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Contents

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SCIENTIFIC COMMITTEE ON ANTARCTIC RESEARCH

at the

Scott Polar Research Institute, Cambridge, England

SCAR Working Group on Glaciology
Meeting in Bremerhaven, 6, 10, and 11 September 1987

1. *Members present.* Pedro Skvarca, Argentina; Hugo Decleir, Belgium; Luis Arias, Chile; Heinz Kohnen, Federal Republic of Germany; Dominique Raynaud (for C. Lorius), France; Renji Naruse (for S. Mae), Japan; Olav Orheim, Norway; David Drewry, United Kingdom; Doug McAyeal, United States; Liz Morris, ICSI; Charles Swithinbank, additional member. Apologies for absence were received from the representatives of Australia, New Zealand and South Africa. *Official observer*: Jefferson Simoes, Brazil. *Observers*: Karl-Heinz Bassler, Federal Republic of Germany; Heinz Miller, Federal Republic of Germany; Stig Johnsson, Sweden; Robert Bindschadler, United States; Tony Gow, United States; Bob Thomas, United States.

2. *Chairman and agenda.* Olav Orheim was elected Chairman of the WG meeting, and the draft agenda submitted by the Chairman/Secretary (attached) was adopted.

3. *Reports of meetings since the last formal meeting.* The reports of the formal meeting In Reykjavik, August 1985 (published as extract in SCAR Bulletin No. 84, p.375, and in full in SCAR Report No. 1, p.1-4), and the informal meeting in Cambridge, September 1986, were adopted.

4. *FISAG.* Heinz Kohnen reported that 100 participants were attending FISAG, presenting about 75 papers. Attendance had probably suffered from overlap in themes with the IUGG Vancouver meeting last month and the Hobart meeting in February 1988. Coordination to minimize such overlap is important in the future, but the WG noted that these meetings were planned after FISAG, and that the increased activity was also a healthy sign.

5. *National Reports.*

a). *Presentation.* Written reports were submitted by the representatives of Argentina, Australia, Brazil, Federal Republic of Germany, France, Japan, New Zealand, Norway, United Kingdom and the United States. Reports from national representatives not present at the meeting have been requested by the Chairman/Secretary for distribution to the members.

b). *Frequency and format of national reports.* The question of whether national reports to the WG on Glaciology should be exchanged yearly, and whether these reports should have a uniform format, was discussed. The WG agreed that there was need for national reports every year, and recommended that national reports in glaciology should be produced by 15 September in those years that the WG does not meet. The reports will then be copied and distributed to all members. National reports will as before be submitted at the time of meeting in the years that the WG meets. The Chairman/Secretary, advised by members, will produce guidelines for the contents of these reports, which should concentrate on work in progress and future research. One further suggestion concerned the desirability of including information on educational programmes conducted by each nation's universities. The purpose of exchanging such information would be to foster greater interest in Antarctic glaciology among young people who are contemplating their career options.

6. *International programmes.*

a). *International Antarctic Glaciological Project (IAGP).* The last meeting of the IAGP council was held in San Diego in 1986. The future of IAGP is not clear.

b). *Glaciology of the Antarctic Peninsula (GAP).* GAP, which started in 1973, is still progressing at a steady pace, with some activities shifted to the Filchner-Ronne Ice Shelf. Pedro Skvarca reported that Argentina began a preliminary ice core programme at the South Patagonian Ice Field in 1986. The Head of the British Antarctic Survey's Ice and Climate Division maintains an up-to-date register of all GAP publications.

c). *Filchner-Ronne Ice Shelf Programme (FRISP).* Sea ice conditions prevented the FRG from carrying out their planned field work in 1986/87 season, and their next field season will be in 1989/90. The UK plan their next season of FRISP in 1988/89 at the earliest. Norsk Polarinstitutt renewed an offer to host a third FRISP meeting in Oslo when convenient.

d). *European Science Foundation (ESF) Polar Network.* In launching the Polar Network, the ESF hopes to make better use of the potential for making new advances in polar science and strengthen intra-European cooperation. In the initial two-year period Network Planning Groups are undertaking three major feasibility studies in the fields of (1) Glaciology, (2) Southern Ocean Ecology, and (3) the Geology of Polar North Atlantic Margins. The objective of the first study is to develop a co-ordinated European Glaciological Programme (EGP) in order to understand better the role of ice sheets and ice shelves in both recording and responding to climate on a variety of time-scales. The aims, which concern also the field of atmospheric chemistry, will be pursued primarily through the acquisition, analysis and interpretation of ice cores and related studies of ice dynamics and thermodynamics. Several candidate sites for near surface, intermediate and deep ice drilling and coring have been identified, both in Greenland

(connected with the Eurocore proposal submitted in 1986, independently of the ESF Polar Science network, to the Commission of the European Communities) and in Antarctica. The major options and their priorities are presently as follows:

a. Greenland deep driling: 3000 m (to bedrock); start of field operation - 1990, assuming that the Eurocore (shallow drilling - 300 m) proposal obtains EEC funding to start operations in 1989, in which case Eurocore would become a pilot operation for the deep drillhole, and costs would be less than for two independent exercises (owing to shared logistics).

b. Antarctica (Berkner Island) intermediate drilling: 900-1000 m; field operation to start in (austral summer) 1990/91.

c. Antarctica (continental) deep drilling: reconnaissance studies to start in 1991/92. Deep drilling should then follow (from 1993/94) as a longterm objective not to be included under the initial financial umbrella of the ESF Network.

e). Iceberg Observing Programme. Olav Orheim reported that this programme was still continuing with a high degree of participation by nearly all SCAR nations. He reported at FISAG on glaciological results from the 90,000 icebergs observed. Copies of the computer file (at the cost of copying) would be available at the end of this year for any contributor.

f). *Antarctic Sea Ice Zone (ASIZ).* There was no report available on the progress of ASIZ.

g). *Ice Core Climate Workshop, Bern, April 1987, and International Ice Core Forum (IICF).* The Bern workshop had been very successful, and ice core studies were now a firm part of global climate programmes. There seemed to be a need for a new workshop on ice drilling. Karl-Heinz Bassler and Paul Mayewski organized a meeting during FISAG to establish IICF formally.

h). *Siple Coast Project.* During the last four years (1983-87) the United States Antarctic Research Program has supported a major field effort to investigate ice strams A, B and C (including their snow catchment areas and extensions on the Ross Ice Shelf surrounding the Crary Ice Rise). Objectives of this project include:

(i) determination of the force balance of the ice streams,

(ii) measurement of current mass balance,

(iii) examination of ice stream interaction with the Crary Ice Rise, and

(iv) inquiry into the sub-glacial regime.

Five field camps were established along the length of ice streams B and C, and at the head of the Crary Ice Rise. Measurements included: aerial and surface radar profiling, passive and active seismic experiments, surface measurements of velocity and strain rate, and aerial photogrammetry (with ground control). Work to be conducted in 1987/88 includes:

(i) radar and seismic measurements in the low surface slope outlet of ice stream B,

(ii) drilling through the Crary Ice Rise to determine its temperature - depth profile (for dating the ice-rise formation), and

(iii) measurement of surface velocity, strain rate and snow accumulation rate in the catchment region of ice stream B. While this project is conducted primarily by U.S. investigators, its results are of great interest to the international community.

7. *Satellite remote sensing.* Bob Thomas presented an overview of available systems and data.

The major remote sensing techniques with polar applications are: high-resolution images from Landsat, SPOT and SAR; surface elevation from radar altimetry; parameters such as sea-ice concentrations and regions of melting on the ice sheets from passive microwave radiometers; medium resolution visible and infrared images from weather satellites; and estimates of biological productivity in the oceans from ocean-color-sensors. Landsat 5 and SPOT continue to acquire high resolution images, and there is increasing application of these data to ice sheet mapping and glaciological investigations. Cost of the data still limits the scale of these applications and we do not yet have total coverage of overflown parts of Antarctica. Also, there is a need to assess information content of SPOT images compared with Landsat. The US has not yet released funds for Landsat 6 and this will probably result in a hiatus in Landsat acquisition in the early 1990s.

Geosat continues to collect excellent data (to 72° Lat) over the ice sheets and these are being retracked at NASA/GSFC. Retracked data from Seasat over Greenland will soon be available from NSIDC (Boulder, Col.) and NASA intends that all over-ice Seasat and Geosat Data shall also become freely available. Comparison between Geosat and Seasat data is hindered by problems with ensuring that the orbits of the two missions are compatible. This stresses the need for accurate ephemerides of all altimeter missions.

Passive-microwave data are still being acquired from SMMR aboard NASA's Nimbus-7, and similar data are now being acquired by the SSM/I aboard the U.S.A.F.'s DMSP weather satellite which was launched in June, 1987. Similar

data will probably be acquired at least into the mid 1990s.

Estimates of Arctic sea ice cover for 1973-76 from ESMR measurements were recently published by NASA, and extension of both the Arctic and Antarctic ice estimate to the present, based on SMMR measurements, will be available from NSIDS within the next year. NASA will use the SSM/I data routinely to produce similar estimates which also will be available from NSIDC.

NSF has funded development of a data-processing and image-analysis system for data that will be acquired by a receiving station at McMurdo Station. Initially, real-time (1 km resolution) data from NOAA weather satellites will be obtained, potentially covering all of Antarctica. Later, it is planned to obtain similar data plus SSM/I data from the DMSP satellites. One processing system will be at McMurdo, primarily for operational use, and another will be at Scripps for the use of NSF-approved research investigators.

Data from NASA's CZCS (Coastal Zone Color Scanner) have shown a capability for investigating the periods of very intense high-latitude biological productivity associated with the marginal ice zone. CZCS failed last year, and there may not be another opportunity to obtain routine coverage at high latitudes until the early 1990s, possibly aboard Landsat 6.

The European ERS-1 will provide the earliest opportunity to obtain SAR images over Antarctica. Although there will be many stations acquiring Arctic SAR data, there is still delay in obtaining final approval for stations to receive Antarctic data. The proposed German, Japanese and Australian stations would cover all of the overflown parts of Antarctica and surrounding sea ice. It is important that these stations are available in time for the mission.

Perhaps the major issue in satellite remote sensing is the lack of adequate expertise to interpret and to apply the data. Currently, a small cadre of specialists analyse nearly all available data and very few 'conventional' researchers become involved in either the process of data interpretation or in applying parameters derived from the data to their research. It is imperative that this gap is bridged by conventional scientists and by encouragement of graduate students.

a). *SPOT.* The French SPOT satellite was launched last year, and the first SPOT images from Antarctica were presented at FISAG. These demonstrate that this satellite, which operates in visible bands only, will still be a very valuable addition for glaciological studies, because of its higher resolution and higher latitude coverage than Landsat.

b). *ERS-1 proposal.* An international proposal involving many of the WG members, under the leadership of Bob Thomas, had been submitted in November 1987. Evaluation of the many ERS-1 proposals was expected to be completed late this year.

c). *Satellite receiving stations.* Alfred-Wegener-Institute will apply for funding for a SAR receiving station to be set up at the northern end of the Antarctic Peninsula, in the vicinity of an existing station thus covering Bellingshausen Sea, Weddell Sea and Filchner-Ronne ice shelf areas. It will be a SAR receiving station only (no processing). The station will be operated by DFVLR. Given substantial German or European usage the chances for funding seem good, at the moment. There are also indications that Japan will establish a SAR receiving station at Syowa. Prospects are less good for a SAR receiving station in McMurdo.

d). *Landsat CCT's registration.* The informal WG meeting last year in Cambridge had initiated registration of all Landsat computer tapes of Antarctica acquired by the scientific community. The list was now nearly complete, and is expected to be available from Jane Ferrigno/Richie Williams next month and will then be distributed to members.

e). *SARSAT (Search and Rescue Satellites).* A report was given about SARSAT Personal Locater Beacons by R. Bindschadler. These lightweight beacons transmit a signal which is relayed by a joint US-USSR network of satellites to numerous receiving stations around the world. The beacons are intended to be used to indicate emergency situations. The alert information, which includes a calcualted beacon location accurate to 5 kilometers, is passed on to predetermined rescue centers. It is the responsibility of the rescue center to take appropriate search and rescue procedures. A written report, 'Antarctic Field Tests of SARSAT Personal Locater Beacons' (NASA Technical Memorandum 4008) was distributed to the attendees. it describes the results of tests using the beacons in the Antarctic environment. It concludes that these beacons are suitable for use in the Antarctic and recommends that NSF provide beacons for all American Antarctic field parties. It is expected that the cost of the beacons, in large quantities, will be in the range US$150–200. Copies of the report can be obtained from R. Bindschadler, Code 671 NASA/Goddard Space Flight Center, Greenbelt, MD 20771, USA. More information about SARSAT and the beacons can be obtained from Wayne Hembree, Code 430, NASA/Goddard Space Flight Center, Greenbelt, MD 20771, USA.

8. *Spearhead programmes in Antarctic Glaciology.* The WG held a meeting on 11 September 1987, led by David Drewry, of all interested scientists at FISAG, to discuss future spearhead programmes in Antarctic glaciology, that will contribute to global programmes such as the International Geosphere-Biosphere Programme (IGBP). The discussions

drew attention to the need for focused research, including the selection of representative locations. Three research areas were singled out, of which one, ice core studies, is already well in hand. Two other topics where Antarctic glaciology can contribute to global programmes were particularly noted:

1). *Detecting the climatic signal.* The strongest climatic signal is found in the polar regions, and the Antarctic Peninsula now seems to experience a marked warming. Glaciers are sensitive indicators of changing climate. Glaciology programmes, especially through use of satellites, should be established to detect te climatic signal, for example by monitoring changes in blue ice (ablation) area of glaciers. Such programmes could be relatively inexpensive to establish, but should provide very important and timely information. It is suggested that glaciologists within each SCAR nation initiate such programmes.

2). *The Antarctic ice sheet and changing sea level.* Changes in the mass of Antarctic ice will potentially make the largest contribution to changing sea level. A recent report ('Glaciers, Ice Sheets and Sea Level: Effect of a CO2-induced Climatic Change'; U.S. Dept of energy, Sept 1985, 330 pp.) concluded that a sea level rise between 0.5 and 1.5 m was most likely over the next 100 years. Of this rise the contribution from Antarctica is least certain, and at present we do not even know the sign of the mass balance of Antarctica with confidence. Research on this topic will involve not only glaciologists, but also scientists from other disciplines. Effects of increased ocean melting of the ice shelves, leading to increased ice flow, and effects of higher temperature on precipitation rates over Antarctica, are two of the interdisciplinary uncertainties tied to attempts at model building and prediction. It was considered that there was a strong need to develop a multidisciplinary programme to investigate the short- and long-term effects of changing climate on the Antarctic Ice Sheet and then on sea level. This could be a major contribution to IGBP, and the WG recommended that a group of specialists be established for this spearhead programme. To speed the establishment of such a programme a group consisting of Doug McAyeal, Liz Morris, Hans Oerlemans, and Bob Thomas will produce a document, based on the discussion in Bremerhaven, that will describe in more detail the suggested elements of the programme.

9. *Recommendations.* The WG reviewed past recommendations, and re-adopted and modified three of these to the following:

REC-1987-GLAC-1: The WG on Glaciology, noting the need for an accurate geoid map of Antarctica, so that heights above sea level can be deduced from satellite measurements both Transit and GPS, recommends that all nations make accurate gravity and satellite elevation measurements at points of known height above sea level, and extend such measurements around the continent wit the aim of establishing a net of stations, where satellite elevations and heights above sea level are known, at a spacing of no more than 500 km.

REC-1987-GLAC-2: There is a strong scientific need to complete the radio echo soundings on a 50- to 100-km square grid of the Antarctic Ice Sheet. Many nations are carrying out radio echo soundings in selected areas. The WG recommends that each SCAR nation indicate the areas they intend to cover with radio echo sounding during the next five years and that the WG continue to monitor the coverage.

REC-1987-GLAC-3: The WG recommends that the international glaciological community take full advantage of new research opportunities offered by the extensive coverage of polar ice sheets obtained by existing and planned satellites. These data include radar altimetry, and passive microwave, radar, and optical imagery. Further, it is recommended that National Committees of SCAR stress to their space agencies and other appropriate bodies, the need to give maximum support for the acquisition, reduction and dissemination of satellite altimeter data over ice sheets, and the development of other satellite techniques that will provide new information on Antarctic glaciological parameters. In particular, the WG stresses the immediate need to obtain landsat-5 and similar high resolution, optical images of all ice streams flowing from the Antarctic ice sheet to measure flow rates at these critical areas by comparison with earlier images.

The WG adopted the following two new recommendations:

The WG recommends the establishment of a Group of Specialists on 'Antarctica and sea level change', to include both glaciologists and scientists in the field of oceanography and meteorology, to initiate a multidisciplinary programme to investigate how changing climate will affect the Antarctic ice mass and sea level.

National Reports in Glaciology should be sent to the Chairman/Secretary by 15 September in those years that the Working Group does not meet.

10. *Report for SCAR.* The preliminary draft report of the meeting was approved by the members present.

11. *Election of Chairman/Secretary.* Olav Orheim Norway, was re-elected Chairman/Secretary of the Working Group.

12. *Time and place of next meeting.* The pace of Antarctic glaciology is high, and the group proposed that the next formal meeting should be in 1989 in Seattle, USA, in connection with the IGS Symposium on Ice and Climate. An alternative meeting venue would be at the 21st Meeting of SCAR in 1990. An informal meeting of the WG is planned for whichever Hobart meeting in 1988 (Dynamics of Ice Masses, in February or XX SCAR, in June), that has the largest attendance

of members.

13. *Next Antarctic Glaciology Symposium.* The group reviewed FISAG, and agreed that there was a strong need for a new glaciology Symposium in about 5 years' time. Close contact with related groups is needed to avoid collisions of meetings, and possibly the Symposium should concentrate on very specific themes of Antarctic Glaciology.

SCAR Working Group on Geology
Meeting at Cambridge, England 30 August 1987

1. . *Apologies.* G.E. Grikurov (USSR); J. Lameyre (France); J. Raina (India); T. van Autenboer (Belgium).

2. *Present*: Members: R. del Valle (Argentina); R.J. Tingey (Australia); C.O. Berbert (Brazil); F. Herve (Chile); Z. Li (china); J. Hofmann (Germany, D.R.); H. Miller (Germany, F.R.); B. Lombardo (Italy); Y. Toshida (Japan); P. Barrett (New Zealand); T. Gjelsvik (Norway); K. Birkemaijer (Poland); D.R. Hunter (South Africa); M.R.A. Thomson (UK); D.H. Elliot (USA). O. Gonzalez Ferran (IAVCEI)

Observers: C. Rinaldi (Argentina); B. McKelvery (Australia); D. Liu (China); G. Worner (Germany, F.R.); K. Shiraishi (Japan); J. Bradshaw (New Zealand); I. Dalziel, B. Molnia, P.N. Webb (USA).

3. *Minutes* of the June1986 meeting in San Diego were were confirmed (see SCAR Report No 2). .Matters arising:

(a) Geological maps. R.J. Tingey (Australia) reported on progress with a 1:10,000,000 scale compilation which had been displayed at the Cambridge Symposium and which will be published in 1988. It was agreed that compilation of a geological map of Antarctica at 1:5,000,000 scale could not be completed before the 1989 International Geological Congress as had been suggested at San Diego. D.H. Elliot (USA) noted that there was little enthusiasm for the recompilation of the American Geographical Society Folio of 1:1,000,000 scale geological maps of Antarctica and the WG agreed not to proceed with this project.

After discussion the WG reaffirmed that geological map coverage of Antarctic outcrop areas at 1:250,000 scale was a desirable long term objective. It observed that total coverage of other continents at this scale was far from complete. Members of the WG agreed to submit lists of Antarctic geological maps (published; in preparation; planned) to the Secretary so that a comprehensive inventory can be prepared.

(b) International Geosphere/Biosphere Program IGBP. No news of this was available.

(c) SCAR Review of Antarctic Science - To be published shortly by Oxford University Press.

(d) Annual National Reports to SCAR - Shortcomings in the format were noted but no alternatives were proposed.

4. *Fifth Antarctic Earth Sciences Symposium, Cambridge 1987.* Dr M.R.A. Thomson undertook to prepare a written report for the WG and outlined his plans for publishing the Symposium Proceedings. Members were asked to send appropriate comments to the WG Secretary before the end of October 1987. Dr Thomson's achievement in organising a highly successful Cambridge symposium was acknowledged by acclamation.

5. *Sixth Antarctic Earth Sciences Symposium.* Professor Yoshida (Japan) described and distributed to the WG an outline plan for the next symposium. He noted a possible clash with the International Geological Congress. The proposal was briefly discussed, accepted in principle, and referred to the Joint Meeting with WG SEG. WG members expressed a general preference for a meeting in 1991.

6. *National geological summaries.* Members spoke briefly about their national summaries. In the following list (1) means a written report was provided, (2) means that it was distributed at the meeting, and NR means not represented. Argentina (1) (2), Australia (1) (2), Brazil (1) (2), Chile (1), China (1) (2), France NR, Germany - Democratic Republic (1) (2), Germany - Federal Republic (1) (2), India NR, Italy (2), Japan (1) (2), New Zealand (1) (2), (NZ Antarctic Record), Norway (1) (2), Poland (1) (2), South Africa (1) (2), UK (1) (2) (BAS Annual Report), USSR NR, USA oral report.

7. *Operation of the WG.* The Secretary emphasised that the WG could only operate effectively if all members contributed both by correspondence and attendance at meetings. Dissatisfaction with the current form of the Annual national report to SCAR was expressed but no alternatives were suggested. The current format of the SCAR report was regarded as not particularly communicative. The national Geological summaries reports presented at WG meetings and circulated to EWG Members at other times were thought to be useful in raising members' awareness of trends and activities in national programs of Antarctic geological research.

8. *International Space Year (ISY).* The WG thought that ISY would be of little relevance to Antarctic geological research and decided to take no action on it.

9. *1989 International Geological Congress—Antarctic field excursion.* The WG noted with regret that SCAR Executive had declined to associate SCAR with the excursion as had been requested. It decided (1) that the WG should respond to the SCAR Executive Secretary's letter; and (2) that the WG should formally sponsor (but not contribute funds to) the Excursion as a means to improving links between the Antarctic and world-wide earth science communities.

10. *Antarctic Treaty activities.* The WG was further advised about the progress of the Antarctic Minerals Regime negotiations. The issues of (1) confidentiality of data; and (2) desirability and safety of scientific drilling were identified as of special significance to WG. It was noted that scientific drilling in Antarctica was subject to stringent safeguards and that it followed that such drilling should not be subject to any form of blanket prohibition.

11. *Groups of Specialists.* Drs I. W. D. Dalziel and P .N. Webb briefly reported on the work of Groups of Specialists on the Structure and Evolution of the Antarctic Lithosphere (SEAL) and Southern High Latitude Cainozoic Palaeoenvironments respectively. Fuller reports were presented to the joint meeting with the WG on Solid Earth Geophysics. Dr Dalziel noted that his group focussed on the integrity of the Antarctic continent and plate, reiterated that geological relationships between East and West Antarctica were a continuing puzzle that required further study, and observed that palaeotectonics was probably a major control on Antarctic Palaeoenvironments. Dr Webb reported tht his goup was giving particular attention to stratigraphic drilling as a means of studying Cainozoic Palaeoenvironments.

12. *Future scientific meetings.*

Evolution of the Antarctica Biota – England, May 1988.

Gondwana Symposium – Brazil, July 1988.

XX SCAR – Australia, September 1988 (to include Workshop sessions on the activities of the Groups of Specialists, and, possibly, Antarctic Meteorites).

International Geological Congress, USA, July 1989.

13. *Election of officers.* R.J. Tingey (Australia) resigned but was re-elected Secretary until the meeting in Hobart in September 1988. He will definitely cease to be Secretary then. P. J. Barrett (New Zealand) will remain as Chairman.

14. *Next meeting.* The WG will meet formally in conjunction with XX SCAR informally at the 7th Gondwana Symposium in Sao Paulo in July 1988.

SCAR WORKING GROUPS ON GEOLOGY AND SOLID EARTH GEOPHYSICS

JOINT MEETING 31ST AUGUST 1987 DEPARTMENT OF EARTH SCIENCES, UNIVERSITY OF CAMBRIDGE

1. PRESENT: Members: R. del Valle (G), C. Rinaldi (SEG), (Argentina); R.J. Tingey (G), P.G. Quilty (SEG), (Australia); C.O. Berbert (G), (Brazil); F. Hervé (G), J.C. Parra (SEG), (Chile); D. Liu (G) Z. Li (SEG), (China); J. Hofmann (G), (Germany, DR); H. Miller (G), F. Thyssen (SEG); B. Lombardo (G), M. Manzoni (SEG) Italy, ; Y. Yoshida (G) (Japan), , K. Kaminuma (SEG), (Japan); P. Barrett (G); F.J. Davey (SEG), (New Zealand); T. Gjelsvik (G), (Norway); K. Birkenmajer (G); A. Guteruch (SEG) (Poland); D. Hunter (G), (South Africa); M. Thomson (G); P.F. Barker (SEG), (UK); D.H. Elliot (G); D. Blankenship (SEG) (USA); O. Gonzalez-Ferran IAVCEI.

   Observers: M. Asami, Y. Hiroi, K. Shiraishi (Japan); T. Stern (New Zealand); J. Behrendt, A. Cooper, I. Dalziel, B. Molnia, P.N. Webb (USA).

   (G) W.G. Geology (SEG) W.G. Solid Earth Geophysics.

2. APOLOGIES G. Grikurov (USSR), M. Keller (Argentina), J. Lameyre (France), T. van Autenboer (Belgium).

3. MINUTES OF THE MEETING IN SAN DIEGO, USA, JUNE 1986. The account published in SCAR Report No. 2 was approved.

4. MATTERS ARISING FROM THE ABOVE MINUTES. These were considered under seperate agenda items.

5. SCAR GROUP OF SPECIALISTS ON THE STRUCTURE AND EVOLUTION OF THE ANTARCTIC LITHOSPHERE. The Convenor, Prof. I.W.D. Dalziel, reviewed the Group's terms of reference and reported on its first meetings, held in Cambridge on 23 and 29 August 1987 during the 5th International Symposium on Antarctic Earth Science. Prof. Dalziel identified two themes in the Group's activities, (a) the integrity of the Antarctic continent; and (b) tectonic control on Antarctic Palaeoenvironments. Regarding the Group's input into the Global Geoscience Transects Program of the International Commission for the Lithosphere, Prof. Dalziel reported that 20 Antarctic Transects were possible and suggested that Workshops be held in 1988 to construct the transects (for example, Marie Byrd Land - Wilkes Land - East Antarctic Transects could be discussed at sessions in conjunction with XX SCAR, Hobart, September 1988). The aim is for a selection of transects to be displayed at the 1989 International Geological Congress, and published by 1991.

6. SCAR GROUP OF SPECIALISTS ON CENOZOIC PALAEOENVIRONMENTS OF THE SOUTHERN HIGH LATITUDES.
   Prof. P.N. Webb, Convenor, commented that Cainozoic studies were a relatively new aspect of Antarctic Earth Science, and stressed the need to compile information and set research

goals. He noted the importance of integrating Antarctic studies, with other research such as glaciology, Arctic studies, palaeoceanography and the Ocean Drilling Program, and identified chronology as a research priority because Cainozoic time is poorly recorded and calibrated in Antarctica. He indicated that his Group would produce a folio of Cainozoic sedimentary basins and a time chart and, in the field, would promote drilling. Prof. Webb foreshadowed 1988 Workshop meetings in London (May) and Hobart (September). P.F. Barker commented that ODP drilling proposals were invited but were needed before a planning meeting on 8 - 9 October 1987. Prof. Webb suggested that a bibliography of Antarctic Sedimentary basins be established, preferably at the Scott Polar Research Institute, and easily accessible.

7. 5TH INTERNATIONAL SYMPOSIUM ON ANTARCTIC EARTH SCIENCE, CAMBRIDGE, AUGUST 1987. Dr M.R.A. Thomson, Chairman of the UK organising committee delivered a spoken report in which he emphasised the success of the poster session, and the importance of subsidiary discussion meetings, and outlined the publication schedule for the proceedings.
Dr Thomson's report was accepted with acclamation. [A written report by Dr Thomson is now [Nov 1987] available]

8. 6TH INTERNATIONAL SYMPOSIUM ON ANTARCTIC EARTH SCIENCE
The Joint Meeting considered (as had the preceding separate Working Group meetings) the proposal received from Japan and introduced by Prof. Yoshida. Professor Yoshida was thanked for his proposal. The meeting agreed that a 1991 meeting was preferable in view of the pace of Antarctic earth science research and to avoid a clash with the 29th IGC. It was agreed that the 6th symposium would resemble the 1987 Cambridge meeting in format and style, and that symposium topics will likely reflect Japanese research interests. Preference was expressed for a September meeting and for a venue other than Tokyo but it was recognised that these decisions had to be made by the Japanese organising committee.

   The question of thematic meetings between the major symposia was also considered and the Working Groups resolved to urge SCAR to give financial support to such meetings.

9. MAPS. Map series, projections, and scales were discussed and potential for confusion was recognised in the fact that different projections were used for onshore and offshore maps. Satellite imagery was also discussed briefly and it was resolved that a meeting with the Working Group on Geodesy and Cartography should be arranged for XX SCAR in Hobart.

10. CONSERVATION AND ENVIRONMENT. The meeting expressed its concern about the low level of Earth Science input into conservation and environment activities in the SCAR arena; it was felt that this was potentially detrimental to freedom of earth science investigations. SCAR Executive's proposal to form a Group of Specialists on Antarctic Environmental Affairs and Conservation (SCAR Bulletin 87, p. 744 item 3.6) was

welcomed and it was resolved to offer the services of the Antarctic Earth Science Community, and to propose that the proposed Group has at least one earth scientist member.

11. XX SCAR, HOBART, Australia - 2-16 September 1988. Dr Quilty described arrangements. The week 5-9 September would be devoted to Working Group meeting plus Workshops on the Antarctic Lithosphere, and Cainozoic Palaeoenvironments. The week of 12-16 September would be devoted to meetings of SCAR delegates; these would not involve most W G members. The joint Working Groups expressed the hope that 2 one-day field trips could be organised for earth scientists.
[The first circular for XX SCAR is available from Dr Quilty, Antarctic Division, Kingston, Tas. 7150, Australia]

12. ANTARCTIC GEOCHRONOLOGY. Professor Miller (FRG) addressed the meeting about this topic. The following motion was, as a result, adopted: "The Joint Working Groups observe that a symposium to focus on Antarctic geochronology is urgently required invite Prof. H. Miller (FRG) to organise this symposium and request active support from SCAR for it." Prof. Miller indicated that he had in mind a meeting in Munich in the 1989 northern spring and that themes would include isotope geochronology, biostratigraphy and Quaternary geology. Mailing list suggestions should be sent to Prof. Miller by the end of 1987.

13. JOINT RECOMMENDATIONS (Refer to SCAR Report No. 2)
The Joint Working Groups amended the Recommendations adopted at XIX SCAR in San Diego in June 1986 to read as follows:

Recommendation GEOL SEG-1987-1

RECALLING that Article III Section 1c of the Antarctic Treaty stipulates that scientific observations and results from Antarctica shall be exchanged and made freely available;
ANTICIPATING that future activities under an Antarctic Mineral regime will, if they occur, generate a large body of geological and geophysical data from Antarctica and its continental margins;
RECOGNISING that these data would constitute an important component of information about the tectonic and palaeoenvironmental evolution of the Antarctic region;
and FURTHER RECOGNISING that the timely release of such data will help minimise the risks to the Antarctic environment that are associated with minerals activities;
the SCAR Working Groups on Geology and Solid Earth Geophysics RECOMMEND that scientific data from activities conducted in conformity with provisions of the Antarctic Minerals Regime be made available on request to the Antarctic and wider scientific communities as soon as possible at the cost of reproduction. A maximum time limit of three years from the date of acquisition is recommended for the confidentiality of this data.

Recommendation GEOL/SEG 1987-2 SATELLITE DATA.

The Working Group
RECOGNIZING the international character of the Antarctic
NOTING Antarctic Treaty provisions for free exchange of scientific information,
RECOMMEND the unrestricted release of all satellite data collected south of 60°S to interested scientists at the cost of reproducing the data tapes and film products.

Recommendation GEOL SEG-1987-3 SCIENTIFIC DRILLING

Recognising the likely gains to our knowledge of the palaeoenvironmental history and tectonic evolution of Antarctica from scientific drilling, the Working Groups on Geology and Solid Earth Geophysics:
(1) strongly support scientific drilling already planned by the Ocean Drilling Program in the Southern Ocean;
(2) strongly endorse further scientific drilling in high southern latitudes.
The Working Groups also recognise that drilling carries with it environmental risks and therefore RECOMMEND that National Programmes ensure for scientific drilling which they propose in the Antarctic region :-
(1) that site selection is based on scientific data that is adequate for the avoidance of hydrocarbon accumulations
(2) that drilling resources and procedures are sufficient to ensure environmental and industrial safety.

14. NOTES ON RECOMMENDATIONS
GEOL/SEG 1987-2 The Working Groups recommended closer liaison with Working Groups on Geodesy and Cartography, and Glaciology in these matters. Dr Elliot (USA) encouraged delegates to take note of copyright, compile a data base of pre-commercialisation satellite information (one has recently [Nov 1987] been issued by the Glaciology W.G. - Dr Richard Williams, USGS, Reston, Virginia, USA) consider future satellites, orbits, instruments,and copyright, and to use digital tapes as well as photographic products. Dr Elliot is to circulate members with regard to the copyright question and Working Groups are to write letters to satellite data distribution agencies requesting that for future satellites copyright restrictions be waived for Antarctic scientists.

Dr B Molnia (Observer USA) noted that LANDSAT MSS coverage of Antarctica was almost complete (note above about Glaciology W.G. data base) and that complete Thematic Mapper coverage could be achieved in about 700 scenes. He encouraged the Antarctic Science Community to order at least film or paper products of particular scenes to ensure that the required digital data was acquired and stored for future use. Dr Molnia is to provide members with a summary of his comments.

GEOL/SEG 1987-3 Details of proposed Antarctic drilling programs should be sent to Dr Barrett (New Zealand).

15. **NEXT MEETING**
The Joint Working Groups will meet in Hobart in conjunction with XX SCAR in September 1988.

SCAR WORKING GROUP ON SOLID EARTH GEOPHYSICS

MEETING AT CAMBRIDGE, ENGLAND, 30 AUGUST 1987

Present: Members: P. Quilty, Australia (alternate); J.C. Parra, Chile, F. Thyssen, FRG; K. Kaminuma, Japan (alternate); F.J. Davey, New Zealand - Secretary; Y. Kristoffersen, Norway; A. Guterch, Poland; P.F. Barker, U.K.; D. Blankenship, USA (alternate).

Observers: J. Behrendt, USA; A. Cooper, USA; O. Gonzales-Ferran, IAVCEI; M Manzoni, Italy.

1. Apologies for absence: M Keller, Argentina

2. Agenda

The draft agenda was accepted with the additional items of XX SCAR (Quilty) and Drilling (Davey).

3. Minutes

The minutes of the 19 June 1986 meeting were accepted.

4. Matters arising

Barker (UK) reviewed recent developments in the Ocean Drilling Program (ODP) in high southern latitudes, in particular legs 113 and 114 in the Weddell Sea in Atlantic sector. He noted that pressure from international organisations would have little effect on the drilling program selection process as the prospective drill sites are extensively peer reviewed by ODP.

Quilty (Australia) briefly outlined the progress of the SCAR Review of Antarctic Science noting that the final revised version should be published in hardcover form by Oxford University Press in the next few months.

5. National Reports

Verbal reports of national geophysical programs were given by the delegates present. Written reports were received from Argentina, Brazil, Japan and Norway. The remainder were requested to be with the Secretary

SEGWG by 30 September for circulation. The Secretary expressed dissatisfaction with the lack or lateness of the submission of these national reports from Working Group members and the lack of detail in the contents, which are often only as extensive as reports by National Committees to SCAR. The consensus was that the reporting system was valuable and that it should continue in its present format with detailed summaries of work carried out and including outlines of possible future projects, especially those where international cooperation may be desirable. The Secretary agreed to provide guidelines for contents of reports to be circulated to WG members.

6. Geophysical Maps

Thyssen (FRG) noted the problem of map projections for Antarctic earth science maps, in particular the use of the polar sterographic projection offshore and the Lambert conformal projection onshore. This would be a trivial problem if all data were in digital form. Unfortunately this is frequently not the case, in particular with regards to geological information. Further discussion was deferred to the joint meeting with the Geology WG.

7. Seismology

A broad discussion of seismograph coverage of Antarctica indicated that further information was required. The Secretary SEGWG is to review the current situation and report at the next meeting. It was noted that although there are many short period instruments in the Antarctic Peninsula region, there have been no long period instruments in this region since the Chilean station was destroyed. However it was noted that a broadband seismograph is planned for Northern Antarctic Peninsula under the French GEOSCOPE program.

The proliferation of local networks in the Northern Antarctic Peninsula region has resulted in the need for coordination in operation of these local networks, especially regarding data standards and data exchange. Recommendation SEG-1987-1 (part) resulted from this discussion.

8. Crustal Transects

Discussion on this item was postponed until the joint meeting with Geology WG and the report of the Groups of Specialists.

9. Data Exchange and Availability

The Secretary outlined the conflict between the Antarctic Treaty concept of free exchange of scientific data and some current practices of non-release or trading of data, in particular with regard to digital multichannel seismic reflection data and in view of our joint recommendation GEOL-SEG-1986-1 regarding the early release of information which may be recorded by industry under the Antarctic Minerals Regime. Concern was

expressed that releasing data before publication would enable better funded/equipped institutions to process and publish information before the institution that recorded the data could do so. Acceptance of the practice of trading of data, limits this option only to nations recording the same type of data and would exclude other interested nations. Some delegates saw trading as a viable option in the initial period prior to publication and suggested a time limit could be placed on this initial period. It was also considered that this should not preclude other institutions seeing but not retaining copies of the data. Possible time limits before publication and mandatory release of data were discussed. Recommendation SEG-1987-4 resulted.

10. Drilling

The Secretary outlined the concern for adequate safety procedures for drilling in Antarctica. This concern had originated from US sources and forms the basis of an item for discussion at the next ATCM. Guidelines and procedures similar to those adopted by the Ocean Drilling Program (ODP) were proposed. The Secretary considered these concerns were covered by good planning and conforming to standard safe drilling practice. The importance of good site surveys was stressed especially in view of the cost of drilling but the use of the ODP safety panel for reviewing all proposals was considered inappropriate and probably unworkable.

11. Meetings

Future International Symposia on Antarctic Earth Science. It was noted that Japan have proposed to hold the 6th International Antarctic Earth Science Symposium in Japan in 1992 and that International Geological Congress will also be held in Tokyo in the same year. Further discussion was deferred to the joint meeting with the Geology WG.

XX SCAR will be held in Hobart in 1988 and SEGWG will hold a formal meeting in association with XX SCAR. Quilty (Australia) as organiser outlined the arrangements and requested information on requirements for meetings of the WG and appropriate associated workshops to be held at the time.

12. Antarctic Mineral Resources Convention Meetings

The Secretary outlined the current status of the negotiations noting the lack of progress in early mandatory release of data as recommended by the SCAR earth science working groups. He also noted the intent to complete the negotiations in early 1988.

13. Satellite Information

The availability and proprietary nature of satellite information was discussed, in particular whether these data should be freely available under the Antarctic Treaty. An altitude limit to the Antarctic Treaty areas, whether if satellite data were marketed for mineral resource investigations they should be made freely available and other aspects

were discussed but it was considered unrealistic to pursue these ideas further. Molnia (US) noted that many images were needed to cover Antarctica and these were only being recorded by Landsat if requested. As digital tapes were expensive but photographic prints from them were not, he proposed requesting photographic scenes for all Antarctica to ensure the digital data were recorded and archived. Further discussion was postponed until the joint meeting with Geology WG.

14. XIV ATCM

The agenda items of interest to the WG were outlined by the Secretary.

15. Environmental and Conservation Matters

The Secretary outlined his concern that there has been little or no earth science input into discussions on the Antarctic environment and its appropriate conservation. In discussion it was noted that in SCAR, environmental and conservation comment has been by a subcommittee of the Biology WG. This could lead to a lack of conservation of features of geological importance (SPA can only be set up for ecological purposes) and also to an unrealistic limitation on earth science activities based on perceived, unqualified, concerns.

16. Review of Recommendations

The recommendations were reviewed and the revised recommendations follow. Recommendation SEG-1986-2 was deleted as no comment has been made supporting or otherwise this recommendation for many years.

SEG-1987-1 (modified from SEG-1986-1): Recognising the increasing activities in global seismic monitoring, the Working Group encourages the establishment of broadband seismographs on the Antarctic continent. In an effort to better address regional earth science problems, the Working Group encourages the cooperation and exchange of data from local seismograph networks.

SEG-1987-2 (unchanged from SEG-1986-3): The Working Group, noting the need for an accurate geoid map of Antarctica so that heights above sea can be deduced from geodetic satellite measurements, recommends that all nations: (1) determine mean sea level at their coastal stations; (2) make accurate (about ± 1m) geodetic satellite elevation measurements at points of known height above sea level; and (3) extend such measurements around the continent with an aim of establishing a net of stations, where both geodetic satellite elevations and heights above sea level are known, at a spacing of no more than 500 km.

SEG-1987-3 (unchanged from SEG-1986-4): The Working Group recommends that all marine geologists and geophysicists lodge their sample, station, and traverse locations with the World Data Center within one year using the International Geological/Geophysical Cruise Inventory (IGGCI), to assist others in planning forthcoming data collection cruises.

SEG-1987-4 (modified from SEG-1986-5): The Working Group recognises that digital multichannel seismic reflection profiling is essential to the study of the geological structure of Antarctica and its margin and urges the expansion of this activity, particularly on land. These and other geophysical data should be made readily available in a usable format at the cost of reproduction as soon as possible. Bearing in mind the time required for data processing, a reasonable period for data release would be within four years.

SEG-1987-5 (unchanged from SEG-1986-6): The Working Group recommends that the tracks and types of measurements of all airborne geophysical surveys are lodged with the World Data Center.

SEG-1987-6 (unchanged from SEG-1986-7): The Working Group recognises the great importance of NASA's Geopotential Research Mission (GRM) for studying the Antarctic lithosphere and gravity and magnetic fields, notes that for the current generation of geoscientists, the GRM satellite data may well represent the most comprehensive and consistent gravity and magnetic coverage that can be made available for Antarctica and adjacent marine regions, and recommends that NASA continues its efforts to implement the GRM satellite program as soon as possible and makes available to the scientific community the results of this mission in a timely fashion.

17. Elections

F. Davey was re-elected Secretary of the Working Group (moved Quilty, seconded Kristoffersen).

18. The meeting expressed its great appreciation to M. Thomson and his committee for the very well organised 5th International Symposium on Antarctic Earth Sciences.

THREE RECENT PUBLICATIONS

Waste disposal in the Antarctic

Antarctic Treaty Consultative meeting Recommendation XIII-4 invited SCAR to provide advice on the question of waste disposal in the Antarctic. To prepare this advice SCAR established a group of experts which consulted extensively with National Antarctic research programme operators seeking information on present practices and types and quantities of wastes produced. The compilation of this information, together with recommendations for improving waste disposal procedures constitutes SCAR's response to the Treaty Consultative Parties' request and has been published by the Australian Antarctic Division on behalf of SCAR.

WASTE DISPOSAL IN THE ANTARCTIC. SCAR, 1989. Hobart, Australian Antarctic Division for SCAR, illustrated. ISBN 0-642-14498-2. US$15.00 or £9.00. Orders, with remittances, to SCAR, the Distribution Centre, Blackhorse Road, Letchworth, Herts. SG6 1HN, UK. Price includes unsealed airmail postage.

The role of Antarctica in global change

The International Council of Scientific Unions is launching, in the 1990s, a major world-wide international collaborative study of the interactive physical, chemical and biological processes that regulate the total Earth system and the changes that are occurring in the system. The programme is to be known as 'The International Geosphere Biosphere Programme (IGBP): A study of Global Change'. The primary goal of the programme is, through an improved understanding of the Earth system, to advance the capability to predict changes on time scales of decades to centuries.

The polar regions are important for these studies. Major interaction between the atmosphere, ice, ocean and biota affect the entire global systems through feedbacks, bio-geochemical cycles, deep ocean circulation and changes in ice mass-balance. The effects of global climate change are predicted to be more pronounced in the polar regions than at mid latitudes and therefore will be better observed and monitored. Also, the Antarctic is a rich repository of palaeo-environmental information in its ice sheet and ocean and lake sediments.

As a contribution to the Programme planning, ICSU Press published, on behalf of SCAR, a review of those aspects of Antarctic scientific research that can make significant contributions to the 'Core Global Change' projects identified by the global programme planners. Over the coming years these proposals will have to be developed into an implementation plan, as the national Antarctic science programmes enter commitments to undertake the required research. (A comparable review of possible Arctic contributions to IGBP has been published under the title 'Arctic Interactions' by University Corporation for Atmospheric Research, Boulder, Colorado)

THE ROLE OF ANTARCTICA IN GLOBAL CHANGE. SCAR, 1989. Cambridge, ICSU Press, on behalf of SCAR, illustrated. ISBN 0-930-35718-3. US$10.00 or £6.00. Orders, with remittances, to SCAR, the Distribution Centre, Blackhorse Road, Letchworth, Herts. SG6 1HN, UK. Price includes unsealed airmail postage.

Antarctic krill

'Biology and Ecology of the Antarctic Krill (*Euphausia superba* Dana): a Review' has been produced largely in response to a request from the Commission for the Conservation of Antarctic Marine Living Resources. It follows an earlier publication in this series (Volume 6) reviewing the biology and status of exploited Antarctic fish stocks.

Reviewing the status of Antarctic krill, this book draws heavily on the historical data collected by J.W.S. Marr during his pioneering work on RRS *Discovery*, and succinctly summarizes recent information, gathered as a result of the International BIOMASS programme, on the biology, distribution, abundance, productivity and behaviour of one of the most important and enigmatic marine organisms. Attention is focused on topics which are either directly or indirectly applicable to the effective management of krill exploitation within the provisions set out by Article II of the Convention for the Conservation of Antarctic Marine Living Resources.

BIOLOGY AND ECOLOGY OF ANTARCTIC KRILL (*Euphausia superba* Dana): A REVIEW. D.G.M. Miller and I. Hampton , 1988. Cambridge, SCAR and SCOR (BIOMASS Scientific Series 9). ix + 166pp, illustrated. ISBN 0-948277-09-2. US$25.00 or £14.00. Orders, with remittances, to SCAR, the Distribution Centre, Blackhorse Road, Letchworth, Herts. SG6 1HN, UK. Price includes unsealed airmail postage.

SCAR Report

SCAR Report is an irregular series of publications, started in 1986 to complement SCAR Bulletin. Its purpose is to provide SCAR National Committees and others directly involved in the work of SCAR with the full texts of reports of SCAR Working Group and Group of Specialists meetings, which had become too extensive to be published in the *Bulletin*, and with more comprehensive material from Antarctic Treaty meetings.

SCAR Bulletin

SCAR Bulletin, a quarterly publication of the Scientific Committee on Antarctic Research, is published on behalf of SCAR by Polar Publications, at the Scott Polar Research Institute, Cambridge. It carries reports of SCAR meetings, short summaries of SCAR Working Group and Group of Specialists meetings, notes, reviews, and articles and material from Antarctic Treaty Consultative meetings, considered to be of interest to a wide readership. Selections are reprinted as part of *Polar Record*, the journal of SPRI, and a Spanish translation is published by Instituto Antártico Argentino, Buenos Aires, Argentina.

Polar Record

Polar Record appears in January, April, July and October each year. The Editor welcomes articles, notes and reviews of contemporary or historic interest covering the sciences and humanities in polar and subpolar regions. Recent topics have included polar aspects of agriculture, archaeology, biogeography, botany, ecology, geography, geology, glaciology, international law, medicine, politics, human physiology, psychology, pollution chemistry and zoology.

Articles usually appear within a year of receipt, short notes within six months. For details contact the Editor of *Polar Record*, Scott Polar Research Institute, Lensfiled Road, Cambridge CB2 1ER, UK: Tel (0223) 336567.

The journal may also be used to advertise new books, forthcoming events of polar interest, etc.

Polar Record is obtainable through the publishers, Cambridge University Press, Edinburgh Building, Shaftesbury Road, Cambridge CB2 2RU, or from booksellers. Subscription rates are: for individuals £25.00, for institutions £35.00; single copies cost £10.00.

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