dimensional structure (21.26).
- H. Maeda, T. Araki, A. Suzuki, M. Takeda: UT and day-to-day changes of the electric field and neutral wind deduced from the external current systems (film, 21.27).

# December 6 (Thursday) p.m. Room: Copland G5, Chairman: H. Rishbeth

### Planetary Ionospheres

- A. F. Nagy: Planetary ionospheres: A comparison (invited review, 21.28).
- W. C. Knudsen, K. L. Miller, K. Spenner, V. Novak: Venus ionospheric transport from day-to-nightside (21.29).

### Exosphere and Topside Ionosphere

- J. R. Doupnik: Middle and high latitude thermal plasma dynamics (invited review, 21.30).
- P. G. Richards, E. R. Young, D. G. Torr: Numerical simulation of the interhemispheric exchange of thermal plasma and heat between conjugate ionospheres (21.31).
- B. A. Tinsley: Recent advances in understanding the terrestrial exosphere (invited review, 21.32).
- R. Prange, A. Vidal-Madjar, C. Cazes, S. Emerich, P. Bauer, C. Taieb: Interaction between hydrogen atoms and ions in the upper atmosphere (21.33).
- N. Matuura, S. Igi: Global distribution of the F2 derived from topside sounding observations by ISS-b (with poster, 21.34).

A total of 34 papers were accepted for this symposium, which occupied four half-day sessions. About one-third of the papers were 30-min. invited reviews; some of the shorter contributed papers were supplemented with poster displays and this practice should be encouraged in the future.

The first session dealt with thermospheric circulation, atmospheric waves and tides. The invited papers covering all these topics demonstrated the considerable progress made in recent years. Papers by *Fuller-Rowell* and *Rees*, and by *Dickinson*, described new three-dimensional dynamical models of the thermosphere, which model the large-scale convection cells that represent the basic circulation of the thermosphere. The relative roles of solar-driven and auroral-driven circulations were displayed, and also the relatively rapid changeover at equinox

between the two solstitial conditions. Though the new models represent a substantial advance, it seems that most of the conclusions drawn from older two-dimensional models are still valid. There are still scaling problems regarding the solar XUV input (though these may have been eased by reassessments of heating efficiencies described elsewhere in the programme). Straus outlined the theory of how the passage of a gravity wave perturbs the relative concentration of minor constituents, each of which may react differently according to its molecular weight; AEC data illustrate these phenomena. The session concluded with results from meteor-trail wind measurements at Sheffield and in the USSR, for example the detection of a quasi-2 day oscillation at meteor heights, attributed by Muller and Kingsley to a travelling planetary wave of zonal wavenumber 3.

The second session was first devoted to comparisons of current thermospheric models and data from satellites and incoherent scatter radar, the latter particularly in connection with variations at the lower boundary of the models at around 120 km (Wand). Rice and Sharp suggested that the neutral density at 150-200 km may be systematically a few per cent higher over the oceans than over land masses, suggesting a heat source over the oceans. Subsequently, invited papers reviewed the dynamics of the equatorial, Arctic polar-cap and Antarctic F regions. Herrero and Meriwether interpreted the meridional gradients of red airglow intensity, sometimes observed over Arecibo, as evidence of a front resulting from the meeting of opposing winds from auroral heating and from the equatorial midnight pressure bulge. Winds at high latitudes were discussed by Rees, Roble and Gary, specifically in a theoretical investigation of the scavenging and downwind transport of active and excited constituents from an auroral arc and the resulting distribution of airglow emissions. Delayed data availability from a polar rocket experiment led to the replacement of an intended paper by Chanin and Tulinov by a description of time-varying structured sodium layers over Heiss Island in the recent winter. Kofman and Wickwar gave initial results from the application of a 16 MHz correlator to observations of the plasma line at Chatanika, in particular the detection of a downward Birkeland current.

The third session was devoted, first, to high-to-low latitude coupling and, second, to ionospheric current systems. Two films were projected, one by *Rees and Fuller-Rowell* showing the wind patterns resulting from launching, propagation and reflection of disturbances due to auroral heating (obtained from a 3-dimensional dynamical calculation) and the other by *Maeda et al.* showing the changes of global *E* region winds and electric fields and currents derived from geomagnetic data for every two hours in December 1964. *Suzuki* discussed observations in Antarctica of infrasonic waves believed to be generated by auroral electrojects; *Mazaudier* described the use of the St. Santin radar to measure ionospheric electric currents associated with regular daily variations and auroral disturbances; and *Blanc and Richmond* presented calculations showing that the Hadley cell driven by auroral heating transports westward momentum to midlatitudes, thereby setting up a 'disturbance dynamo' that opposes the normal *Sq* dynamo process.

The fourth session dealt with planetary ionospheres and the earth's exosphere and topside ionosphere, with invited papers reviewing all these topics. *Knudsen et al.* used data from Pioneer-Venus Orbiter to show that transport of  $O^+$  ions from the dayside appeared to give an ample source for the observed nightside ionospheric concentrations of  $O_2^+$  ions. A comprehensive theoretical model of interhemispheric plasma and heat flow was presented by *Richards et al.*, who showed that counterstreaming of  $O^+$  and  $O^+$  and  $O^+$  could occur in the topside ionosphere even in a symmetrical situation with no transequatorial flow. *Prange et al.* advanced

a model, involving interaction between H atoms and ions in ballistic orbits, to account for the observed early morning and latitudinal depletions of H at the exobase: this paper provoked good discussion. Finally *Matuura and Igi* demonstrated the utility of the topside sounder satellite ISS-b for mapping the F2 layer.

In all, the symposium well reflected progress in a very active branch of science, in which observations by a variety of ground-based and space techniques go in hand with computer modelling; and also illustrated the increasing importance of planetary studies.

(H. Rishbeth)

# II-2. IONOSPHERIC IRREGULARITIES (Convenor: P. L. Dyson)

December 7 (Friday) a.m. Room: Copland G7, Chairman: P. L. Dyson

### Equatorial Spread F

- S. L. Ossakow: A review of equatorial spread F (invited, 22.01).
- K. D. Cole: Equatorial spread-F and associated phenomena (invited, 22.01).
- R. G. Rastogi: Spread F and scintillations of radio waves (invited, 22.03).
- R. Raghavarao, P. Sharma: An investigation on the equatorial spread-F with ISIS-1 satellite (22.05).

### F-Region Irregularities

- T. Maruyama, N. Matuura: Global distribution of occurrence probability for spread echoes based on topside soundings by ISS-b (22.06).
- R. Prange, P. Bruston: Evidence for auroral-type plasma instabilities above the sub-equatorial part of the South Atlantic anomaly during magnetic storms (22.07).
- P. K. Chaturvedi, S. L. Ossakow: Current convective instability in diffuse aurora (22.08).
- A. C. Das, J. A. Fejer: Resonance instability of small-scale field-aligned irregularities (22.09).

#### Ionospheric Response to Gravity Waves

- K. A. Ballard, M. G. Morgan: A study of the propagation and dispersion of traveling ionospheric disturbances (22.10).
- P. L. Dyson, L. E. Wharton, W. R. Hoegy: Atmosphere Explorer observations of atmospheric waves in the ionosphere (22.11).
- O. P. Nagpal: The sources of atmospheric gravity waves (22.12).
- E. H. Carman, M. P. Heeran, S. A. Lawrence, R. N. Srivastava: Observation of equatorial irregularities in the [OI] 630 nm nightglow during increasing solar activity (22.15).

# December 7 (Friday) p.m. Room: Copland G7, Chairman: R. S. Unwin

#### Transionospheric Propagation

- R. D. Hunsucker: Preliminary results from College, Alaska ATS-6, RBE Faraday rotation and modulation phase measurements (22-13).
- M. L. Heron: Differential amplitude scintillation on close-spaced radio frequencies in the ionosphere (22.14).

### D and E Region Irregularities

R. A Vincent: D-Region irregularities: A review (invited, 22.16).

- W. K. Hocking, R. A. Vincent: Studies of the structure of *D*-region irregularities in the southern hemisphere (22.17).
- W. J. Baggaley, T. H. Webb: The geomagnetic control of the diffusion of meteoric ionization (22.18).
- B. G. Fejer: Plasma irregularities in the equatorial electrojet (22.19).
- K. K. Moorthy, B. V. K. Murthy, C. R. Reddi: Multispectral studies of equatorial electrojet irregularities (22.20).
- R. A. Greenwald: Characteristics of irregularities in the equatorial and auroral electrojets (invited review, 22.21).
- R. S. Unwin: Height variation in the velocity of irregularities in the eastward electrojet.
- A. V. Shirochkov, V. M. Uvarov: Sporadic *E* and Lacuna in the polar cap as a result of current instability in the ionosphere (invited, 22.22).
- F. A. Morse, C. J. Rice, J. D. Winningham, J. W. Wright, E. Neske: Electron density measurements by Langmuir probe, impedance probe, and ionosonde techniques and implications for sporadic *E* (22.23).

Twenty invited and contributed papers were presented on irregularities in the D, E and F regions of the ionosphere and included artificial irregularities produced by ionospheric heating experiments. Experimental results were presented from ground-based radio and optical experiments, satellite radio and in-situ measurements, rocket in-situ measurements and satellite to ground radio measurements. The irregularity phenomena are quite complex and a diversity of experimental techniques, sensitive to different irregularity scale sizes is required to describe the phenomena and to test proposed theories.

More papers discussed equatorial spread F(ESF) than any other single topic, reflecting the current high level of interest and activity, both experimental and theoretical in this topic. Current understanding of spread F at all latitudes suggests that several processes are involved. Irregularities form first at the larger scale sizes porducing suitable conditions for smaller irregularities to be produced. At the equator the Rayleigh-Taylor (R-T) instability produces bubbles which rise up through the layer. Kinetic type instabilities can occur on the steep edges of bubbles producing small scale irregularities. Various phenomena, including atmospheric gravity waves, could provide the initial perturbation for the R-T mechanism. There is still controversy over whether the R-T mechanism is responsible for initiating all ESP. Alternative suggestions are the gradient drift instability and  $E \times B$  convection. The merits of these three mechanisms were argued in invited papers by Ossakow, Rastogi and Cole.

Although the theory of gravity waves is well developed, experimental tests of the theory are difficult because of the number of parameters which need to be measured. *Dyson, Hoegy* and *Wharton* reported preliminary results using the SE-E satellite. They found that linear theory could explain the electron density perturbation but significant differences occurred in the ion drift and ion temperature.

Radio observation of the *D* region at both MF/HF and VHF show a tendency for reflections to come from preferred heights, with quasi-isotropic scatter apparent for heights above 80 km and quasi-specular reflection with slow fading from lower heights. There are other important height differences, and some inconsistencies between observations at VHF and lower frequencies, which are not yet explained. A thin turbulent shear layer in a gradient of electron density is the most attractive of possible mechanisms, but much theoretical and experimental work remains to be done to understand the phenomenon.

The predicted control of diffusion rate by the geomagnetic field at heights above 95 km has been demonstrated experimentally by observation of radio meteors.

Small scale irregularities in the equatorial electrojet are now fairly well understood in terms of the gradient-drift and ion-acoustic plasma instability theories, but application of these theories to the auroral ionosphere has been of limited success because there are important differences between the observations at high and equatorial latitudes. Although the mean doppler velocity of high latitude electrojet irregularities appears always approximately equal to the electron drift velocity, in agreement with the linear theory of these instabilities, there are many features of the phenomenon that are far from understood, in spite of several recent attempts to generalise and extend the theories to the high latitude case. The presence of the ion-acoustic instability in the polar cap has been shown to be dependent on both the  $B_y$  and  $B_z$  components of the IMF.

Although considerable progress has been made in identifying some of the processes responsible for F region irregularities in the equatorial and auroral regions, these phenomena are still not completely understood. Mid-latitude spread F is poorly understood. Because of the complexities of spread F, co-ordinated experiments using ground based rocket and satellite techniques are very desirable. Further heating experiments to study artificial irregularities are required, particularly to assess the effects of proposed solar power satellites on the ionosphere.

The addition of MST radars to prove the *D* region is adding much new information, but the region is so complex that coordinated observations over a variety of frequencies, probably combined with rocket experiments, will be needed to understand the formation and behaviour of irregularities. Although routine observation of auroral electrojet irregularities is proving a useful diagnostic of plasma drifts and electric fields in the ionosphere and magnetosphere (assuming the mean irregularity drift velocity equals the electron drift velocity), the detailed mechanism of their generation, propagation and decay is poorly understood. It is important that theoretical and experimental work to elucidate the phenomenon continues.

(P. L. Dyson and R. S. Unwin)

# II-3. NON-SOLAR IONIZATION SOURCES IN LOW LATITUDES (Takao Tohmatsu Memorial Session) (Convenor: R. R. Meier)

December 8 (Saturday) a.m. and p.m. Room: Copland G5, Chairmen: R.R. Meier and J.C.G. Walker

R. R. Meier: Introduction

J. C. G. Walker: Overview of the tropical ionosphere (invited, 23.01).

D. F. Strobel, C. P. Opal, R. R. Meier: Nonsolar photoionization sources (invited, 23.03).

L. G. Smith: Energetic particles at low latitudes (invited, 23.04).

J. A. Gledhill: Non-solar ionization in the South Atlantic anomaly: A review (invited, 23.06).

R. Haggard, J. A. Gledhill, D. G. Torr, R. A. Hoffman: Low energy particles at 300 km in the South Atlantic anomaly region (23.07).

B. A. Tinsley: Optical emissions associated with low latitude ionization processes (invited, 23.09).

This session started with the convenor's introductory talk which praised the scientific contributions of the late Professor Takao Tohmatsu. Thanks were expressed by N. Fukushima (Director of the Geophysics Research Laboratory, University of Tokyo, to which Prof. Tohmatsu belonged) for this memorial session, and Mrs. Tohmatsu gave a short greeting to the audience.

The morphology and dynamics of the tropical ionosphere are distinguished by the strong

influence of the geometry of the magnetic field and the various sources of ionization. The emphasis in this Symposium was on those ionization sources which are characteristic of the ionosphere at low latitudes.

An overview of the characteristic properties of the tropical ionosphere was given by *Walker*. This was followed by a review of nighttime photoionization sources by *Strobel*, *Opal*, and *Meier*. At midnight the principal source of photons in the *E*-region is found to be stellar continuum in the 911–1026A wavelength range, producing as much as 2.5 ions cm<sup>-3</sup> s<sup>-1</sup> at 110 km over the equator. The sidereal time dependence of starlight results in a seasonal modulation of the ionization rate of a factor of four. Since the majority of hot stars are in the southern hemisphere, the ionization rate at southern mid-latitudes can be a factor of two higher than at the equator. Resonantly scattered H and He airglow are also important sources in the *E*-region. The radiative recombination continuum of  $O^+$  at 910A is a major *F*-region photoionization source in the Appleton Anomaly.

Smith summarized data from sounding rocket, satellite, and ground-based experiments which showed various global zones of particle precipitation. Fluxes of particles in the 20–100 keV energy range show strong dependence on geomagnetic activity, but with absolute values several orders of magnitude lower than auroral fluxes. At mid and low latitudes, the precipitation is attributed to protons originating in the ring current. The source mechanism at mid latitudes is thought to be wave-particle interactions, whereas double charge exchange of ring current particles may supply the equatorial fluxes.

Precipitation of ring current particles, initially neutralized by charge capture from exospheric hydrogen atoms, was discussed by *Tinsley*. Optical emissions associated with the precipitating neutrals have been observed from H (Ba $\alpha$ ), He ( $\leq$ 304A), He<sup>+</sup> (4688A), and O<sup>+</sup> (4416A). The different temporal variabilities of the emissions reflect a changing population of ring current population during magnetic storms. It may be possible to use remote sensing of the various emissions as global diagnostics of ring current properties, ionospheric ionization, and energy input.

The South Atlantic Anomaly was reviewed by *Gledhill*, who concluded that there is a great need for more intensive studies of all aspects of the SAA. Ionization of the D- and lower E-region is thought to be one of the most important consequences of the precipitation. Some isolated observations suggest an increase in the electron density in the F-region. Low energy particles (0.2 to 26 keV) measured from the SE-C satellite were discussed by *Haggard*, *Gledhill*, Torr, and *Hoffman*. The observed fluxes are an order of magnitude higher in the SAA than in the surrounding region. The electron fluxes range from 0.5 to  $30 \times 10^{-4}$  erg cm<sup>-2</sup> s<sup>-1</sup> and proton fluxes from 0.5 to  $15 \times 10^{-4}$  erg cm<sup>-2</sup> s<sup>-1</sup>. Interestingly, the regions of maximum electron energy precipitation correspond to minimum electron density.

In summary, the Symposium highlighted the emerging recognition of the importance of "routine" ionization sources (especially starlight) and "irregular" sources such as ring current and SAA precipitation. Much experimental and theoretical work needs to be done to quantitatively tie together the coupling between such vastly different phenomena.

(R. R. Meier)

### II-4. THERMOSPHERIC PHOTOCHEMISTRY

(Convenors: L. Thomas and D. G. Torr)

December 12 (Wednesday) a.m. and p.m. Room: Copland G5, Chairmen: D. G. Torr, J. C. G. Walker, L. Thomas

- H. E. Hinteregger: Response of the thermosphere to solar cycle variations in the EUV and 10.7 cm fluxes (invited, 24.01).
- A. O. Nier: Improved knowledge of the netural and ionized composition of the thermosphere (invited, 24.02).
- F. A. Morse, D. R. Hickman, J. B. Pranke, A. B. Christensen: Upper atmospheric UV emissions and derived densities (24.03).
- R. W. Schunk, W. J. Raitt: Atomic nitrogen and oxygen ions in the daytime high-latitude F-region (24.04).
- A. Dalgarno: Recent laboratory and aeronomic studies of thermospheric processes (invited, 24.06).
- M. R. Torr, D. G. Torr: Temperature dependence of reactions of  $O^+(^2D)$  with electrons and  $N_2$  (24.07).
- D. G. Torr: An experimental and theoretical study of vibrationally excited  $N_2$  molecules in the thermosphere (invited, 24.09).
- M. R. Torr: Excitation rates of several important constituents and their role in the energy balance of the thermosphere (invited, 24.10).
- L. L. Cogger, J. C. G. Walker, J. W. Meriwether Jr., R. G. Burnside: F-region airglow: Are ground based observations consistent with recent satellite results? (24.11).
- R. N. E. Baulch: Some measurements of effective collision frequency (24.13).
- B. A. Tinsley: The latitude distribution of energetic neutral atom precipitation (24.14).

As might be expected, results derived from the successful series of Atmospheric Explorer (AE) satellites featured strongly in the programme. Of the eleven papers presented, eight were concerned directly with, or made use of such results.

The invited papers by *Hinteregger* and *Nier* were largely based on AE observations of EUV intensities and of molecular oxygen distributions, respectively. *Hinteregger* dealt with the variations of EUV intensities and of thermospheric structure, as represented by EUV absorption characteristics, and their correlation with changes in the 2800 MHz radio-noise flux and the planetary magnetic index *Ap*. From a preliminary analysis of data obtained up to June 1979 it was found that the ionizing EUV intensities were correlated with a two-term expression for the 2800 MHz flux, one term representing the average over several days and the second the deviation from this average for the day under consideration. Furthermore, a non-EUV energy source showing some correlation with the *Ap* index was required to explain the thermospheric variations. The 2800 MHz flux was also adopted as an index of solar activity by *Nier* in his study of changes in molecular oxygen concentrations relative to what would be expected for height distributions corresponding to diffusive separation. In one set of results for 200 km altitude, the oxygen concentrations at low values of radio-noise flux were about 25% smaller than would be expected for diffusive separation.

D. G. Torr described the use of AE-C measurements to deduce the rate coefficient for the reaction of atomic oxygen ions and nitrogen molecules. From a comparison with previous laboratory measurements, estimates could be made of the vibrational temperature of the thermospheric nitrogen. Below 300 km the vibrational temperature was found to be near the corresponding atmospheric temperature, and an associated theoretical study revealed that thermalisation occurred through quenching by atomic oxygen, this representing the main loss

process for vibrationally excited nitrogen molecules at these heights. Further analysis of AE data had been used by M. R. Torr and D. G. Torr to examine the temperature dependence of electron quenching of the metastable  $O^+(^2D)$  ion and of charge transfer between this ion and molecular nitrogen.

Dalgarno gave an invited review of rate coefficients derived from AE data and related them to recent laboratory measurements, emphasising current uncertainties and problems. In his consideration of the dissociative recombination of molecular oxygen ions with electrons, he drew attention to the influence of the vibrational state of the ion on the electronic states of the oxygen atoms produced. He described the uncertainties in the chemistry of the metastable oxygen atom ions,  $O^+(^2D)$  and  $O^+(^2P)$ , and drew a comparison between the rate coefficients deduced for reactions of each with molecular oxygen and nitrogen with those found for mixtures of the ions in recent laboratory measurements; the AE-based values seemed to be significantly larger. Dalgarno pointed out that in the light of recent laboratory measurements showing very rapid reactions between doubly ionized atomic oxygen ions and molecular oxygen and nitrogen, a source of these ions is probably required additional to those considered to date in the interpretation of AE measurements of their concentrations.

In an invited review of thermospheric heating by EUV radiation, M. R. Torr made use of AE and other data to examine the energy budget involved in photoionization processes, the associated and subsequent excitation processes, the losses of excited states by radiation and quenching, and overall chemical reactions. An important feature of the results was the marked height variation of the deduced heating efficiency of EUV radiation, with a maximum of about 55% being shown near  $170 \, \text{km}$ .

Cogger, Walker and Meriwether described an analysis of observations at Arecibo of airglow emissions, and electron density and temperature profiles, based on chemical rate coefficients derived previously from AE data and the MSIS model of thermospheric density, which itself incorporates AE data. It was found that the 6300 Å emission intensities predicted were greater than those observed. This seemed to imply that the molecular oxygen concentrations adopted from the model needed to be reduced, but Dalgarno had drawn attention in his review to a recent reduction in the rate coefficient of the reaction between atomic oxygen ions and molecular oxygen, which would also serve to reconcile the computed and observed results. In the only model of ion composition presented, Schunk and Raitt extended their previous studies of the high-latitude F region to include the atomic nitrogen ion. Their results showed that this ion was sometimes dominant in the upper F region and was generally the second most abundant ion at these levels.

Of the three remaining papers presented, that by Morse, Hickman, Pranke and Christensen was concerned with observations of ultra-violet and visible emissions by limb scanning from a satellite. Daytime measurements of  $1356 \, \text{Å}$  emissions from atomic oxygen, excited by photoelectrons, were used to derive the height distribution of the atom concentration; nighttime observations of sodium airglow indicated a decreasing intensity and increasing height of maximum emission with increase in latitude from  $10^{\circ} \, \text{S}$  to  $40^{\circ} \, \text{N}$ . Tinsley described a study of the precipitation of energetic neutral atoms resulting from charge-exchange loss of ring-current ions. The results of the new calculations presented were concerned with the latitude variations of the atom precipitation for various pitch angles of energetic ions in the inner magnetosphere, and the contributions of these atoms to optical emissions and ionization at middle and low latitudes were examined. Finally, the presented paper by Baulch was concerned with the estimation of effective electron collision frequencies at E and F region

heights from vertical-incidence radio pulse-sounding experiments.

As a consequence of the withdrawal of a few papers from the initial programme, a reasonable time was available for discussions. These discussions served to enhance the value of the papers presented and made a useful contribution to the programme.

(L. Thomas)

# II-5. ELECTROMAGNETIC COUPLING WITHIN THE ATMOSPHERE (Convenors: H. Volland and F. S. Mozer)

December 13 (Thursday) a.m. Room: Copland G5, Chairmen: H. Volland and F. S. Mozer

- J. R. Wygant, F. S. Mozer, R. H. Holzworth: Electrical coupling between magnetosphere and atmosphere (invited, 25.01).
- A. D. Richmond, M. Blanc, R. H. Wand, B. G. Fejer, R. F. Woodman, R. A. Behnke, B. A. Emery: An electric field model for the middle and low latitude ionosphere on quiet days (25.02).
- H. Maeda: Impact of magnetospheric electric fields on the thermospheric dynamics (invited, 25.03).
- M. Blanc: Electric fields at thermospheric heights derived from backscatter measurements (invited, 25.05).
- H. Volland, L. Grellmann: Electric coupling between E- and F-layer (25.07).
- R. J. Stening: A two-layer ionospheric dynamo calculation (25.08).
- V. Bucha: Mechanism of coupling corpuscular radiation to atmospheric circulation (25.09).

Electromagnetic fields of low frequencies with periods smaller than about one hour can easily penetrate from the lower into the upper atmosphere and vice versa with very short time constants. Therefore, they can serve as a coupling link to transfer energy from one region into another region. One prominent example is the transfer of kinetic energy of the solar wind into thermal energy of the upper atmosphere via a magnetohydrodynamic generator process in which the electric convection field of the magnetosphere is the link between magnetosphere and ionosphere by driving high latitude electric currents within the dynamo region.

Another exmaple is the electric coupling between ionospheric E- and F-layer via the electric polarization field of the Sq current. Here, thermal energy input into the lower and the middle atmosphere due to solar radiation is redistributed via the generation of tidal waves, associated electric fields and Sq currents at E layer heights, and the driving of F layer winds by the polarization field mapped upward into the F layer. Finally, the thunderstorm electric fields within the troposphere can map into the magnetosphere and may be responsible for field-aligned irregularities in that region, or electric fields of magnetospheric origin may map downward into the lower atmosphere.

The IAGA-session "Electromagnetic coupling within the atmosphere" was an attempt to bring together people dealing with atmospheric electricity—so far considered mainly as a domain of meteorology—with people studying the electric fields of the upper atmosphere. Several review papers covered the whole range of the subject from a theoretical as well as from an experimental point of view.

(H. Volland)

# GC-II. GENERAL CONTRIBUTIONS TO DIVISION II (Convenor: B. A. Tinsley)

December 11 (Tuesday) a.m. and p.m. Room: Copland G5 Chairman: B. A. Tinsley

- B. L. Gattinger, A. Vallance-Jones: Quantitative spectroscopy of aurora in the 9000-17000 A range (G2.01).
- M. H. Rees, G. G. Sivjee, G. J. Romick: Auroral electron energy inferred from spectroscopic ratios of  $O^+(^2P)$  (7320A),  $N(^2D)$  (5200A),  $O(^1D)$  (6300A), and  $N_2^+(B^2\Sigma)$  (4278A) radiations (G2.02).
- W. Bangert, R. Scheidle, H.-J. Bolle: OH\* and  $O_2(^1\Delta_g)$  airglow measurements as diagnostic tool for the investigation of the mesosphere (G2.03).
- J. Crawford, P. Rothwell: On the nature of OH airglow structure imaged with low light level TV cameras (G2.05).
- M. J. Taylor, P. Rothwell: TV ellipsometer measurements of polarization in noctilucent clouds (G2.06).
- M. Gadsden: The sizes and shapes of noctilucent cloud particles (G2.07).
- L. G. Björn: The European summer campaign 1978 for study of noctilucent clouds (G2.08).
- E. Kopp, P. Eberhardt, U. Herrmann, L. G. Björn: Positive ion composition in noctilucent clouds (G2.09).
- S. Okano, J. S. Kim: Recent photometric and interferometric observations of the SAC arc (G2.12).
- S. Okano, J. S. Kim: Interferometric measurements of nighttime thermospheric temperatures and winds during geomagnetic storms (G2.13).
- E. A. Essex, J. A. Klobuchar, C. R. Philbrick, M. Mendillo: Total electron content observations during the February 26, 1979 total solar eclipse over North America (G2.15).
- T. Yonezawa, H. Shimoi: Quasi-biennial variations in electron density of the F2- and E-layer of the ionosphere (G2.16).
- N. Matuura, M. Kotaki, I. Iwamoto, H. Mori, E. Sagawa: Summary of satellite observations on the ionosphere and radio noises by ISS-b (G2.17).
- M. P. Hickey, K. D. Cole: Gravity wave heating of the thermosphere in magnetically quiet and disturbed conditions (G2.18).
- G. O. Walker, A. E. Strickland: A comparison between the morphologies of the ionosphere in the East Asian/West Pacific and the American zones for low solar activity (G2.R1).

As one mainly responsible for arranging the Division II program, I have been very much aware of the problem of arranging sessions to cover all of the topics where significant developments of wide interest to the aeronomers have taken place. Especially at union meetings, there is never enough time for all of the sessions we would like to have.

The general contributions sessions relieve this stituation to some extent, and it is possible to group together a number of papers on a given topic within the session. The general contributions sessions at Canberra included studies of the mesosphere and noctilucent clouds by various techniques, and also studies of the F region and energy input into the thermosphere by a variety of techniques.

(B. A. Tinsley)

# III-1. NON-LINEAR WAVES IN GEOPHYSICAL PLASMAS (with URSI through URSI/IAGA Joint Working Group) (Convenors: P. L. Dyson and R. L. Dowden)

December 4 (Tuesday) a.m. and p.m. Room: Copland G5, Chairmen: R. L. Dowden and P. L. Dyson

- C. R. Francis, K. Bullough, T. R. Kaiser: Discrete VLF emissions (7 to 9 kHz) displaying unusual banded and periodic structure (31.01).
- I. D. Smith, A. J. Smith: A study of banded periodic emissions observed at Halley (31.02).
- M. T. Rietveld: Phase studies on monochromatic VLF emissions (31.03).
- L. Bergamasco, A. R. Osborne, S. Alessio, G. C. Castagnoli: Plasma nonlinear effects in the scintillation of 20–100 GV cosmic ray particles (31.04).
- J. A. Fejer: Ionospheric heating and nonlinear waves (31.05).
- P. J. Christiansen, M. P. Gough, G. Martelli, G. R. Wrenn, J. F. E. Johnson, K. Ronnmark: Quasi-linear and nonlinear phenomena associated with strong electrostatic waves in the magnetosphere (31.06).
- H. Matsumoto: Computer simulations on nonlinear wave particle whistler interactions (31.07).
- D. Nunn: The quasi static generation region approach to the theory of triggered VLF emissions (31.08).
- A. Roux, R. Pellat: Nonlinear generation mechanism of an electromagnetic coherent radiation from beatings between primary electrostatic waves. Interpretation of the auroral kilometric radiation (31.09).
- F. W. Crawford: Lagrangian methods in nonlinear plasma wave interaction (31.10).

The following two papers were displayed by posters along with 31.03 and one by R. L. Dowden:

- T. F. Bell, U. S. Inan, R. A. Helliwell: ISSE-1 observations of VLF emissions triggered by non-ducted coherent VLF waves from ground transmitters.
- U. S. Inan, T. F. Bell, R. A. Helliwell: Precipitation of radiation belt particles induced by coherent waves from VLF transmitters.

This session was held under the auspices of the URSI-IAGA Joint Working Group on Wave Instabilities in Space Plasmas. Ten orally presented papers and four posters covered a wide range of waves and plasmas.

The first three papers concerned observations of VLF interactions in the magnetosphere and showed, among other things, the presence of remarkably monochromatic signals in the magnetosphere which cannot be attributed to PLR (power line radiation). Those observed in Alaska and New Zealand show no relation to either 50 Hz or 60 Hz harmonics and those observed at Halley showed frequency drifts of up to 500 Hz per minute.

Computer simulations of VLF cyclotron interaction were presented in three papers and in general such simulations based on current non-linear theory gave good agreement with the real world.

Three papers concerned non-linear wave-wave interaction and it was suggested that AKR might be efficiently produced by non-linear heating between electrostatic waves.

Other papers ranged from non-linear instabilities excited in the ionosphere during heating experiments to those involving cosmic rays in galactic magnetised plasmas. Although the latter plasma is well beyond "geophysical" and the resonant frequencies ( $10^{-6}$  Hz or periods of days) are extraordinarily low, the physics is similar. This suggests that a session on, say, "non-linear wave-wave interactions in natural plasmas" involving astro and cosmic ray physicists as well as geophysicists might be fruitful in the future.

Despite the intractability of many non-linear problems without using highly simplified models or computer simulation, the science represented by the Joint Working Group has progressed well beyond the hand waving stage.

(P. L. Dyson and R. L. Dowden)

# III-2. QUANTITATIVE DESCRIPTION OF MAGNETOSPHERIC PROCESSES (Convenor: W. P. Olson)

December 6 (Thursday) a.m. and p.m. Room: Copland G8, Chairman: W. P. Olson

The purpose of the symposium was to provide an assessment of our current quantitative understanding of magnetospheric processes. The 'quantitative' test is met when a model (usually computer code) output is in good numerical agreement with the observational data collected for a particular magnetospheric feature. The 'understanding' test is satisfied when the physics of the particular feature is understood and used to construct the model. Currently the quantitative models used are mostly representative (as opposed to explanatory). Thus, although there may be quantitative agreement between the model output and observational data, it can still not be said that the particular process or feature in the magnetosphere is quantitatively well understood. Very few quantitative explanatory models are in existence (even the models of the magnetospheric magnetic field are not derived from the plasma properties which produce the magnetic current systems).

Several papers were presented on representative quantitative models of the magnetic and electric fields and on correlations between magnetospheric and solar wind and interplanetary parameters. Current magnetic field models agree very well with observational data at low geomagnetic latitudes, while at high latitudes and in the cusp region, where fewer observational data are available, the representation is not nearly as accurate. Although the quantitiative modeling of electric fields is in its infancy, some simple representations of the convective electric field were noted. Also the quantitative modeling of the electric fields that result from time variations in the magnetic field was discussed. Quantitative descriptions of other magnetospheric features were also presented: the coupling of magnetospheric and ionospheric current systems, the dependence of cusp location on solar wind parameters, electric fields and resultant field-aligned currents, and plasmas and their relation to disturbed currents.

The discussions illustrated that the quantitative modeling of the magnetosphere is in a transition from the representation of magnetospheric features to magnetospheric processes. Thus, although models of the magnetospheric magnetic and electric field will continue to be improved, the emphasis is now toward the representation of dynamic processes in the magnetosphere, e.g., the magnetic storm and magnetospheric substorm. The trend in modeling appears to be moving from the representation of specific magnetospheric features, e.g., magnetic and electric fields, to the representation of magnetospheric processes, where the emphasis is on quantitative agreement between the model and the 'represented' process. Few explanatory models are being developed, although some attempt is currently being made to self-consistently examine the interaction between plasma and the magnetospheric electromagnetic field. The recent Coordinated Data Analysis Workshops have generated considerable interest in the modeling of specific magnetospheric events. Such comparisons between time-varying observational data and models provide a very demanding test of any

quantitative model. These workshops also appear to be a mechanism for improving our quantitative understanding of magnetospheric features on a timely basis.

In summary, much has happened in the quantitative modeling of the magnetosphere since the last IAGA meeting. However, much work remains before quantitative explanatory models of magnetospheric features will be routinely available. Tentative plans were formulated for a symposium on the quantitative description of specific magnetospheric events to be part of the next IAGA meeting.

The papers actually presented are summarized below.

(W. P. Olson)

- W. P. Olson: Symposium overview (32.01).
- D. N. Baker, S. J. Bame, P. R. Higbie, B. T. Tsurutani, E. J. Smith: Real-time data input for magnetospheric modeling (32.02).
- T. V. Kuznetsova, M. I. Pudovkin, S. A. Zaitseva: Influence of solar wind parameters on the magnetopause and day cusp position (32.03).
- R. J. Walker: Quantitative modeling of planetary magnetospheric magnetic fields (32.04).
- R. L. McPherron: Physical processes affecting the synchronous orbit magnetic field (32.05).
- G. Rostoker: The magnetosphere-ionosphere current system responsible for coupling the high latitude ionosphere to the magnetosphere (32.06).
- N. A. Tsyganenko: Numerical models of quiet and disturbed magnetic field in the cislunar part of magnetosphere (32.07, by title only).
- K. D. Baker, L. P. Blok, R. Kist, W. Kampa: Investigation of electric double layers in a large plasma chamber (32.08).
- W. P. Olson: Summary of IAGA Working Group III-3 on Quantitative Magnetospheric Models activities.
- R. H. Manka, T. A. Fritz, R. G. Johnson, W. P. Olson, R. A. Wolf: July 29, 1977 substorm event: Description of characteristics to be modeled (32.21).
- Yu. I. Galperin, A. M. Mozhaev, N. K. Osipov, Y. N. Ponomarev, A. G. Zosimova: DPY-variations in the magnetospheric convection pattern and the resulting Svalgaard-Mansurov effect in the ionosphere (32.11).
- R. L. Carovillano, R. W. Nopper, Jr.: Model ionospheric electric fields driven by field-aligned currents
- W. P. Olson, K. A. Pfitzer: A model of the magnetospheric electromagnetic field (32.13).
- D. T. Young: Magnetospheric plasmas and their relation to disturbed current systems (32.14).
- H. B. Garrett, D. C. Schwank: ATS-5 and ATS-6 quantitative models of the geosynchronous plasma (32.15).
- M. Harel, R. A. Wolf, R. W. Spiro: Quantitative modeling of geomagnetic disturbances (32.16).
- D. J. Cooke, J. E. Humble, D. F. Smart, M. A. Shea: The cosmic ray penumbrum and its relationship to the geomagnetic field (32.17).
- E. Flückiger, H. Debrunner, D. F. Smart, M. A. Shea: Theoretical study of the effects of a partial ring current in the magnetosphere on cosmic ray cutoffs (32.18).
- T. Murayama: Dependence of the auroral electrojet intensity on interplanetary parameters and its implication to the reconnection process at the dayside magnetopause (32.19, by title only).
- J. Lemarie, L. Kowalkovski: The role of plasma interchange motion for the formation of a plasmapause (32.20).

# III-3. GEOMAGNETIC PULSATIONS (Convenor: D. J. Southwood)

The six sessions devoted to pulsations at Canberra probably amount to the largest symposium devoted to the topic yet held. Virtually all aspects of present research were covered by the papers presented and for this reason and because there were very few no-shows it seemed very useful.

Ten review papers are presented by authors from eight different countries. Amongst topics reviewed were multipoint measurements on the ground and in space, ground-spacecraft correlation, pulsations associated with geomagnetic substorms, solar wind control of pulsations, auroral radar pulsation measurements and new GEOS spacecraft measurements of high frequency pulsations. Theoretical reviews were given which covered the effect of ionosphere and atmosphere on signals and particle-wave interactions. Highlights are hard to pick out. The GEOS results were probably the most dramatic as they revealed an unexpected control of *Pc1* signals by the He<sup>+</sup> population in the dayside magnetosphere.

Topics presented in contributed papers followed the review topics in a general way. It has become clear that pulsations are no longer just investigated with magnetometers. Many papers reported non-magnetic data such as particle flux oscillations and direct and indirect measurements of electric fields in the ionosphere and magnetosphere.

Ongoing areas of interest which received much attention were the ground-spacecraft correlation problem which is turning out more complex than many expected and the overall structure of the *Pi2* pulsation signal. The *Pi2* is associated with geomagnetic substorm onset in the auroral zone and so has obvious diagnostic uses. The magnetometer networks set up during the IMS have provided the opportunity for worldwide studies.

December 6 (Thursday) a.m. and p.m. Room: Copland G4, Chairmen: B. J. Fraser, R. L. McPherron and E. W. Greenstadt

# a. Observational Tests of Pulsation Theories

- S. Kokubun: Observations of *Pc* pulsations in the magnetosphere: The rotation of hydromagnetic waves by the ionosphere (33a01).
- A. D. M. Walker, R. A. Greenwald: Pulsation structure in the ionosphere derived from auroral radar data (revieew, 33a02).
- F. Glangeaud, J. L. Lacoume, C. Latombe, C. Hanna: *Pc3-Pc4* geomagnetic pulsation cross spectrum analysis with maximum entropy method between satellite and ground (33a03).
- M. K. Andrews, L. J. Lanzerotti, C. G. Maclennan: The rotation of hydromagnetic waves by the ionosphere (33a04).
- H. J. Singer, D. J. Southwood, R. J. Walker, M. G. Kivelson: Alfvén wave resonances in a realistic magnetospheric magnetic field geometry (33a05).
- D. J. Southwood: Particle behaviour in low frequency pulsations (review, 33a06).
- G. Haerendel, H. Junginger, F. Melzner: Measurements of the plasma drift in *Pc5* pulsations at the geostationary orbit (33a07).
- A. Korth. G. Kremser: Observations of large-amplitude quasiperiodic variations of the energetic particle intensity and the geomagnetic field with the GEOS-2 satellite (33a08).
- C. A. Green, R. A. Hamilton, W. F. Stuart: Ionospheric influence on geomagnetic field line oscillations as evidenced in a study of conjugate *Pi2* pulsations (33a09).
- F. W. Menk, K. D. Cole, J. C. Devlin: Effect of geomagnetic pulsations on the ionosphere (33a10).

- b. Pulsation Generation and Propagation Theory
- A. Roux: New results on wave-particle interactions in the ULF range as deduced from GEOS-1 and -2 observations (review, 33b01).
- F. Glangeaud, C. Latombe, J. L. Lacoume: Propagation of *Pc1* in the magnetosphere from GEOS and ground data (33b02).
- D. T. Young, C. de Villedary, R. Gendrin, S. Perraut, A. Roux, D. Jones, A. Korth, G. Kremser: Observations of waves below the proton gyrofrequency in helium-rich magnetospheric plasma (33b03).
- T. A. Fritz, D. J. Williams: Observations of multiple period wave on the magnetopause (33b05).

December 7 (Friday) a.m. and p.m. Room: Copland G4, Chairmen: W. J. Hughes, O. M. Raspopov, A.D.M. Walker and C. W. Arthur

### b. Pulsation Generation and Propagation Theory (continued)

- E. W. Greenstadt, K. Takahashi, R. L. McPherron: Solar wind control of pulsations (review, 33b06).
- N. A. Barkhatov, N. S. Bellyustin, Y. I. Feldstein: The new mechanism of Alfvén wave attenuation in the solar wind (33b07).
- T. Saito, K. Yumoto, T. Sakurai: Analysis of low-latitude Pc3 by means of high-speed spectrum analyzer (HISSA) (33b08).
- V. A. Troitskaya, A. V. Busevich, V. A. Parchomov, A. S. Potapov, T. N. Polushkina, R. A. Rakhmatulin: Observations of geomagnetic pulsations during the experiment Siberia IMS-79 (33b09).
- F. B. Knox, W. Allan: Damping and coupling of long-period hydromagnetic waves by the ionosphere (review, 33b11).
- C. K. Goertz, R. W. Boswell: Magnetosphere-ionosphere coupling during sudden commencements (33b12).

#### c. Substorm Associated Pulsations

- R. L. McPherron: Substorm associated micropulsations at synchronous orbit (review, 33c01).
- O. M. Raspopov: Pi2 auroral zone and mid-latitude observations (review, 33c02).
- W. J. Hughes: A global study of the Pi2 events on July 13/14 1977 (33c03).
- T. Saito, K. Yumoto, I. Aoyama, T. Sakurai: A long-period *Pi2* associated with a mini-substorm observed by the Japanese satellite "JIKIKEN" (33c04).
- W., F. Stuart, C. A. Green: A mechanism for the generation of mid latitude Pi2's and bays (33c05).
- P. R. Sutcliffe: Evidence of a low latitude resonance in Pi2 generation (33c06).
- T. Sakurai, R. L. McPherron: On an observed relation between *Pi2* activity and field aligned current at synchronous orbit (33c07).
- N. G. Kleimenova, N. F. Maltzeva: The connection between IPDP pulsations and VLF chorus generation during substorm development (33c08).
- F. Søraas, I. A. Lundblad, N. Maltseva, V. Troitskaya, V. Selivanov: A comparison between simultaneous IPDP groundbased observations and observations of energetic protons obtained by satellites (33c09).
- A. Egeland, I. Holtet, S. Asheim, K. Aasen, I. Kangas, V. A. Troitskaya, N. Maltseva, E. Gerasimovitch,
   L. Baransky: The location of the generating region and investigation of some peculiarities of IPDP-events on the data of north-south chain of observatories (33c10).
- N. Klöcker, B. Theile: High amplitude pulsations above the lower ionosphere (33c12).

December 8 (Saturday) a.m. and p.m. Room: Copland G4, Chairmen: M. K. Andrews, S. Kokubun and W. F. Stuart

## d. Multipoint Measurements of Geomagnetic Pulsations

- G. Rostoker, J. C. Samson, J. V. Olson: Spectral characteristics of Pc and Pi micropulsations as a function of latitude and longitude and the identification of resonance regions (review, 33d01).
- P. F. Fougere: Geomagnetic pulsation observations using the AFGL magnetometer network (33d02).
- U. Wedeken: Latitude dependence of magnetic pulsations compared to satellite data and auroral phenomena (33d03).
- L. Baransky, V. A. Troitskaya, I. V. Sterlinkova, V. A. Pelipenko, O. Hillebrand, M. Siebert, U. Wedeken, W. F. Stuart: Simultaneous observations of *Pi2* pulsations along Scandinavian and UK geomagnetic meridian (33d04).
- A. D. M. Walker, R. A. Greenwald: Determination of magnetospheric and ionospheric quantities by means of STARE observations of Pc5 pulsations (33d05).
- D. J. Webster, B. J. Fraser: Pc1 source location using ULF goniometer techniques (33d06).
- W. Kemp, B. J. Fraser: Ionospheric duct propagation of Pc1 pulsations at high and low latitudes (33d07).
- W. J. Hughes: Multisatellite observations of geomagnetic pulsations (review, 33d08).
- C. W. Arthur: Multiple satellite observation of a long duration Pc4 pulsation at synchronous orbit (33d09).
- P. R. Higbie, D. N. Baker, R. D. Belian, E. W. Hones, Jr.: Micropulsations observed in > 30 keV electron fluxes measured at geostationary altitudes (33d10).
- H. J. Singer, M. G. Kivelson, C. T. Russell, T. A. Fritz, W. Lennartsson: The spatial structure of *Pc3*, 4, 5 pulsations near the magnetospheric equator (33d11).
- V. A. Troitskaya, R. V. Schepetnov, N. F. Maltzeva, O. A. Pochotelov, E. T. Matveeva, R. L. McPherron, J. N. Barfield: Time sequence and interconnection of geomagnetic pulsations in the magnetosphere and on the ground during substorms (33d12).
- C. A. Green, W. F. Stuart: Apparent phase velocities of Pi2's (33d13).
- M. Kuwashima, T. Toya, M. Kawamura, B. J. Fraser: Morphological features of low-latitude Pc1 pulsations (33d14).
- A. Suzuki, H. Nagano, J. S. Kim, M. Sugiura: Statistical study on characteristics of high latitude Pi3 pulsations (33d15).
- A. Suzuki, M. Sugiura, H. Nagano, J. S. Kim: A motion picture representation of magetic pulsation vectors (33d16).
- H. Nagano, A. Suzuki, J. S. Kim, M. Sugiura: Latitudinal and longitudinal dependence of high latitude Pi3 magnetic pulsations (33d17).

Significant progress in understanding the origin of geomagnetic pulsations followed J. W. Dungey's suggestion, in the early 1950's, that they might be due to hydromagnetic waves in the earth's magnetosphere. The 1960's saw an accumulation of evidence, but in the 1970's the field blossomed. A variety of factors were responsible for the rapid development. Most important was that theories of large-scale structure of signals were developed just as the first arrays of magnetometers were measuring the north-south signal structure along lines of longitude. Theory and experiment agreed probably better than theorists or experimenters had expected; thus began a healthy mix of collaboration between theorists and experimenters.

At the session, Stuart (U.K.), Wedeken (F.R.G.), and Hughes (U.S.A.) described studies on an international scale that were directed toward establishing the large-scale structure of Pi2 pulsations signals on the ground. A review by Raspopov (U.S.S.R.) made clear that the Pi2 is seen far equatorward of the auroral zone, with a defined structure through mid- to low-latitudes. The damped form of the signal is less obvious in an analog record far from midnight, but recent East-West studies find a surprising coherence and small phase differences over several hours of local time, as well as a systematic polarization variation. Pursuing such work offers the potential for mid- or even low-latitude diagnosis of auroral activity. Rostoker

(Canada) presented evidence that continuous pulsation activity on the dayside of the earth could even be correlated with nighttime substorm activity. Signal period decreases with substorm onset.

A variety of spacecraft measurements, auroral radar measurements, and ingenious interpretation of VLF (very low frequency) Doppler measurements have come to the topics in the pulsation study.

Andrews (N.Z.) and coworkers showed that signal polarization is rotated by  $90^{\circ}$  between magnetosphere and ground, a theoretical prediction greeted with skepticism by experimenters some years ago. The  $90^{\circ}$  rotation was also illustrated by the auroral radar data. Stare (Scandinavian Twin Auroral Radar Experiment) radar measures essentially the ionospheric electric field every 20 seconds over a  $400 \times 400$ -km grid with 20-km resolution. Walker (South Africa) reviewed results which fit well with the 'field line resonance' picture of pulsations in which signal amplitude peaks on a resonant magnetic shell where energy is fed into the hydromagnetic mode which is guided by the magnetic field.

Walker and Greenwald emphasized the rate of ionospheric Joule heating that low-frequency pulsations (Pc5) provide in the high-latitude ionosphere. Knox (N.Z.), in his review of the theory of signal propagation through the ionosphere, described the strong modification of signal structure that can occur when magnetically conjugate ionospheres have very different conductivities. Stuart (U.K.) reported work by Green which used data from a pair of conjugate stations (Halley Bay, Antarctica and St. Anthony, Newfoundland). The data showed strong seasonal dependence in signal symmetry between stations that could be due to the radical variation in conductivity above Halley between seasons.

Several studies used data from more than one spacecraft and/or data from more than one spacecraft instrument. The paper by Singer et al., presented by C. T. Russell (U.S.A.), used data from the two closely spaced spacecraft, ISEE 1 and 2, and three others. Different signal frequencies were seen at different locations, which was interpreted as evidence of spatially localized field line resonance regions. Electric and magnetic field data comparisons suggested the presence of second harmonic signals as well as the fundamental field line resonance. The presence of an ion mass spectrometer on ISEE spacecraft led to another significant discovery. During the period studied, O<sup>+</sup> dominated the ion mass density, so the Alfvén speed was much smaller than in a proton plasma of similar number density. Only because of this do observed and theoretical resonance frequencies agree.

The European Space Agency's GEOS 2 spacecraft is providing a variety of exciting results on magnetospheric plasma waves. In a major review of waves seen by the S-300 experiment in the upper range of the pulsation band, *Roux* (France) emphasized the role of heavy ions in this band (which includes the ion Larmor frequencies), as did an associated paper by *Young* (Switzerland) that used ion mass spectrometer data. *Haerendel* (F.R.G.) reported on an ingenious electric field measurement technique—an electron gun fires a beam of electrons, and by analyzing when and where the beam returns to the spacecraft, the local plasma drift velocity (proportional to the electric field) can be deduced. Resolution is good, the only disadvantage being that the present system only works over a range of magnetic field orientations. Pulsation fields are easily detected. *Korth* (F.R.G.) showed some remarkable examples of sinusoidal low-frequency signals detected in energetic particle data on GEOS 2. Both energetic protons and electrons oscillate closely in phase with strong compressional changes in the magnetic field.

Hughes (U.S.A.) used other synchronous orbit spacecraft in his review of multispacecraft measurements, a developing field. His descriptions of well-defined types of signals (correlated,

for instance, with particular types of local particle distribution), which have no obvious counterpart on the ground, led to discussion of spacecraft-ground correlations. Troitskaya (U.S.S.R.) suggested that different nomenclature might be needed for the types of signals seen in space, stressing the difference in Pi2 pulsations seen on the ground and in space and also reporting that low-frequency continuous pulsation (Pc 4-5) activity in space during substorms correlated with high-frequency activity of the intervals of pulsation with diminishing period (IPDP) type on the ground. It seems clear that the spacecraft-ground correlation problem is not turning out to be straightforward. Earlier papers by Glangeaud (France) and Kokubun (Japan) showed examples of correlations but also examples of failures to correlate. Reasons may not be hard to find—the ionosphere tends to shield localized signals from the ground, and spacecraft measurements are often made near the equatorial plane, where magnetic signals may be small because of a symmetry effect. In addition, it seems agreed that many types of signal are ordered by the background field (through e.g. the field line resonance phenomenon). We are often ignorant of how field lines map from magnetosphere to earth, and yet the signal-mapping problem is tied to this relationship. A start was made by Singer et al. (presented by Southwood (U.K.)), who showed how a simple treatment of signals in the realistic Olson-Pfitzer magnetospheric field model revealed radically different diurnal variations in resonant frequencies on the ground and in space.

An area of endeavour where theorists still seem to have some way to catch up with observations is the correlation of the behavior of some types of continuous pulsations with parameters of the interplanetary plasma medium. Specific allowance for a combined influence of both solar wind velocity and interplanetary magnetic field direction has produced some very tidy empirical results. There seems no general agreement on mechanisms for the control that the external medium exerts over the magnetosphere. *McPherron* (U.S.A.) reviewed this topic in a paper by *Greenstadt et al.* 

Some new directions in the field are clear: The trend toward large network studies is not played out; attention is being directed at East-West signal structure. The *Pi2* signal seems singled out for a lot of study in the immediate future. The study of pulsations in spacecraft data, in charged-particle data especially, looks to be an expanding field. It also looks as if we may only have raised the corner of the curtain on the ground-space correlation problem and there should be progress there. The auroral radar technique is now established and is partly responsible for the secure position on the theory front of ideas like field line resonance and signal polarization rotation by the ionosphere. There is still controversy on the theory of wave-particle interactions, and there are whole areas, such as interplanetary medium correlations or large-scale *Pi2* structure, where theory development is keenly required.

(D. J. Southwood)

# GC-III. GENERAL CONTRIBUTIONS TO DIVISION III

(Convenor: C. T. Russell)

December 4 (Tuesday) a.m. and p.m. Room: Copland G7, Co-Chairmen: C.-G. Fälthammar, D. J. Southwood; B.T. Tsurutani, R. J. Walker

Magnetospheric and Auroral Processes

D. J. Williams: Prospects for solar-terrestrial physics in the United States in the 1980's (G3.01).

M. Lester, A. J. Smith: Whistler duct structure and formation (G3.02).

L. R. Lyons, D. J. Williams: A source for the geomagnetic storm main phase ring current (G3.03).

- S. Kokubun: Stormtime field configuration at synchronous altitude (G3.04).
- K. Ronnmark, P. J. Christiansen, R. Horne, M. P. Gough, H. Borg, G. Wrenn, J. J. Sojka: Electrostatic electron cyclotron harmonic waves observed from the GEOS spacecraft—Comparison of theory and experiment (G3.R1).
- P. J. Christiansen, M. P. Gough, J. Etcheto, J. G. Trotignon, D. Jones, G. Belmont, A. Roux: Observations of cotinuum radiation in the earth's magnetosphere (G3.R2).
- P. W Daly, E. Keppler: Bursts of 25 keV protons and 20 keV electrons seen in the magnetotail at 22 R<sub>E</sub> by ISEE-2 (G3.06).
- R. H. Eather, S. B. Mende, E. J. Weber: Dayside aurora and the substorm process (G3.07).
- T. J. Hallinan: Detailed relationships between Birkeland current sheets and field-aligned charge sheets deduced from observations of auroral forms (G3.08).
- J. H. Meek: An intuitive look at the magnetosphere (G3.10).

# Planetary Magnetospheres: IMF Control of Magnetosphere

- R. P. Lepping, L. F. Burlaga: The magnetopause and bow shock of Jupiter: Voyagers 1 and 2 (G3.11).
- K. W. Behannon, N. F. Ness, L. F. Burlaga, R. P. Lepping: Jupiter's magnetic tail and current sheet (G3.12).
- F. M. Neubauer, N. F. Ness, M. H. Acuna: The electrodynamic interaction of Io with the Jovian magnetosphere (G3.13).
- M. G. Kivelson, J. A. Slavin, D. J. Southwood, R. J. Walker: Interaction of Jovian plasma with an Ionian magnetosphere (G3.14).
- M. I. Pudovkin, D. I. Ponyavin, A. D. Cherkov: On the origin of recurrent geomagnetic activity (G3.15).
- A. Berthelier, C. Guerin: Variations of magnetic activity observed in response to the interaction of structured variations of the interplanetary medium with the magnetosphere (G3.16).
- A. Berthelier, J.-J. Berthelier: A study of the influence of the IMF polarity and of the north south IMF component of the north south hemispheric dissymmetry of the terrestrial magnetic activity (G3.18).
- K. Lassen, C. Danielsen: Magnetospheric convection pattern and position of polar cap auroral arcs (G3.19).
- T. Nagai, N. Fukushima: Seasonal dependence of geomagnetic variations in the polar region in connection with large-amplitude annual Z-variation at the geomagnetic pole (G3.20).
- J. Oksman, H. Ranta: Influence of the IMF sector polarity on annual and diurnal variations of absorption in the auroral zone (G3.21).
- G. K. Rangarajan: IMF control of the diurnal variation in equatorial geomagnetic field in Indian region (G3.22).
- C. R. Francis, K. Bullough, T. R. Kaiser: Secular, seasonal and diurnal variations in the spectra of high latitude ELF/VLF hiss (G3.R3).

There were two half day sessions of general contributions to Division III. Many papers that would have been sent to these sessions were presented instead at the week long IMS meeting held in Melbourne the previous week. Nevertheless the two half day sessions were quite full. The first morning was devoted to magnetospheric and auroral processes. The plasma wave populations, energetic particle populations and electric currents were the main topics of discussion. The afternoon session began with an examination of the Jovian magnetosphere with particular attention to the interaction of Io with the Jovian magnetosphere. The latter half of this session returned its focus to the earth with an examination of the influence of the solar wind and interplanetary magnetic field on terrestrial geomagnetic activity.

(C. T. Russell)

# IV-1. MULTIPOINT STUDIES OF EVOLVING SOLAR WIND STRUCTURES (Convenors: P. C. Hedgecock and L. F. Burlaga)

December 4 (Tuesday) a.m. and p.m. Room: Copland G4, Chairman: L. F. Burlaga

- G. L. Siscoe, C. T. Russell, E. J. Smith: Comparison of ISEE-2 and 3 magnetic field observations (41.01).
- F. M. Neubauer, L. F. Burlaga, R. P. Lepping, J. Sullivan, F. Mariani, H. Rosenbauer, R. Schwenn: Observation of nolinear shock interaction in the solar wind by Helios-1, -2, IMP-8 and Voyager-1, -2 (41.02).
- L. F. Burlaga, K. W. Behannon, A. Lazarus: Magnetic fields in transient, postshock flows: Voyager-1 and -2 results (41.03).
- D. S. Intriligator: Multipoint studies of evolving solar wind structures between 0.8 AU and 20 AU (41.05).
- R. Schwenn, A. K. Richter, H. Rosenbauer, K. H. Mühlhäuser, J. R. Asbridge: Solar wind stream deflections as determined from simultaneous IMP and Helios observations (41.06).
- Y. C. Whang: Magnetohydrodynamics of corotating interplanetary structures (41.07).
- U. Villante, R. Bruno, F. Mariani, L. F. Burlaga, N. F. Ness: The shape and location of the sector boundary surface in the inner solar system (41.08).
- J. D. Scudder, E. C. Sittler, Jr.: Empirical evidence for a polytropic equation of state for thermal solar wind electrons between 0.4 and 5 AU: Mariner 10, Voyager 1 and Voyager 2 (41.09).

Russell (paper 41.01) compared the interplanetary magnetic field measured in 3-hr intervals by ISEE-3 near the sunward liberation point with the corresponding interplanetary magnetic field measurements made by ISEE-1 closer to the earth. The correlation was found to be highly variable and unpredictable. There was a velocity dependent effect which could be removed and the correlations were further improved when it was assumed that the fluctuations were spiral aligned. The results indicate that ISEE-3 is a relatively poor monitor of the short period fluctuations which influence substorm phenomena. Neubauer (41.02) reported some results from the Helios/Voyager/IMP Workshop. Using data from 5 spacecraft between 0.6 AU and 1 AU, he showed strong evidence for the coalescence of two shocks near 1 AU. The MHD theory of this process was briefly reviewed. Burlaga (41.03) presented evidence for a magnetic bubble in the ejecta behind a shock observed by Voyagers-1, -2 and by IMP-8. He also showed how both the large-scale observations and small-scale observations of discontinuities could be combined to delineate the structure of the ejecta. Intriligator (41.05) presented a number of observations of the solar wind speed and density from Pioneer Venus and Pioneer-10, -11 between 15-20 AU. She showed additional evidence for a nearly uniform shock speed in the outer solar system and for the narrowing of the speed distribution with increasing distance from the sun. Some models and the effects of streams and shocks on cosmic rays were also discussed.

The afternoon session began with a talk by *Schwenn* (41.06) who discussed the interaction of corotating streams with slow flows between 0.29 and 1 AU, using data from Helios 1,2 and IMP 7,8. He showed that the interaction causes large deflections from the radial flow, being larger for the lower density plasma. With this understanding, it was possible to devise an improved method for mapping flows back to the sun. A theoretical paper, 41.07, on the magnetohydrodynamics of corotation was presented by *Whang*. His model is three-dimensional (although only 2-D results were presented), and it describes the effects of diverging

flux tubes near the sun, the effects of Alvén waves, and the effects of viscous damping of Alfvén waves. A  $500 \, \mathrm{km/s}$  solar wind can be produced with a coronal temperature of  $2 \times 10^6$  when damped Alfvén waves are introduced. In paper 41.08, presented by *Mariani*, the shape of the sector boundary in the inner solar system was determined using Helios-1 and -2 data. The boundary was approximately a warped plane situated close to the solar equator. The final paper, 41.09, by *Scudder and Sittler* showed, using Mariner 10 and Voyager electron data, that the electron pressure satisfies the polytropic law,  $p = \mathrm{const.} \times \rho^{\gamma}$  where  $\gamma \sim 1.16$ . This confirms the theoretical predictions of Olbert and Scudder and provides a much-needed closure relation for fluid models of the solar wind.

(L. F. Burlaga)

# IV-2. SOLAR WIND INTERACTION WITH PLANETARY ATMOSPHERES (Convenors: D. J. Winningham, T. Gombosi and S. J. Bauer)

December 5 (Wednesday) a.m. and p.m. Room: Copland G7, Chairmen: T. Gombosi and S. J. Bauer

- P. A. Cloutier: The dynamics of the solar wind interaction with Venus (invited, 42.01).
- T. K. Breus: Peculiarities of the solar wind interaction with the upper atmospheres of Venus and Mars (invited, 42.02).
- C. T. Russell, R. C. Elphic, J. A. Slavin, G. L. Siscoe: Solar wind interaction with Venus in light of Pioneer Venus observations (invited, 42.03).
- S. J. Bauer: The ionosphere of Venus-Consequences of the solar wind interaction (invited, 42.04).
- R. E. Daniell, Jr.: Ionospheric convection models in the light of Pioneer Venus data (42.05).
- W. Knudsen: Photoelectron fluxes in the Venus dayside ionosphere.
- T. Gombosi, T. E. Cravens, A. F. Nagy, C. T. Russell: Absorption of solar wind by dayside ionosphere of Venus (42.07).
- R. H. Manka, F. C. Michel, D. Bulgher: Solar wind interaction with the lunar atmosphere—Analogies to Venus and Mars (42.08).
- K. I. Gringauz, M. I. Verigin, T. K. Breus: Low energy electrons revealed by Venera-9, -10 satellites in the Venus's shadow—The source of the planetary nocturnal ionosphere: Comparison with Pioneer Venus results (42.09).
- K. Spencer, W. C. Knudsen, K. L. Miller, V. Novak: Observations of the Venus ionospheric mantle formed between ionosphere and ionosheath (42.10).

This session was planned by IAGA Division IV with the Cosponsorship of Division II. Maximum attendance was about 35, minimum (afternoon) about 20 people. Attendance seems to have suffered from time conflict with Reporter Review Session of Division III and Session II-1.

The morning session commencing at 0900 was devoted to invited papers according to the program (IAGA Bulletin No. 43, pp. 37–40). Paper 42.01 of *Cloutier*, who was absent, was combined with contributed paper 42.05 and presented by *Daniell*.

In the afternoon session, commencing at 1420, paper 42.06 was not presented due to the absence of the author (*Wallis*). In its place a paper "Photoelectron Fluxes in the Venus Dayside Ionosphere" by *W. Knudsen* was presented upon the invitation by the Chairman. All other papers were presented as scheduled. Session IV-2 closed at approximately 1715.

Session IV-2 provided a lively forum for discussion of recent results, primarily on the solar

wind interaction with Venus obtained by US and USSR spacecraft. The participants seemed to have been highly satisfied with the presentations and ample opportunity for discussion. By coincidence, the day of this session fell on the 1st anniversary of the Pioneer Venus orbit injection.

(S. J. Bauer)

# IV-3. SCHOCKS, DISCONTINUITIES AND WAVES IN THE SOLAR WIND (Convenors: F. M. Neubauer and S. Pinter)

December 8 (Saturday) a.m. and p.m. Room: Copland G8, Chairman: F. M. Neubauer

### Wave Instabilities, Turbulence

- M. Dobrowonly, A. Mangeney, P. L. Veltri: Properties of hydromagnetic turbulence in interplanetary space (43.01).
- B. Bavassano, M. Dobrowonly, F. Mariani: Studies of the polarization state of alfvénic fluctuations in the solar wind (43.02).
- B. T. Tsurutani, B. T. Thomas, E. J. Smith, J. H. Wolfe: Alfvén waves and interplanetary discontinuities at large heliocentric distances: Pioneers 10, 11 (43.03).
- Grzedzielski, W. Rozmus: Low-frequency wave instabilities in the solar wind induced by new ions (43.04).
- C. P. Sonett: Alfvénic fluctuations observed in the solar wind.

### Fine Structure of Shocks

- C. Gurgiolo, C. S. Lin, B. Mauk, G. Parks, R. P. Lin, K. Anderson, H. Réme: Three-dimensional flow and plasma temperature characteristics in the neighborhood of the bow shock (43.08).
- S. Wang, L.-Z. Fang: The large-scale spiral waves in the solar wind (43.07).

### Sector Boundary Structure

K. W. Behannon, F. M. Neubauer: Fine-scale structure of interplanetary sector boundaries (43.09).

#### Observations of Macroscopic Shock Flow and Propagation

- R. Schwenn, H. Rosenbauer, K. H. Mühlhäuser: Evidence for singly ionized helium in the piston plasma behind interplanetary shock waves (43.10).
- L. F. Burlaga, R. Lepping, C. Goodrich, J. Sullivan, F. Mariani, F. M. Neubauer, H. Rosenbauer, R. Schwenn: Shock waves observed by Voyager-1, -2, IMP-8, Helios-1, -2 between 0.6 and 1.6 AU (43.11).
- M. H. Acuna, L. F. Burlaga, R. P. Lepping J. D. Sullivan: The solar events of September 1977: Interplanetary magnetic field and plasma observations (43.12).
- K. I. Gringauz, M. I. Verigin, G. A. Kotova, Ye. G. Yeroshenko: Simultaneous observations of the interplanetary shock wave by the Prognoz-6 and ISEE-1, -2 satellites on October 26, 1977 (43.14).

In this IV-3 session a number of generally high-quality papers were presented, starting with the subset of papers on waves, discontinuities and turbulence:

1) Dobrowolny-Mangeney-Veltri reported an important breakthrough in the theory of Alfvénic turbulence. Nonlinear interactions do not occur in large amplitude turbulence if the turbulence is propagating parallel or antiparallel to the average magnetic field only. An asymmetric distribution of k-vectors leads to a final state in which only the half-space of k-

vectors occurs ( $k\langle B\rangle > 0$ ) which was initially the dominant one. Results for observational tests were also offered, some of which were tested in the paper.

- Bavassano-Dobrowolny-Mariani tested consequences of the condition of constant magnetic field magnitude in Alfvénic turbulence, and the decomposition into Alfvénic and slow modes was discussed.
- 3) Tsurutani-Thomas-Smith-Wolfe showed the occurrence of Alfvén waves beyond 1 AU through the high correlation between pulsations in the radial components in speed and magnetic field. Mainly the occurrence and the properties of directional discontinuities were discussed using the so-called minimum variance technique (MVT). 80% of the discontinuities were found to be rotational from  $|B_n|/B_L$  with increasing thickness as a function of distance from the sun. No latitude variation was found as told in the discussion period.
- 4) Grzedzielski and Rozmus presented a comprehensive theoretical discussion of the distribution functions added to the solar wind plasma by the ionization of interstellar neutrals. The resulting instabilities were discussed for numerous special cases in the solar equatorial plane and on the solar polar axis. Maximum growth-times were lower than 100 sec. The efficiency of the ion pickup in the cold piston region following interplanetary shocks was amplified in the discussion period. Instead of the withdrawn paper by Kalva, a late paper was added.
- 5) C. P. Sonett used interplanetary magnetic field observations to study Alfvén waves in the solar wind. Several examples of peculiar types of waves were shown also in relation to their use for lunar induction studies.
- 6) Gurgiolo-Lin-Mauk-Parks-Lin-Anderson-Rème deals with the rapidly varying ion distribution functions in connection with the earth's bow shock with high time resolution, using electrostatic analyzers on ISEE-1 and -2. High velocity components of reflected particles perpendicular to the ecliptic plane were found.

The following two papers on the sector boundaries were presented.

- 7) Wang and Fang analyzed the linearized perturbation equations for isothermal background solar wind in order to obtain the sector structure as a spiral wave solution which was also shown to be neutral in its stability properties.
- 8) Behannon and Neubauer showed that the sector boundaries during the primary mission of Helios-1 (Dec. 74—March 75) had a complex structure containing a number of directional discontinuities which were tangential and because of their unusual thickness (10 times average thickness of usual DD's), must be distinct from the usually occurring directional discontinuities. In view of the "ballerina" model of the macroscopic sector boundaries, the high elevation of normals were interpreted as being due to either high-amplitude corrugations or a two-dimensional rather than one-dimensional structure of the individual transitions. The discussion of the paper was chaired by F. Mariani.

Finally, four papers were presented relating to "Observations of macroscopic shock flow and propagation".

9) Schwenn-Rosenbauer-Mühlhäuser identified singly ionized helium in the cold piston plasma of an interplanetary shock wave. It was the only case of this occurrence among a large number of shocks observed by the Helio-plasma-analyzers. Possible interpretations in terms of He<sup>+</sup> being picked up from the interstellar gas (in the gravitationally focussed region!) or He<sup>+</sup> originating from the solar chromosphere were discussed. The consideration of "quarks" as an alternative interpretation (origin in nuclear reactions in the flare) was thrown into the ensuing discussion by S. Grzedzielski.

- 10) Burlaga-Lepping-Goodrich-Sullivan-Mariani-Neubauer-Rosenbauer-Schwenn discussed shock observations from the Helios-Voyager Workshop also in relation to stream-structure during these interesting events. In particular, for shock sequence of events starting on Dec. 1, 1977, it was shown that the piston had a restricted longitudinal extent since it was identified by Helios-1 but neither by Voyager-1 nor -2.
- 11) Acuna-Burlaga-Lepping-Sullivan reported a number of shocks observed in September 1977 both by the Voyager and Helios spacecraft. Interesting information of the longitudinal extent could be obtained because of the almost opposite locations of Helios and Voyager. The shocks were originating from essentially one activity region, the shock and flare activity of which could be studied over 360 degrees. Also the appreciable spatial variations of shocks observed at Voyager-1 and -2 could be investigated.
- 12) Gringauz-Verigin-Kotova-Yeroshenko discussed the shock observations at Prognoz-6 in relation to the ISEE observations in relation to the problem of triangulation of the shock surface. The good accuracy of the density measurements by Prognoz-6 was discussed by comparing the two instruments.

(F. M. Neubauer)

# GC-IV. GENERAL CONTRIBUTIONS TO DIVISION IV (Convenor: K. I. Gringauz)

December 6 (Thursday) a.m. Room: Copland G7, Chairman: K. I. Gringauz

- T. Saito, M. Seto: Two-hemisphere model on the three-dimensional structure of the interplanetary magnetic field (G4.01).
- E. Marsch, K. J. Mühlhäuser, H. Rosenbauer, R. Schwenn: Helium and hydrogen temperature and velocity differences in the solar wind between 0.3 and 1 AU (G4.02).
- H. Oya, A. Morioka, R. Aoyama: Solar wind effects on the Jovian magnetosphere and relationships to the enhancement of Jovian decametric radio waves (G4.04).

This session is for various problems of the solar wind and interplanetary magnetic field, which are not dealt with in the three specialized topical sessions of IAGA Division IV. Three papers were presented in this General Contributions session. Saito and Seto showed that the whole interplanetary space is divided by one warped neutral sheet into two hemispheres with away- and toward-magnetic polarities, and they suggested a drastic change of the heliomagnetosphere within these 2–3 years. Marsch et al. pointed out that  $\alpha$ -particles are observed by the Helios solar probes to move faster than protons in high speed streams. The ion differential speed  $\Delta v$  reaches up to 150 km/sec at 0.3 AU. Different heliocentric radial temperature dependences have been measured for both ion species.  $\alpha$ -particles appear to cool down faster than protons during high speed wind expansion. Indications have been found that  $\Delta v$  and the temperature ratio  $T_{\alpha}/T_{p}$  are limited by Coulomb friction in slow speed wind. Finally Oya et al. showed important observational evidence of strong correlation of Jovian radio wave emission with solar wind condition revealed in the geomagnetic activity with possible mechanism for Jovian wave excitation.

(K. I. Gringauz, Convenor)

# V-1. WORKSHOP ON OBSERVATORY PRACTICE AND THE REDUCTION OF SECULAR VARIATION OBSERVATIONS (Convenor: W. F. Stuart)

December 11 (Tuesday) p.m. and December 12 (Wednesday) a.m. Room: Copland G7, Chairmen: W. F. Stuart and C. G. Sucksdorff

- J. M. Cantin, D. Gilbert, J. Bitterly, R. Schlich: Magnetometer portable pour la mesure de la declinaison et de l'inclinaison du champ magnétique terrestre (V1.01).
- C. Sucksdorff, R. Pirjola: Correcting QHM observations for elastic creep (V1.02).
- G. Fischer, P.-A. Schnegg: A new geomagnetic survey of Switzerland (V1.03).
- T. A. Rodgers: Seasonal variation in La Cour baselines at Scott Base (V1.04).
- G. Fischer, D. Naunapper: A small vector-magnetometer equally suitable for field use and as observatory standard (V1.05).
- J. Bitterly, J. M. Cantin, R. Schlich: Enregistrement numerique des variations du champ magnétique dans les observatoires Français de hautes latitudes (V1.07).
- Özdogan, N. Orbay, A. M. Isikara: Evaluation of geomagnetic data obtained in Istanbul since 1600 (V1.10).
- A. N. Pushkov, T. N. Bondar, M. N. Ivchenko: The representation of recent geomagnetic field variation (V1.12).
- A. Galdeano, J. Le Mouel, V. Courtillot: Updated magnetic charts for France (epoch 1978. 5) using improved secular variation models constructed from measurements at repeat stations and observatories (V1.13).
- J. A. As: The dipole vector for the presentation of the data of the annual mean values (V1.14).

This has now become an established part of the Division V programme. Papers were read dealing with instrumental problems ranging from electric creep in QHM's to advanced technology for portable absolute observations. Observatory problems were highlighted with particular reference to antarctic stations and possible magnetisation of surface rock material.

Much of the workshop was informed discussion when views were exchanged. It continues to surprise experienced observers that the small details of observatory operation and observations present problems of one kind or another and that these problems occur worldwide wherever geomagnetic measurements are made.

(W. F. Stuart)

# V-2. "MAYAUD" SYMPOSIUM ON USE OF GEOPHYSICAL INDICES (Convenor: L. Svalgaard; Organizers: J. H. Allen and J. V. Lincoln)

December 13 (Thursday) a.m. and p.m. Room: Copland G8, Chairmen: J. V. Lincoln, T. Saito and A. Berthelier

H. W. Kroehl: AE indices: Derivation, application and interpretation (invited, V2.01).

A. Berthelier: Latitudinal variation of the response of local magnetic activity to the interaction of structured variations of the interplanetary medium with the magnetosphere (V2.02).

- A. Berthelier, C. Guerin: A statistical analysis of the variations of terrestrial magnetic activity in high latitude regions (V2.03).
- H. B. Garrett, D. F. Smart, M. A. Shea: Correlation studies of *AE*, *ap* and *Dst* at time lags between 0 and 30 hours (V2.04).
- W. H. Campbell: Occurrence of AE and Dst geomagnetic index levels and the selection of the quietest days in a year (V2.05).
- M. Menvielle: A possible geophysical meaning of K indices (V2.06).
- M. Siebert, J. Meyer, D. Damaske: On the significance of geomagnetic equivalent amplitude indices (V2.07).
- D. Damaske: Daily and annual modulations of planetary geomagnetic activity (V2.08).
- J. H. Allen, T. Kamei: Intercomparison of magnetic activity indices (V2.10).
- M. Sugiura, D. J. Poros, J. H. Allen: The equatorial Dst index (V2.12.).
- T. Saito: Mechanism of semiannual variation in geomagnetic activity indices (V2.13).
- J. O. Cardus: 36 years of K-indices at the Ebro observatory (V2.14).
- E. J. Chernosky: A directly obtained geomagnetic activity index, J (V2.16).

This symposium was held, to honor P. N. Mayaud of the Insitut de Physique du Globe, Paris. Mayaud was recognized for his long years of service toward the development and improvement of geomagnetic indices. Mayaud has now retired and will be sorely missed by his many colleagues around the world. However, he is leaving a legacy to his coworkers in the form of Derivation, Meaning, and Use of Geomagnetic Indices (Geophysical Monograph Series, vol. 22), to be published by AGU in 1980.

The presented papers stressed high-, middle-, and low-latitude indices, and general topics. Two papers, given by Allen, covered the techniques of derivation, physical meaning, and applications of auroral electrojet (AE) indices and equatorial disturbance-storm time (Dst) indices. The AE index, now based on 13 circumpolar stations, could be improved by adding data from Amderma and a site midway between Barrow and Tiksi. Magnetic observatories on the east coast of Canada, and between Yellowknife and College, would also improve station coverage. To improve the Dst index, magnetometer data from Alibag is being added to that of Hermanus, Kakioka, Honolulu, and San Juan. Operation of digital recording magnetometers at all these observatories (and at the AE sites) was strongly urged because of the need to streamline the derivation process.

Two statistical studies compared magnetic activity indices. One by *Garrett*, *Smart* and *Shea* correlated AE, ap, and Dst with various solar wind parameters as measured by satellites at time lags between 0 and 30 hours. the purpose of the study was to investigate techniques for possible prediction of geomagnetic activity. Persistence of the phenomena was the best basis of prediction up to 5 hours; solar wind bulk properties were important after 5 to 10 hours. The southward turning of the interplanetary magnetic field was one of the better predictors of increased activity. The paper, by *Allen* and *Kamei* compared differential equatorial Dst; Kp, Kn, Ks, Km,  $K_{\text{Hartland}}$ ,  $K_{\text{Toolangi}}$ , aa (subauroral zone); and AE (auroral zone). All the subauroral zone indices are highly correlated with aa (r=0.94), indicating that data of two suitably placed antipodal stations might be able to replace the 13-station Kp or the 25-station Km network for many purposes, even providing real-time indices. The AE and Dst indices can only be partially related to variations in the subauroral zone indices. Thus these indices serve unique purposes, especially in interpreting the coupling of the geomagnetic field to the solar wind. The subauroral zone indices were found to be contaminated by auroral zone substorm activity,

although they are supposed to be derived in a way to make them immune to these variations. The equatorial *Dst* indices have a systematic diurnal Universal Time variation that may arise from residual uncompensated variations that are imperfectly removed from one or more stations' records in the index derivation process.

A new method of selecting the quietest days in a year has been developed by Campbell. It used the AE index and the positive and negative value groups of the Dst index. The selection requires the correspondence of equivalent fraction portions of the distribution of days in which all hourly values of indices are below specified levels. Two selections are made in order to provide either 19 or 30 chosen quiet days per year. Lists for 1958–1974 are available. Comparison with the five international quiet days per month, based on Kp, showed only one third to one half of the low Kp days to be quiet by AE and Dst index standards.

Berthelier studied the latitudinal response of local magnetic activity and found that the increase in activity that is related to the increase in the southern Bz IMF component is larger in the auroral regions that are shifted toward lower invariant latitudes. In a second paper, her analysis of the K indices of 30 observatories with invariant latitudes greater than  $60^{\circ}$ , for 1964–1968, showed that the yearly averaged profile of the variation with invariant latitude depended on the solar cycle and that there was a systematic difference between the southern and northern hemispheres. Hemispheric differences are also observed in the An and As indices. If the index of activity is statistically corrected for diurnal and seasonal variations, it can prove useful in studies of the influence of the solar wind on local magnetic activity.

Menvielle found the K index at subauroral latitudes to be linearly related to the root mean square of certain irregular variations of the geomagnetic field. Damaske demonstrated a good correlation between Ap and Am. For the correlation between Ap and aa, a divergence was noticed for indices after 1965. Arguments for continuing Ap were given. Damaske also reported that the semiannual wave and the daily UT variation are now understood as being interrelated magnetospheric modulation effects which are determined by the varying inclination of the earth's dipole axis toward the direction of the solar wind through a sine-squared law. Saito discussed the semiannual variation in geomagnetic activity indices, not as a direct equinoctial effect but as an axial effect. Cardus presented an analysis of 36 years of K indices at the Ebro Observatory. Chernosky presented a possible real-time geomagnetic index similar to the U-measure by comparing momentary extremes in the H component.

The success of the Mayaud Symposium indicates the need for the continual development of geophysical indices that can be used to interpret magnetospheric activity and interplanetary magnetic fields.

(J. V. Lincoln)

# GC-V. GENERAL CONTRIBUTIONS TO DIVISION V (Convenor: P. H. Serson)

December 12 (Wednesday) p.m. Room: G7 Chairman: C. G. Sucksdorff

At the IAGA Canberra Assembly all the Division V papers (except the one shown here) were presented to specified sessions. The paper in this session was:

S. P. Kingsley, H. G. Muller, P. Rutter: A new automatic meteor wind recording facility at Sheffield (GV.02).

which demonstrated an on-line minicomputer system connected to coherent pulse-type meteor radar. The authors analyzed 55,000 meteor echoes after 40 days' observation, and showed good statistics of the upper atmospheric wind with some interesting examples of wind oscillations.

(C. G. Sucksdorff)

## EI-1. INTERNAL CONTRIBUTIONS OF THE IONOSPHERIC ELECTROJETS (Convenors: S. Matsushita and W. H. Campbell)

December 10 (Monday) a.m. and p.m. Room: Copland G7, Chairmen: W. H. Campbell and S. Matsushita

#### Polar Electrojets

- V. Haak, D. Damaske, M. Beblo: Electrical conductivity beneath Iceland derived from the analysis of polar substorms (E1.01).
- J. F. Hermance: Combined magnetotelluric and geomagnetic deep-sounding experiments beneath the auroral electrojet in Iceland (E1.02).
- H. Maurer, B. Theile: Induction effects of the polar electrojet (E1.03).
- K. Lange, A. G. Jones: Geomagnetic induction studies in the Scandinavian auroral zone—I (E1.05).
- A. G. Jones, B. Olafsdottir: Geomagnetic induction studies in the Scandinavian auroral zone—II (E1.06).
- A. D. Richmond, W. Baumjohann, A. G. Jones: Separation of external and internal auroral electrojet magnetic effects based on Scandinavian magnetometer array data (E1.04).
- S. Matsushita: On the production of ionospheric electrojets (invited, E1.07).
- W. H. Campbell: Observations of electric currents induced in the Alaska oil pipeline resulting from auroral electrojet current sources (invited, E1.08).
- V. R. S. Hutton, E. W. Mbipom: Parameters affecting EM transfer functions at island sites in the sub-auroral zone (invited, E1.09).
- D. H. Boteler, T. Watanabe, G. Marchisio, S. Watanabe: Induced currents and their effects on the 500 kV power transmission system in British Columbia (E1.10).

#### Equatorial Electrojets

- B. P. Singh, B. N. Bhargava: On currents induced by equatorial electrojet (invited, E1.11).
- E. Oni: Crustal and upper mantle conductivity effect on field measurements at equatorial stations (E1.12).
- N. B. Trivedi, H. Fournier: Upper mantle structure determined from magnetotelluric measurements at Eusebio in Brazil (E1.13).
- C. S. Cox: Conductivity of the ocean crust near the East Pacific rise (invited, E1.15).
- J. T. Weaver, T. W. Dawson: Induction by a line current over a coastline (E1.16).
- H. W. Dosso, W. Nienaber, J. P. Greenhouse, J. A. Wright, R. C. Baily: An analogue model study of the response of the eastern coast of North America to induction by uniform and line current fields (E1.17).
- R. Raghavarao, B. G. Anandarao: Vertical winds—A plausible cause for counterelectrojet (E1.19).
- P. Bernard: Variations of monthly means of horizontal geomagnetic field (poster, E1.20).

The purpose of Session EI-1 was to consider the geomagnetic induction problems associated with coastal current channeling effects and also with stationary and moving ionospheric electrojet current sources whose fields at the earth's surface cannot be modeled properly by plane-wave approximations. Heretofore, induction studies of crustal conductivity properties have largely neglected the effects of irregular current source characteristics. At high latitudes, the research efforts in solar terrestrial physics properties seem to have neglected the consideration of geomagnetic data adjustments for induction effects.

The presentations of this session were divided between studies of the high latitude and equatorial current systems. Models of the auroral electrojet current and its induction at the earth, surface-array studies of the field, and induction effects in long power lines and oilpipelines were presented in the high latitude portion of the meeting. Some effective techniques for treating the fields from the strong and variable auroral electrojet were presented. In particular, computer simulations of ionospheric electric fields and currents produced by the field-aligned currents during a typical substorm, which were compiled in the form of a color movie, clearly presented behavior of the auroral electrojet and its frequent and swift interactions with the equatorial electrojet. The equatorial region studies of the phenomena were largely of a descriptive nature. A few, but very competent, groups are studying the induction processes at coast lines with modeling techniques that seem to approach the observed field phenomena.

(S. Matsushita and W. H. Campbell)

# EI-2. EXTERNAL AND INTERNAL MAGNETIC VARIATIONS FOR *Sq, L* AND RELATED PHENOMENA (Convenors: S. R. C. Malin and V. R. S. Hutton)

December 11 (Tuesday) a.m. Room: Copland G7, Chairmen: V. R. S. Hutton and S. R. C. Malin

- T. Yukutake, J. C. Cain: The effect of the averaging process of the daily change on the solar cycle variation of the geomagnetic field deduced from annual mean values of the observatory data (invited, E2.01).
- J. F. Hermance: Regionalization of global electromagnetic induction data (E2.03).
- D. E. Winch: Sq, L and Hough functions (invited, E2.04)
- R. S. Anderssen: The depth at which geomagnetic disturbances appear to see a radially symmetric conductivity (E2.05).
- W. H. Campbell: A review of recent studies of the lunar tidal variations in the geomagnetic field (invited, E2.06).
- B. H. Briggs: A 27-day recurrence tendency in ionospheric dynamo currents (E2.09).
- S. Matsushita: On the production of  $S_a^p$  external field (invited, E2.10).
- R. S. Anderssen, S.-A. Gustafson: Perturbations in the Sq-field (E2.11).
- D. R. K. Rao, B. R. Arora, N. S. Sastri: S and L profile studies in the Indian region (invited, E2.12).
- G. O. Walker, S. I. Kannangara: A study of quiet day magnetic field variations at low latitudes in the longitude range 100-150°E at sunspot minimum (E2.13).

Ten papers were presented, dealing with geomagnetic variations with periods from 11 years to 1 day, with the emphasis nearer the latter. Some of the papers were largely observational (E2.09, E2.12, E2.13), others were more concerned with interpretation (E2.03, E2.05, E2.10, E2.11) while others emphasized the importance of mathematical techniques (E2.01, E2.04, E2.05). *Campbell* presented a valuable and comprehensive review of recent lunar studies (E2.06).

It is some years since IAGA has held a session devoted to Sq and L, and it is apparent that research in these topics is still being actively pursued and that there are still many problems to be solved. These concern both the ionospheric dynamo mechanism and the conductivity structure where the induced currents flow. While the global pattern is becoming clearer, there are many local features, particularly in the polar and equatorial zones, whose elucidation and interpretation will be of great geophysical interest.

(S. R. C. Malin, Convenor)

#### IAGA RESOLUTIONS OF THE CANBERRA ASSEMBLY

(adopted on 13 December 1979)

#### Resolution of Thanks

IAGA expresses its gratitude to those member countries that in recent years have hosted international conferences in the fields of IAGA's interest. IAGA expresses its deep appreciation to the Australian Academy of Sciences and to the Local Organizing Committee of the quality of the arrangements and the hospitality shown to the participants that have led to productive and pleasant meetings in Canberra and Melbourne.

#### Resolution No. 1

IAGA, noting with satisfaction that there are many IUGG member countries carrying out strong scientific programs in IAGA disciplines thus providing a large and important scientific input to IAGA Scientific and General Assemblies, recognizing that the most crucial financial decisions directly affecting the operations of IAGA as well as many programmatic decisions are in the purview of the IUGG Bureau, the IUGG Finance Committee and, ultimately, the IUGG Council, encourages the IAGA Adhering Bodies to promote within the IUGG National Committees to which they belong, the appointment of Delegates to the IUGG Council drawn from the disciplines of IAGA, so as to achieve a representation of IAGA interests in the Council, and ultimately in the IUGG Bureau and Finance Committee, that is commensurate with the actual volume of scientific and programmatic work carried out by this Association.

#### Resolution No. 2

IAGA, noting that SCOSTEP was converted by ICSU into a Scientific Committee, and taking into account the continued strong interest and active participation of IAGA and IAMAP scientists in SCOSTEP programs such as MAP, the IMS Data Analysis phase, SMY, and Solar-Weather Relationships, recommends to IUGG endorsement of the new Constitution drafted for SCOSTEP, and provision of continued financial support to this Scientific Committee.

#### Resolution No. 3

IAGA acknowledges the major contributions to the success of the International Magnetospheric Study that have been made by the IMS Satellite Situation Center (SSC) and by the IMS Central Information Office (IMSCIE); notes that during the

post-IMS period there will be a continuing need for an information flow of the type at the present being provided by the SSC and the IMSCIE Office; and *urges* SCOSTEP and its affiliated international bodies to persuade relevant national agencies and academies to provide continued support to these services during the next decade.

#### Resolution No. 4

IAGA, recognizing the contributions that have been made in the past by experiments on geosynchronous applications satellites, urges that provision be made for the inclusion of coherent radio beacons and other equipment for geophysical experiments when such satellites are being planned.

#### Resolution No. 5

IAGA, noting the success of radar techniques in providing new information about the dynamic and spatial structure of electric fields, and the importance of such information for increasing the understanding both of the ionosphere-magnetosphere coupling and of global energy dissipation in the ionosphere through joule heating, urges that member nations collaborate in establishing radar systems in both hemispheres over as wide a longitude range as possible.

#### Resolution No. 6

IAGA, noting the progress which has been achieved in the investigation of dynamical processes in the upper atmosphere by means of the meteor radar method (especially under the auspices of the IAGA Global Radio Meteor Wind Studies Project (GRMWSP)), and the progress in the development both of automated meteor radars and of mathematical simulation of meteor phenomena, and noting that the necessity of measuring mesopause dynamics on a global scale requires the comparison of data measured by different equipment using different analyses, recommends (i) that all groups which use the radio meteor method during the preliminary MAP period coordinate their efforts in the development of the global network of meteor wind radars, to include transportable radars; (ii) that other techniques (for example, incoherent scatter, partial reflection drifts and LF spaced receiver drifts) should be used in coordinated measurements; (iii) that the existing GRMWSP network carry out simultaneous observations during periods of particular meteorological significance, at least until completion of MAP; and (iv) that greater efforts be made to standardize equipment and analysis techniques, with particular emphasis on comparing results obtained using different observational techniques.

#### Resolution No. 7

IAGA, noting that a comprehensive study along an east-west profile of geomagnetic secular variations recorded in sediments deposited since the last glaciation in lakes is likely to yield new data basic to our understanding of the origin of the geomagnetic field and that such a profile would be optimally located in the Eurasian and American

continents, within a band of latitudes between 40° and 50°N, *recommends* that National Bodies in the respective countries support the preparation of a cooperative project in which standardized techniques will be used.

#### Resolution No. 8

IAGA, considering the importance of establishing and maintaining an adequate geographical distribution of magnetic observatories, urges the establishment of an observatory on Easter Island, appeals to the authorities concerned to maintain an electromagnetic noise-free area around the Pamatai (Tahiti) observatory site, and the opening of a permanent magnetic observatory on Amsterdam Island.

#### Resolution No. 9

- IAGA, considering the need for secular change data of the magnetic field from remote ocean areas and the possibility of achieving this by measurements at certain specified islands, urges the responsible authorities both to establish the following repeat stations and to re-observe at them at intervals of not more than 5 years:
  - Atlantic Ocean: Ascencion, St. Helena, Cape Verde, Tristan da Cunha, Trindade Falkland, Gough, Bermuda;
  - Pacific Ocean: Clipperton, Galapagos, Juan Fernandez, Line, Marquesas, Gambier, Austral, Marshalls, Carolines, Wake, Baker, Adak, Raoul, Auckland Island, Campbell, Snares, Cooks, Fiji, Niue, Chatham, Bounty, Antipodes, Tonga, Solomons, Nauru, New Caledonia, New Hebrides;
  - Indian Ocean: Heard, Diego Garcia, Seychelles, Maldives, Cocos, Christmas, Amsterdam Island.

#### Resolution No. 10

IAGA, recognizing the value of the MASGAT geomagnetic measurements, urges the continuing support of the geomagnetic observatories and measurements at repeat stations to maintain the high precision of world magnetic charts and recommends that, until the end of 1980, observatories send hourly values (preliminary values, if need be) to the World Data Centres not later than two months after the end of the recording period.

#### Resolution No. 11

IAGA, recognizing the importance of rapid run magnetograms for global studies of ULF pulsations, recommends that observatories operating rapid-run magnetometers continue to do so, where possible increasing the sensitivity, and that other observatories initiate rapid-run recording.

#### Resolution No. 12

IAGA, draws attention to the desirability of digital magnetic observatories using a sampling

rate no slower than once every 10 seconds and *asks* these observatories to send these data to the World Data Centres as one-minute means (with clear identification of the method of averaging). These means should be centred on the minute (e.g. the first value within an hour is labelled  $00^h01^m$  and is the mean calculated from  $00^h00^m30^s$  to  $00^h01^m03^s$ ).

#### Resolution No. 13

IAGA, considering the need of some magnetic observatories to compare their horizontal intensity standard with the international standard and recalling the availability of the standard QHM's which are owned by IAGA and maintained by the Danish Meteorological Institute, urges the magnetic observatories to make use of this facility by requesting loan of the standard QHM's from that Institute.

#### Resolution No. 14

IAGA, recognizing the immense value to the scientific community of the publication of AE-indices by World Data Center A, urges all contributing northern hemisphere observatories to use digital recording and further urges observatories to maintain the necessary data flow, and further recommends all World Data Centers to participate; particularly of importance is the digitization of magnetograms by WDC-C2 (Kyoto, Japan).

#### Resolution No. 15

IAGA, noting that standards of K-index scaling can change, urges that each country appoint a qualified scientist to check regularly the K-index scalings at all the observatories within that country to maintain these standards and requests that Observatory Directors notify the Central Km-Bureau (Institut de Physique du Globe, Paris) of any changes of the Chief Observer at the Km Observatories to allow the Central Km-Bureau to be alert to detect possible systematic changes in K-scaling.

#### Resolution No. 16

IAGA, considering the interest in global magnetic anomalies and that a certain number of countries have already completed maps on a scale of 1:2 500 000, urges the compilation of such maps within the next four years as a contribution to a global magnetic anomaly map.

#### Resolution No. 17

IAGA, recognizing the ever-increasing pressure upon geophysicists to provide fast returns in the form of practical applications of their research, draws attention to the fact that basic research motivated by intellectual curiosity is the most effective breeding ground for the long-term development of applications in resource exploration and exploitation, environmental protection, and new technologies; urges its member

countries to provide continued strong support of basic research in the geosciences, and *encourages* them to embark in a concerted effort towards establishing an appropriate balance between the current opportunities offered in basic research and the long-term needs in applied fields and technology.

Remark: Resolution 2 is adopted also by IAMAP. Resolution 17 is adopted also as an IUGG Resolution.

#### RESOLUTIONS AIGA DE L'ASSEMBLEE DE CANBERRA

(Adoptées le 13 décembre 1979)

#### Résolution de Remerciements

L'AIGA exprime sa gratitude aux pays membres qui ont récemment accueilli des conférences internationales sur des sujets intéressant l'AIGA. L'AIGA exprime à l'Académie Australienne des Sciences et au Comité d'Organisation local sa profonde reconnaissance pour l'excellence des dispositions pratiques et l'accueil réservé aux participants, conditions qui ont conféré aux réunions de Canberra et Melbourne un caractère à la fois agréable et fécond.

#### Résolutions

- 1) L'AIGA, notant avec satisfaction que de nombreux pays membres de l'UGGI mènent à bien d'ambitieux programmes scientifiques dans les disciplines relevant de l'AIGA et contribuent ainsi par des résultats scientifiques nombreux et importants aux assemblées scientifiques et générales de l'AIGA, reconnaissant que les décisions financières les plus cruciales qui affectent directement les opérations de l'AIGA, ainsi que de nombreuses décisions sur les programmes, relèvent du Bureau de l'UGGI, du Conseil financier de l'UGGI, et, en dernier ressort, du Conseil de l'UGGI, encourage les organismes adhérents de l'AIGA à promouvoir au sein des comités nationaux de l'UGGI auxquels ils appartiennent la nomination au Conseil de l'UGGI de délégués issus des disciplines de l'AIGA, afin qu'ils réalisent dans ce Conseil, et finalement dans le Bureau et le Comité des finances de l'UGGI, une représentation des intérêts de l'AIGA qui soit en rapport avec le volume réel de travaux scientifiques et d'organisation menés à bien par cette association.
- 2) L'AIGA, notant que le SCOSTEP a été transformé par le Conseil International des Unions Scientifiques (CIUS) en un Comité Scientifique, et tenant compte du fait que les scientifiques de l'AIGA et de l'AIMPA continuent à porter un profond intérêt et participent activement aux programmes du SCOSTEP tels que le Programme d'Atmosphère Moyenne, (MAP), la phase d'Analyse des Données de l'Etude Internationale de la Magnétosphère (IMS), l'Année du Maximum Solaire (SMY) et les relations Soleil-Climat, recommande à l'UGGI d'approuver la nouvelle constitution préparée pour le SCOSTEP, et de prévoir un soutien financier durable pour ce Comité Scientifique.
- 3) L'AIGA constate les contributions majeures au succès de l'Etude Internationale de la Magnétosphère apportées par le Centre de Situation des Satellites (SSC) et par le Bureau Central d'Information de l'IMS (IMSCIE); note qu'après "IMS il sera toujours nécessaire d'assurer une circulation de l'information telle que celle organisée actuellement par le SSC et le

bureau de l'IMSCIE; et *demande instamment* au SCOSTEP et aux instances internationales qui lui sont affiliées de persuader les agences et académies nationales concernées de poursuivre leur aide à ces services durant la prochaine décade.

- 4) L'AIGA, reconnaissant les contributions qui ont été apportées par des expériences embarquées à bord de satellites géosynchrones d'applications, demande instamment que des dispositions soient prises pour inclure des radio-balises cohérentes et d'autres équipments d'expérimentation géophysique dans les projets de tels satellites.
- 5) L'AIGA, notant le succès remporté par les techniques radars dans l'obtention de résultats originaux sur la structure spatiale et dynamique des champs électriques, et l'importance de ces résultats pour l'amélioration de la compréhension du couplage ionosphère-magnétosphère et de la dissipation globale d'énergie dans l'ionosphère, demande instanument aux nations membres de collaborer pour établir des systèmes radar dans les deux hémisphères sur un intervalle de longitudes aussi grand que possible.
- 6) L'AIGA, notant les progrès réalisés dans l'étude des processus dynamiques dans la haute atmosphère à l'aide des radars météoriques (en particulier sous les auspices du Programme Global d'études des vents par mesures radio-météoriques (GRMWSP) de l'AIGA et les progrés réalisés dans le développement de radars météoriques automatiques et de méthodes mathématiques de simulation des phénomènes météoriques, notant également que la nécessité d'appréhender la dynamique de la mésopause sur une échelle globale suppose la comparaison de données mesurées par différents instruments avec différentes méthodes de dépouillement, recommande (i) que tous les groupes utilisant la technique radio météorique durant la période préliminaire de MAP coordonnent leurs efforts de développement du réseau global de radars météoriques, en y incluant des radars transportables; (ii) que d'autres techniques (par exemple la diffusion incohérente, et les mesures de dérives par réflection partielle et par récepteurs basse fréquence espacés) soient utilisées dans des campagnes de mesures coordonnées; (iii) que le réseau existant du GRMWSP effectue des observations simultanées pendant les périodes d'intérêt météorologique particulier, au moins jusqu'à l'achèvement de MAP; et (iv) que des efforts plus importants soient faits pour normaliser l'équipement et les techniques d'analyse, en insistant sur la comparaison de résultats obtenus par des techniques d'observation differentes.
- 7) L'AIGA, *notant* qu'une étude exhaustive le long d'un profil est-ouest des variations géomagnétiques séculaires enregistrées dans les sédiments déposés dans les lacs depuis la dernière glaciation est susceptible d'apporter de nouvelles données fondamentales pour notre compréhension de l'origine du champ géomagnétique et qu'un tel profil serait localisé de façon optimale sur les continents Eurasien et Américain, à l'intérieur d'une bande de latitudes s'étendant de 40° à 50°N, *recommande* que les instances nationales dans les pays respectifs apportent leur soutien à la préparation d'un projet coopératif mettant en jeu des techniques normalisées.
- 8) L'AIGA, considérant l'importance de l'établissement et du maintien d'une distribution géographique adéquate d'observatoires magnétiques, demande instamment qu'un observatoire magnétique soit établi sur l'île de Pâques, que les autorités concernées maintiennent une zone de calme électromagnétique autour de l'observatoire de Pamatai (Tahiti), et qu'un observatoire

magnétique permanent soit ouvert sur l'île Amsterdam.

- 9) L'AIGA, considérant le besoin de données de variations séculaires du champ magnétique en provenance de régions océaniques difficilement accessibles, et la possibilité de satisfaire ce besoin par des mesures sur certaines îles spécifiées, demande instamment aux autorités responsables, d'une part d'établir les stations de répétition suivantes, et d'autre part d'y répéter les observations tous les cinq ans au moins:
- Océan Atlantique: Ascension, Ste Hélène, Cap Vert, Tristan de Cunha, Trinité, Falkland, Gough, Bermudes;
- Océan Pacifique: Clipperton, Galapagos, Juan Fernandez, îles de la Ligne, Marquises, Gambier, Australes, Marshall, Carolines, Wake, Baker, Adak, Raoul, Auckland, Campbell, Snares, Cook, Fidji, Niue, Chatham, Bounty, Antipodes, Tonga, Salomon, Nauru, Nouvelle Calédonie, Nouvelles Hébrides;

Océan Indien: Heard, Diego Garcia, Seychelles, Maldives, Cocos, Christmas, île Amsterdam.

- 10) L'AIGA, reconnaissant la valeur des mesures géomagnétiques de MAGSAT, demande instamment que soit maintenu le soutien aux observatories géomagnétiques et aux mesures aux stations de répétition pour conserver la haute précision des cartes magnétiques mondiales et recommande que, jusqu'à la fin de 1980, les observatoires envoient des valeurs horaires (préliminaires, si nécessaire) aux Centres Mondiaux de Données dans un délai de deux mois au plus après la fin de la période d'enregistrement.
- 11) L'AIGA, reconnaissant l'importance des enregistrements magnétiques rapides pour les études des pulsations UBF, recommande que les observatoires disposant de magnétomètres pour enregistrements rapides poursuivent leurs observations, en accroissant dans la mesure du possible la sensibilité de leurs instruments, et que d'autres observatoires effectuent des enregistrements rapides.
- 12) L'AIGA, *attire l'attention* sur l'intérêt de disposer d'observatoires magnétiques fournissant des données numérisées avec une cadence d'échantillonnage inférieure à 10 secondes et *demande* à ces observatoires de faire parvenir ces données moyennées sur une minute, aux Centres Mondiaux de Données (en indiquant clairement la méthode utilisée pour l'obtention de la moyenne). Ces moyennes doivent être centrées sur la minute (par exemple la première valeur de l'intervalle horaire est intitulée 00 h 01 m et correspond à la moyenne calculée entre 00 h 00 m 30 s et 00 h 01 m 30 s).
- 13) L'AIGA, considérant la nécessité pour certains observatoires magnétiques de comparer leur étalon d'intensité horizontale à des étalons internationaux et rappelant que sont disponibles des QHM étalons propriété de l'AIGA et entretenus par l'Institut Danois de Météorologie, encourage vivement les observatoires magnétiques à utiliser ces QHM étalons en sollicitant le prêt auprès de cet Institut.
- 14) L'AIGA, reconnaissant l'apport essentiel à la communauté scientifique que constitue la publication des indices AE par le Centre Mondial de Données A, demande instamment à tous les observatoires magnétiques de l'hémisphère nord qui contribuent à l'établissement de ces

indices de se doter de moyens d'enregistrement numériques, demande instamment aux observatoires de maintenir le débit d'enregistrement nécessaire, et recommande enfin une participation de tous les Centres Mondiaux de Données; la numérisation des magnétogrammes par le WDC-C2 (Kyoto, Japon) est, en particulier, d'importance primordiale.

- 15) L'AIGA, notant que les règles suivies pour établir les indices K sont susceptibles d'évoluer, demande instamment à chaque pays de désigner un scientifique compétent chargé de vérifier réguliérement les mesures des indices K dans tous les observatoires de son pays afin de maintenir le mode de mesure conforme aux normes établies et demande aux directeurs d'observatoires de signaler au Bureau Central des Km (Institut de Physique du Globe, Paris) tout changement d'observateur principal dans un observatoire Km afin de permettre au Bureau Central des Km d'être en mesure de détecter d'éventuelles variations systématiques dans la mesure des indices K.
- 16) L'AIGA, considérant l'intérêt des anomalies magnétiques globales et considérant qu'un certain nombre de pays ont déjà réalisé des cartes à l'échelle de 1:2 500 000, demande instamment que soit réalisé l'inventaire de telles cartes dans un délai de 4 ans à titre de contribution à l'établissement d'une carte globale d'anomalies magnétiques.
- 17) L'AIGA, constatant que les géophysiciens sont appelés de manière de plus en plus pressante à dégager rapidement des retombées pratiques de leurs travaux de recherche, attire l'attention sur le fait que la recherche fondamentale motivée par la curiosité intellectuelle est le terrain le plus fertile pour le développement à long terme des applications dans les domaines de l'exploration et de l'exploitation des ressources, de la protection de l'environnement et des technologies nouvelles; demande instamment aux pays membres d'apporter de manière continue un appui solide à la Recherche fondamentale en Géophysique, et les encourage à s'engager dans une action concertée visant à établir un équilibre judicieux entre les possibilités actuelles offertes par la Recherche fondamentale et les besoins à long terme dans les domaines des applications et de la technologie.

Remarque: La résolution 12 est adoptée également par l'AIMPA;

La résolution 17 est adoptée également comme résolution de l'UGGI.

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#### for the Period of 1979-1983

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At the 1975 Grenoble Assembly, the following Past Presidents were named as Honorary Members: J. Coulomb (France), V. Laursen (Denmark), M. Nicolet (Belgium) and T. Nagata (Japan).

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Working Group I-3. Electromagnetic Induction and Electrical Conductivity (earth and moon)

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Vice-Chairman: B. A. Hobbs, Department of Geophysics, University of Edinburgh, JCMB King's Bldgs., Mayfield Road, Edinburgh EH9 3LA, U.K.

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#### Appendix 1.

#### INTERNATIONAL MAGNETOSPHERIC STUDY

## REPORT ON THE SYMPOSIUM HELD AT LA TROBE UNIVERSITY

Many regional symposia on IMS results were held during the last few years. The first major symposium on results of the IMS was held at La Trobe University, Bundoora, Victoria, Australia from November 27 to December 1, 1979. The meeting was co-sponsored by the Scientific Committee on Solar-Terrestrial Physics (SCOSTEP), the International Association of Geomagnetism and Aeronomy (IAGA), the Australian Institute of Physics and the Australian Academy of Science, and was held as part of the XVII General Assembly of the International Union of Geodesy and Geophysics. 166 attendees from over twenty countries heard 126 papers from 270 authors on results acquired so far from IMS experiments.

#### Summary of Scientific Aspects of the IMS Symposium

The IMS Symposium was opened by the key-note address of Nobel Laureate Professor H.O.G. Alfvén entitled "Plasma in Laboratory and in Space". The major sub-divisions of the Symposium were in the areas of (i) Magnetopause and Boundary Layers, (ii) Auroral Substorms and Magnetotail, (iii) Auroral Arcs, Pulsations and Hiss, (iv) Lower Latitude Phenomena, (v) Electric Fields and Current, (vi) Energetic and Thermal Plasmas, (vii) Waves.

New information was presented on the structure of the dayside magnetopause and boundary layer based upon measurements from the ISEE 1 and 2 satellites, of magnetic field, energetic particle velocity and pitch-angle distributions, and electromagnetic waves. Some data was consistent with reconnection of the earth and interplanetary magnetic field occurring at least in small regions of the magnetopause. From the Intercosmos 19 polar orbiting satellite results were presented showing small-scale and short-time fluctuations of soft electron intensities. Inside the boundary layer the flow is highly variable. Towards the flanks of the magnetosphere the boundary layer flow speeds can substantially exceed those of the adjacent magnetosheath. The magnetopause has been measured to reveal thicknesses of 500 to 2000 km and evidence was shown for the transfer of magnetic flux from the dayside to the nightside of the earth of sufficient quantity to account for magnetic substorms. Field-aligned asymmetries of energetic ion fluxes near the magnetopause were interpreted as evidence for magnetic field tubes open to interplanetary space.

A vacuum ultraviolet-TV camera on board the Japanese satellite KYOKKO (EXOS-A) has produced about 20,000 images so far. Each image covers almost the whole of the northern polar region. This technique shows great promise for extending our knowledge of auroral morphology and its relation to magnetospheric electrodynamics.

Balloon-borne X-ray imaging of the upper atmosphere under auroral break-up conditions, were reported. With a spatial resolution of 10 km at 100 km altitude structures of scale length about 10 km and motions of a few kms per sec. of aurora were observed.

Numerous rocket experiments on auroras and electric currents were reported combined with simultaneous ground-based measurements of drifts using radar systems. Synthesis of the results enabled determination of field-aligned and horizontal currents in auroras to be made.

Studies of auroral zone ionospheric electric fields, conductivities and currents were reported from the Chatanika Radar System, the Scandinavian Twin Auroral Radar Experiment (STARE), the Siberia-IMS-76 expedition, the Finnish All-sky Camera Chain, the Scandinavian Magnetometer Array, the IMS-Alaska Meridian Chain, and the TRIAD satellite magnetometers. An area of auroral research that received considerable attention was the relationship of electromagnetic and hydromagnetic waves to auroras.

Low-latitude work related to the IMS featured VHF doppler auroral radar measurements from Southern New Zealand, the morphology of the trough using measurements from the AE-C satellite and the distribution of magnetic pulsations from the pole to the equator.

The GEOS and ISEE spacecraft presented new measurements of electric fields in the magnetosphere on magnetic field lines connected with the auroral zones. Coupled experiments between the GEOS satellite and the Scandinavian Twin Auroral Radar Experiment related plasma drifts in the distant magnetosphere to those in the ionosphere. Long-period variations of magnetospheric drift often map fairly accurately along the geomagnetic field, whereas short period variations do not map very well. Balloon and rocket measurements of electric fields of magnetospheric origin measured under the auroral zone have been interpreted in terms of the development of anomalous resistance and longitudinal electric fields in tubes of force connected to the aurora. The MIT Millstone Hill Incoherent Backscatter Radar reported measurements of ionospheric drift in the invariant latitude range from 60 to 75° with a time resolution of 20 minutes.

Theory was presented on magnetospheric dynamo action, modelling of magnetospheric electric fields and on the process of formation of parallel electric fields in the magnetosphere and wave-particle interaction.

Surveys of the heavy ion distribution in the magnetosphere were given. These important new results should bring new insights into the local acceleration process within the magnetosphere, and the relative importance of the ionosphere and solar wind as sources of heavy ions.

Important new results were described regarding the thermal plasma at the sites of GEOS 1 and 2 satellites using the mutual impedance experiments. The ionospheric experiments on the MAG-IK (Intercosmos 18 satellite) produced new information on the dynamics of the ionospheric trough, ionospheric composition precipitated particles, and VLF and ELF emissions.

Multi-spacecraft observations were reported on such phenomena as the effects of sudden commencement on trapped particle populations and the variation of phase-space density of particles during a magnetic storm. Evidence was reported that electrostatic acceleration of charged particles may take place in the high latitude plasma mantle of the magnetosphere.

Results from the Japanese IMS dedicated satellite JIKIKEN (EXOS-B) demonstrated relationships between the VLF fields and energetic electron populations in the magnetosphere.

Experiments involving ground-based transmitters such as those at Siple Antarctic and OMEGA Network coupled with receivers on the ISEE 1 spacecraft, show that signals can propagate to the satellite through non-ducted paths, and new features of triggered ULF emissions emerged from these studies.

Auroral kilometric radiation was the subject of an extensive report from the JIKIKEN satellite group. The source region is in the height range 3000 to 6000 km above auroras and is thought to be associated with electrostatic double layers.

Though progress has been already achieved, much remains to be learnt about the

magnetosphere in the areas of the cusp and boundary layers especially about M.H.D. turbulence, eddy convection and non-linear plasma physics. The connection of the distant geomagnetic tail to the polar cap remains not understood as does the connection of current generating regions near the magnetopause to the ionosphere. More work needs to be done on the composition of the ring current and trigger mechanisms for substorms. The whole field of magnetosphere-ionosphere coupling and the deposition of energy into the neutral atmosphere, needs global study for its comprehension, not only from the point of view of physics but also from the point of view of application in radio communications.

The effectiveness of the International Magnetospheric Study has been most important in the recognition of the discipline of solar-terrestrial physics and of the clear necessity of a project-oriented interdisciplinary body such as SCOSTEP, which is required for the carrying out of international collaborative programs in solar-terrestrial physics. Academies, space agencies, universities and about 10,000 individual scientists contributed to the development and prosecution of programs of the IMS. A mile-stone in solar-terrestrial physics has been achieved by all their efforts. It is not an overstatement to say that solar-terrestrial physics is now recognised to be of fundamental importance to man in his attempts to understand and come to terms with his environment.

The IMS Symposium brought forth only a small amount of IMS material. IMS work on geomagnetic pulsations was reported separately at the IAGA meetings in Canberra in the week following the IMS Symposium. An enormous amount of work remains to be done with data collected during the IMS. This is a task for the Data Analysis Phase of IMS activities commencing in 1980 and going on for several years. We can expect many more new and exciting results.

The data analysis phase of the IMS will call for the same kind of dedication and commitment by academies, agencies, universities and individuals as did the experimental phase except, of course, that the emphasis will be on the analysis of data rather than experiments. Naturally many experiments will continue to run into the 1980's. It is clear that mechanisms for the interchange of data and information, and for the gathering together of scientists in workshops will be necessary during the data analysis phase. Agencies and universities are encouraged to provide the funding necessary in order to extract from the existing data the maximum amount of understanding about the magnetosphere.

It cannot be too strongly emphasised that progress in this area can only be made by intercomparison of simultaneous observations made on many different interacting phenomena and regions of space. The needs of magnetospheric scientists in terms of funding and interaction greatly differ from those of conventional laboratory physicists, who, by and large are in the happy position of being able to isolate the particular phenomenon they are interested in.

It is now clearly understood that magnetospheric processes contribute to perturbations of the minor constituents and the dynamics and electrodynamics of the earth's upper atmosphere, particularly in the stratosphere and mesosphere, and since these regions are now known to be an important component of man's environment, the magnetosphere, as a consequence, becomes also important as a component of our environment. Sooner or later the connections between the magnetosphere and the upper atmosphere have to be understood, and in order to do this the fundamental physics of the magnetosphere must be revealed. The data analysis phase of the IMS can be expected to reveal important new insights into magnetospheric physics.

Abstracts of the IMS Symposium and of the relevant IMS material presented at the IAGA meeting are available in IAGA Bulletins numbers 42 and 43 respectively and are available from IUGG Publications Office, 39 ter, Rue Gay-Lussac, 75005 Paris, France.

K. D. Cole, (President of SCOSTEP, and Chairman of the Organising Committee for the IMS Symposium)

#### Appendix 2.

# INFORMAL WORKSHOP ON NATURAL EM FIELDS AT AUDIO FREQUENCIES

An informal workshop was convened under the auspices of IAGA at the 1979 Assembly, Canberra (7.30–11 pm, 11 December) to explore the state of knowledge regarding variations in natural EM fields in the ELF and lower VLF. The question arose when specifying sensors for Audio MT equipment, and it became evident that the behaviour of amplitudes with latitude, season, and time of day is not well known. We wished to consider whether it would be useful to plan a cooperative program of synoptic measurements. The 50–60 participants heard presentations by *D. Hoover* (USGS), *D. Strangway* (Toronto), *G. Fischer* (Neuchâtel), *L. Holcomb* (Macquarie), *J. Clarke* (Berkeley), and *N. Kleimenova* (Inst. Phys. of the Earth, Moscow).

Hoover described his system, results, and difficulties. He finds that at times he is unable to measure usable signal between 300 Hz and 3 kHz, but that interference from power line fundamental and harmonic frequencies is a more severe problem in some regions. It was essential that his band selection filters be sufficiently narrow to reject these frequencies. Constant Q filters were unsatisfactory for higher harmonic rejection.

Strangway also uses a switchable narrow band scalar system, with which he has done more than a thousand sites. He also reported occasional problems with weak signal in the 1-3 kHz band. His approach is to rapidly acquire data at many locations with perhaps  $\pm 5\%$  accuracy, instead of  $\pm 1\%$  data at fewer sites. Thus the infrequent loss of data in this absorption band is not serious. With this approach he has carried out surveys at high latitudes in both winter and summer.

Fischer referred to a paper he and Schnegg were to give on the 14th. Their measurements in Switzerland suffer severe interference from the electric railways using  $16^{2/3}$  Hz and the mains at 50 Hz. Thus in addition to facing power line fundamental and harmonics, they must deal with a strong subharmonic. The approach they have developed is to notch filter enough of the highest amplitude harmonics that they can record digitally, without saturation, most of the time. Those record segments which include saturation are rejected. Remaining harmonics are filtered digitally, and then results from the majority are averaged together. Averaging continues until impedance-frequency plots are acceptably smooth.

Holcomb sketched the AMT system assembled at Macquarie, then went on to describe the low noise induction coil-preamplifier design. By choice of materials and design, a resonant frequency of 3 kHz and a Q in excess of 50 was obtained. This is loaded and drives a "cold resistance" preamplifier integral to the coil structure. The predicted noise level ( $\sim 10^{-6}$  nT/Hz<sup>1/2</sup>) in the absorption band is 30–40 db below the signal levels reported there by Bleil and by Clerc. At lower frequencies, preamplifier noise increases as f<sup>-1</sup>, and may be too great near 1 Hz. This can be overcome by using a chopper amplifier for the lower frequency band (0.1–100 Hz). By virtue of a large dynamic range and slewing rate, the system operates without saturating in suburban Sydney.

Clarke outlined the physical basis of Josephson junction Squids, including the difference between AC and DC designs, and between magnetometers and gradiometers. Noise is determined by junction capacitance and circuit inductance. Using precision photolithographic

equipment to reduce junction area, he is now able to produce DC Squids with noise levels of  $10^{-7}$ – $10^{-8}$  nT. Hz<sup>-1/2</sup> with a frequency response from DC to well above any frequency of geophysical interest. The latter is limited by the slewing rate of associated electronics rather than by the Squid itself. Clarke also showed the great improvement in MT apparent resistivity curves which results from using the "remote reference" technique pioneered in his laboratory in 1977–78.

Kleimenova's laboratory has for many years routinely monitored variations above 700 Hz as a tool for investigating magnetospheric processes. It appears to be the only such observatory, and is located well outside a small village which is several hundred km from the closest power transmission line. Because of their concern with processes outside the atmosphere, they record hiss, chorus, and whistlers, but reject atmospherics which are the dominant signal. She estimates that atmospherics are typically 20 db larger than the magnetospherics.

Due to the lateness of the hour (and the imminent closing of the bar) concluding discussions were held in the University Union. It appeared that the new Squids offered adequate sensitivity for AMT purposes, although they might not have sufficient dynamic range to deal with very large near-source atmospherics and power transients at the same time as the worldwide atmospherics background. Only minor improvements can be anticipated in portable induction coil systems. These apparently have low enough noise most of the time for most purposes. However, it is evident that the statistical parameters of field variations are not well known (except possibly for magnetospheric events).

From these considerations one can conclude that there is some benefit to be gained from synoptic monitoring using common equipment and procedures. This benefit might be considerably enhanced if the measurements are done in such a way as to assist ionospheric, radio propagation, or meteorological studies as well. Individual discussions have since been held on the topic, Macquarie will send a tentative design to interested parties for comment, and will build at least one channel during 1980. *Hoover* definitely plans to participate as well. Correspondence and suggestions are invited.

K. Vozoff (Exploration Geophysics Centre, Macquarie University, North Ryde, N.S.W. Australia)

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(Denmark)	(Spain)	(Spain)	(U.S.A.)	(U.S.A.)	(U.S.A.)	(Japan)	(Japan)
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J. Bartels	J. Kaplan	V. Laursen	M. Nicolet	T. Nagata	V. A. Troitskaya	J. G. Roederer	K. D. Cole
(FR Germany)	(U.S.A.)	(Denmark)	(Belgium)	(Japan)	(U.S.S.R.)	(U.S.A.)	(Australia)
1954–1957	1957–1960	1960–1963	1963–1967	1967–1971	1971–1975	1975–1979	1979–1983

#### Appendix 4.

# DATE, PLACE AND NUMBER OF PARTICIPANTS OF THE PAST IAGA ASSEMBLIES

			1	Papticipa	nts
Assembly	Date	Place	Coun- tries	Total	(from Home country)
Establishment Assembly	1919 7.18–28	Brussels, Belgium	5	13	(?)
Ist General Assembly	1922 5.4-9	Rome, Italy	12	33	(8)
IInd General Assembly	1924 10.1-10	Madrid, Spain	13	25	(5)
IIIrd General Assembly	1927 9.3-10	Prague, Czechoslovakia	18	39	(4)
IVth General Assembly	1930 8.15-23	Stockholm, Sweden	17	54	(10)
Vth General Assembly	1933 9.17-25	Lisbon, Portugal	14	32	(4)
VIth General Assembly	1936 9.17-24	Edinburgh, U.K.	17	65	(18)
VIIth General Assembly	1939 9.4-15	Washington, D. C., U.S.A.	16	156	(124)
VIIIth General Assembly	1948 8.19-28	Oslo, Norway	24	112	(10)
IXth General Assembly	1951 8.21-9.1	Brussels, Belgium	26	201	(10)
Xth General Assembly	1954 9.14-25	Rome, Italy	36	224	(18)
XIth General Assembly	1957 9.3-14	Toronto, Canada	27	270	(46)
XIIth General Assembly	1960 7.25-8.6	Helsinki, Finland	35	368	(16)
XIIIth General Assembly	1963 8.20-30	Berkeley, U.S.A.	41	350	(173)
XIVth General Assembly	1967 9.25-10.6	St. Gallen, Switzerland	31	294	(4)
Ist Gen. Scientific Ass.	1969 9.1-12	Madrid, Spain	42	475	(16)
XVth General Assembly	1971 8.2-14	Moscow, U.S.S.R.	33	629	(297)
IInd Gen. Scientific Ass.	1973 9.9-21	Kyoto, Japan	37	600	(265)
XVIth General Assembly	1975 8.25-9.6	Grenoble, France	53	684	(119)
IIIrd Gen. Scientific Ass.	1977 8.22-9.3	Seattle, U.S.A.	37	658	(353)
XVIIth General Assembly	1979 12.2-15	Canberra, Australia	37	373	(80)

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