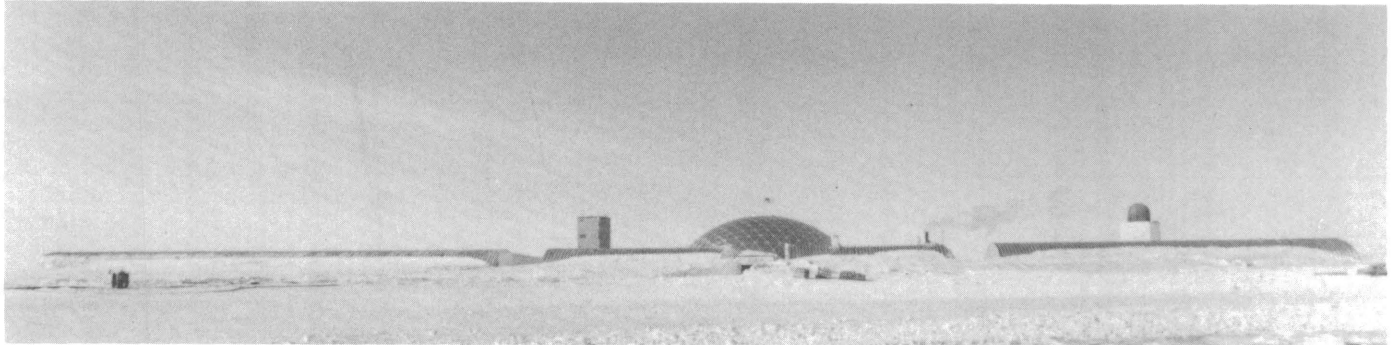


antarctic Journal OF THE UNITED STATES

March 1984

National Science Foundation

Volume XIX—Number 1



U.S. Navy photo (XAM 90118-11-78) by Dana B. Babin.

Amundsen-Scott South Pole Station (1978). Ice coring is an important component of U.S. research at the geographic south pole. From these ice cores, glaciologists are able to reconstruct climatic conditions and the composition of the atmosphere over the last several thousand years. In this issue of the *Antarctic Journal*, two articles (beginning on pages 10 and 16) relate to glaciological studies of ice cores.

Eight recommendations approved at Twelfth Consultative Meeting

From 13 to 17 September 1983, representatives of 27 nations—all but one of the Antarctic Treaty contracting parties—met in Canberra, Australia, for the Twelfth Antarctic Treaty Consultative Meeting. These representatives devoted their attention to improved cooperation in science and logistics and to the operation and evolution of the Treaty system. Eight recommendations were developed and approved during the 2-week sessions, the Canberra session did not include resource questions; they are handled separately. Negotiation of a regime for antarctic mineral resources is taking place in a separate Special Consultative Meeting, and a separate mechanism for managing fisheries—the Convention on the Conservation of Antarctic Marine Living Resources—entered into force in 1982.

Attendance at the meeting demonstrated growing international interest in Antarc-

tica. Two new consultative parties to the Treaty—Brazil and India—participated in the meeting, raising the number of consultative parties to 16. The other 14 consultative parties are Argentina, Australia, Belgium, Chile, the Federal Republic of Germany, France, Japan, New Zealand, Norway, Poland, the Republic of South Africa, the Union of Soviet Socialist Republics, the United Kingdom, and the United States of America.

For the first time observers from nations that have acceded to the Treaty but are not consultative parties were invited to attend. Eleven of these 12 acceding nations (Bulgaria, Denmark, Czechoslovakia, the German Democratic Republic, Italy, the Netherlands, Papua New Guinea, the People's Republic of China, Peru, Spain, Rumania, and Uruguay) were represented at the meeting.

In this issue . . .

Eight recommendations approved at Twelfth Consultative Meeting	1
(Text of Treaty recommendations)	4
Geological studies in the Patagonian Andes: R/V <i>Hero</i> cruises 82-5 and 83-5	7
Estimated ages and temperatures of South Pole ice	10
Eklund Biological Center: supporting research for 25 years	13
Ice cores available for research	16
NASA publishes new sea ice data compilation	17
U. S. Geological Survey geologists review potential petroleum and mineral resources	19
Target date for antarctic proposals	20
Hungary joins Treaty nations	21
Translation published	21
For the record	21
Foundation awards of funds for antarctic projects, 1 October to 31 December 1983	21
Correction	22
Weather at U. S. stations	23

The Canberra session was another in the regular series of meetings provided for under the Antarctic Treaty. The Treaty reserves the area south of 60° South for peaceful purposes, sets aside territorial claims, ensures free access throughout the area, permits member nations to inspect installations, prohibits military participation except in support of peaceful activities, prohibits nuclear explosions or nuclear waste disposal, and encourages scientific investigation and international cooperation. During these regular meetings, which take place approximately every 2 years, the consultative parties consider measures to further the principles and purposes of the Treaty.

The agenda included

- improvement of telecommunications and collection and distribution of meteorological data

- man's impact on the environment
- Sites of Special Scientific Interest (SSSI)
- effects of tourism and nongovernmental expeditions in the Treaty area
- activities of countries that are not contracting parties to the Treaty
- operation of the Treaty system
- public availability of consultative meeting documents
- appointment of observers at consultative meetings
- exchange of Treaty information.

Telecommunications and meteorological data

Two of the eight adopted recommendations relate to communications in Antarctica. One calls for implementing procedures and communications systems to collect and transmit meteorological data. Based on collaborative work between the consultative parties and the World Meteorological Organization (WMO), it addresses both the exchange of data among stations and the introduction of the data into worldwide data systems. The representatives discussed requirements for exchanging raw and processed meteorological data among antarctic national programs. Because stations providing data are subject to various limitations, the representatives felt that each country's statement of meteorological data requirements should be revised to include not only what data are needed but also what could be provided.

The second recommendation deals with telecommunication systems and procedures. Antarctic telecommunication systems carry operational, scientific, and meteorological information; improving these systems would make the exchange of data more timely. To increase reliability, some antarctic programs now use satellite communications between their stations and the outside world. The representatives discussed widespread use of satellite communications and what effects this could have on communications among stations. They suggested that national programs not yet using such systems could learn from the experiences of those programs using them. Increased airplane flights and shipping in Antarctica place an additional burden on communications. The existing systems must be adequate to support these activities without interfering with the capability for emergency communications among stations. Recommendation XII-2 suggests that the consultative parties work through their national committees to the Scientific Committee on Antarctic Research (SCAR) to examine these issues.

During the meeting the representatives reviewed the recently completed *Antarc-*

tic Telecommunications Guidance Manual (SCARCOM), developed by the SCAR Working Group on Logistics in response to Treaty Recommendation X-3. Recommendation XII-2 endorses this manual and urges that it be updated periodically. With an updated manual, telecommunications operators will have adequate guidance on the practices of national programs and relevant internationally agreed procedures.

Environmental issues

Consideration of human impact on the environment generated two recommendations. The first, Recommendation XII-3, urges the consultative parties to scrutinize how their activities affect the environment. The representatives recommended that regular environmental evaluations continue, and, if necessary, the environmental impact of proposed activities should be assessed.

Recommendation XII-3 invites SCAR to help elaborate specific procedures for impact assessments. To assist SCAR in its investigation, the representatives included in the final report of the meeting steps taken by some national antarctic programs to assess environmental impacts. The outline includes some of the following procedures:

- define criteria to determine whether or not an activity will have a significant impact on the environment;
- describe clearly a specific activity;
- assess the activity's impact, including predicting potential changes, comparing these with changes that would occur naturally, and estimating the nature, magnitude, and significance of changes caused by human activity;
- consider indirect and cumulative impacts;
- describe measures to maintain or restore environmental quality;
- decide after an environmental assessment whether to proceed with the original activity or to modify or cancel it.

The representatives felt that these details would help SCAR in its investigation. They also suggested that the consultative parties and their national committees to SCAR might wish to provide additional material on their own procedures. In Recommendation XII-8, governments are invited to consider requests from SCAR for additional funds to cover costs incurred in responding to requests from the consultative parties.

The second recommendation, supplementing results of earlier consultative meetings, suggests that the consultative parties update the code of conduct for disposal of wastes in Antarctica. Over the years, antarctic operations have increased in size and complexity; consequently, more



Editor: Winifred Reuning

Antarctic Journal of the United States, established in 1966, reports on U.S. activities in Antarctica and related activities elsewhere, and on trends in the U.S. Antarctic Research Program. It is published quarterly (March, June, September, and December) with a fifth annual review issue by the Division of Polar Programs, National Science Foundation, Washington, D.C. 20550. Telephone: 202/357-7817.

Subscription rates are \$11.00 per five issues, domestic, and \$13.75 per five issues, foreign; single copies are \$2.25 (\$2.85 foreign) except for the annual review issue, which is \$7.00 (\$8.75 foreign). Address changes and subscription matters should be sent to the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

The Director of the National Science Foundation has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this agency. Use of funds for printing this periodical has been approved by the director of the Office of Management and Budget through 31 March 1986.

potentially damaging substances have been introduced. Technological improvements, however, make possible on-site treatment of some wastes and ease the removal of solid wastes, residues, and noxious substances from the continent. The representatives recommended that the consultative parties, working with their national program offices, consider problems of implementing the present code of conduct and revisions that might be made to take advantage of technological improvements.

Antarctic Treaty operations

The representatives asked a working group to consider the operation of the Antarctic Treaty system. The working group concluded that this question was closely related to the public availability of consultative meeting documents and drafted a recommendation that covers both subjects. The recommendation was approved in the plenary session.

As interest in Antarctica grows and activities there become more complex, continuing attention to the Treaty system will be needed. The recommendation outlines specific steps to ensure that accurate information about consultative meetings, and the Antarctic Treaty system generally, is publicly available. As part of this effort, the representatives recommended that copies of the final consultative meeting report, along with other designated documents, should be sent to all contracting parties (consultative parties and acceding nations) and to the Secretary General of the United Nations.

This recommendation also changes the name of the "Handbook of Measures in Furtherance of the Principles and Objectives of the Antarctic Treaty" to the "Handbook of the Antarctic Treaty" and suggests that the handbook include history of the Treaty and other information. The country that hosts a regular consultative meeting would update the manual after the meeting.

Because for the first time observers attended a consultative meeting, the representatives discussed procedures governing such attendance. Although a recommendation was not adopted, they agreed to refer draft rules of procedure to their governments. These rules will be accepted if no objections are raised by 1 April 1984. In conjunction with this discussion, representatives agreed to invite observers from nonconsultative Antarctic Treaty parties to the Thirteenth Antarctic Treaty Consultative Meeting, which is to be held in Brussels, Belgium, in 1985.

Sites of Special Scientific Interest

The consultative parties adopted a housekeeping recommendation, "Facilitation for

Scientific Research—Sites of Special Scientific Interest (SSSI)." The recommendation extends the designation of the eight existing sites until after the next consultative meeting. This extension is necessary to prevent an inadvertent lapse in the status of these sites. SCAR will review the status of the sites and present the results of their study at the Thirteenth Consultative Meeting. Work on designating a new SSSI (proposed by Chile) near South Bay, Doumer Island (64°51'S 63°35'W), was not completed. The representatives requested that the national programs bring the proposal to the attention of those active in Antarctica.

Tourism and nongovernment expeditions

Tourism and nongovernment expeditions were discussed, particularly because private expeditions and resultant requests for assistance from antarctic programs have increased. Suggestions were considered for publicizing that private expeditions should be self-sufficient and should adequately insure or underwrite costs for emergency or other assistance. A recommendation was not adopted, but the issue will be considered at the Thirteenth Consultative Meeting.

The United Nations and Antarctica

The representatives discussed the possibility that an item on Antarctica may be included on the agenda of the 38th United Nations General Assembly. In the final report of the meeting the representatives unanimously reaffirmed their commitment to the Antarctic Treaty and recorded their concerns about any attempt to modify or replace it.

Exchange of information

The representatives gave considerable attention to the provisions for exchange of information under the Treaty and suggested that the requirements for effective exchanges be reviewed at the Thirteenth Consultative Meeting.

They identified specific information that the national program offices might address for consideration at the Thirteenth Meeting:

- Identify the date by which each national program ideally wishes to receive the information exchange.
- Can the offices responsible for managing each national program organize the information a month earlier than the ideal date so that the material could be transmitted through diplomatic channels?
- Should the report of modifications to planned research programs (required by

Recommendation II-6) be combined with the report of planned activities (required by Recommendation VIII-6)?

- Should some information required by Recommendation VIII-6 be exchanged after an activity occurs?
- Would including brief reports of completed investigations more effectively implement the free exchange of information required by Treaty Article III.1(c)?

The importance of ensuring that the results of geophysical research are exchanged was discussed also. As an example, the United States outlined how it planned to treat the results of geophysical work conducted by the R/V *S.P. Lee* during January and February 1984. Record sections and magnetic tapes of seismic and other data will be deposited in the U.S. National Geophysical Data Center in Boulder, Colorado, where copies will be available for the cost of reproduction. A map of the planned cruise track was available before the cruise; the actual cruise track will be available after the work is completed.

Historical monument

In Recommendation XII-7 the consultative parties designated the landing site of the first Indian expedition as an historical monument. The site is at 70°45'S 11°38'E on the Princess Astrid Coast in Queen Maud Land, East Antarctica.

Thirteenth Consultative Meeting

The Twelfth Consultative Meeting, which was highly successful from the U.S. point of view, concluded with Belgium's invitation to hold the Thirteenth Consultative Meeting in Brussels in 1985.

The text of the eight recommendations adopted at the meeting follows this article; annexes referred to in the recommendations have not been included. Copies of the final report, including the annexes, may be obtained from the Polar Information Program, Division of Polar Programs, National Science Foundation, Washington, D.C. 20550, (telephone, 202/357-7817).

—R. Tucker Scully, Director, Office of Oceans and Polar Affairs, Bureau of Oceans and International Environmental and Scientific Affairs, U.S. Department of State, Washington, D.C. 20520.

XII-1. Collection and Distribution of Antarctic Meteorological Data

The Representatives,

Recalling Resolutions 4, 5, 6, 7, and 8 of the WMO Executive Committee, Thirty-fourth Session June 1982 concerning meteorological observing networks, collection and transmission of meteorological data and meteorological data processing in Antarctica;

Recognizing

(1) the continuing importance of antarctic meteorological data for support of operations within Antarctica and for weather forecasting and research, especially climate research in the rest of the world;

(2) the need to maintain a basic network of meteorological stations providing surface and upper-air synoptic data to meet in so far as possible the requirements of Consultative Parties and of the WMO World Weather Watch;

(3) the diminished value of meteorological data if it is not available to users within and outside the Antarctic in accordance with the WMO schedules for the receipt of raw and processed data;

(4) the paucity of antarctic meteorological surface and upper air data and the consequent importance of maintaining regularity of meteorological observations; and

(5) that the increasing shipping and aircraft activities in Antarctica will give rise to increasing demands for meteorological support;

Reaffirming the importance of the WMO Global Telecommunications System (GTS) for purposes of transmitting antarctic meteorological data between antarctic stations in cases where direct transmission within Antarctica is inhibited by ionospheric conditions, and noting that the adoption by some Consultative Parties of satellite communications may facilitate the reception within Antarctica of meteorological data from the GTS;

Noting:

(1) that monitoring carried out by WMO in 1982 and 1983 on the flow of antarctic meteorological data into the GTS indicates that significant deficiencies remain;

(2) the reactivation of the WMO Executive Committee Working Group on Antarctic Meteorology and the outcome of its Third Session in April 1982, including preliminary work on a review of the requirements for raw and processed data set out

in Annexes 1 and 2 of Recommendation VI-3;

(3) the efforts of the WMO Meeting of Experts on Antarctic Data Telecommunication Arrangements in June 1983, in reviewing and updating the meteorological telecommunications routing diagrams set forth in Annexes 1, 2 and 3 of Recommendation X-3; and

(4) that the aforesaid WMO Meeting of Experts arrived at a number of conclusions and recommendations aimed at improving antarctic telecommunications for meteorological purposes, and at improving the manner in which antarctic meteorological data is transmitted within the GTS of the WMO World Weather Watch;

Recognizing the need to keep under review:

(1) the requirements for raw and processed antarctic meteorological data; and

(2) the arrangements for transmission of meteorological data within Antarctica and between Antarctica and the WMO World Weather Watch system;

Recommend to their Governments that they:

(1) use their best endeavors, subject to any overriding scientific, administrative or budgetary considerations, to secure full implementation of the network of stations and observational programs set forth in Annex 1 of this Recommendation;

(2) maintain and improve, subject to any overriding scientific, administrative or budgetary considerations, the system for collection and distribution of meteorological data to, from and within Antarctica having regard to the routing arrangements shown in Annexes 2 and 3, which are based on the conclusion of the WMO Meeting of Experts on Antarctic Data Telecommunication Arrangements in June 1983;

(3) seek, through their Permanent Representatives with WMO, the completion of Annex IV to the Final Report of the aforesaid WMO Meeting of Experts, as a helpful contribution to planning the exchange of available meteorological data;

(4) seek, through their Permanent Representatives with WMO, to ensure that consideration is given, as appropriate, to other conclusions and recommendations made by the aforesaid WMO Meeting of Experts;

(5) invite WMO through their Permanent Representatives with that Organization, to keep under review the arrangements for routing of meteorological data within Antarctica and between Antarctica and the GTS of the World Weather Watch, and to suggest actions which might be taken to improve the timely receipt of data at stations in Antarctica and at World Me-

teological Centers Melbourne, Moscow and Washington and other centers in the World Weather System, having particular regard to changing requirements for meteorological information and to opportunities offered by new technology; and

(6) note that the statements of requirements for raw and processed antarctic meteorological data provided by the WMO pursuant to Recommendation X-3, paragraph 9, require refinement, and invite WMO, through their Permanent Representatives with that Organization, to undertake such refinement.

XII-2. Antarctic Telecommunications

The Representatives,

Recalling Recommendations VI-1, VII-7 and X-3;

Recognizing that antarctic telecommunications are designed to carry operational, scientific and meteorological traffic and that improvement of the telecommunications system would serve to ensure timely and full exchange of information;

Recognizing that recent developments in the use of satellites, of which some Consultative Parties have made use, have improved the reliability of communication links between antarctic station and the outside world, but that consequent diminished reliance on conventional telecommunication methods may have affected the capability of stations to communicate with each other;

Noting with appreciation, the response of the SCAR Working Group on Logistics to the request in Recommendation X-3, paragraph 6, to prepare an Antarctic Telecommunications Guidance Manual (SCAR-COM);

Noting that the increasing shipping and aircraft activity in Antarctica will require improved telecommunications and meteorological support by Consultative Parties undertaking such increased activity;

Recommend to their Governments that:

(1) they strive to ensure effective use of the antarctic telecommunication systems already in existence, and to utilize as appropriate the developing satellite communication systems with a view to achieving improved communications between the antarctic stations, as well as between those stations and points outside Antarctica;

(2) they invite SCAR, through their National Antarctic Committees, to:

(i) consider, in consultation with agencies responsible for national antarctic programs (hereinafter referred to as "national antarctic programs"), how best SCARCOM can be periodically updated so that it may provide adequate guidance to telecommunications operators on telecommunication practices of national antarctic programs and relevant internationally agreed procedures;

(ii) examine issues relating to increased use of satellite communications including:

(a) an exchange of information and experience arising out of the adoption of satellite communications for the benefit of those national antarctic programs which have not adopted this means of telecommunication,

(b) the cost-effectiveness of satellite communications and the benefits to operational efficiency and scientific research that may be derived therefrom,

(c) identification of any problems which may be encountered in communication between the stations of different national antarctic programs in the event of more widespread adoption of satellite communications, and

(d) exploration of means by which any such problems might be overcome while maintaining the cost-effectiveness and other benefits of satellite communications;

(iii) examine the adequacy of the antarctic telecommunications system to meet demands arising from the expansion of shipping and aircraft activity in Antarctica, and to suggest improvements where these might be desirable. In this examination particular attention should be given to:

(a) communications between Antarctic stations,

(b) use of the existing facilities for communications between Antarctica and the outside world, and

(c) communications between stations, ships and aircraft for the purpose of coordinating emergency and search and rescue operations.

XII-3. Man's Impact on the Antarctic Environment

The Representatives:

Recalling Article II of the Antarctic Treaty, Recommendations VI-4, VIII-11, VIII-13 and IX-5;

Noting that in these Recommendations, which have become effective in accordance with Article IX, Paragraph 4 of the Antarctic Treaty, certain principles were elaborated and adopted, namely that:

(i) the ecosystem of the Antarctic Treaty Area is vulnerable to human interference;

(ii) the Antarctic derives much of its scientific importance from its uncontaminated and relatively undisturbed condition;

(iii) in considering measures for the wise use and protection of the antarctic environment their Governments shall act in accordance with their responsibility for ensuring that such measures are consistent with the interest of all mankind; and

(iv) no act or activity having an inherent tendency to modify the environment over wide areas within the Antarctic Treaty Area should be undertaken unless appropriate steps have been taken to foresee the probable modifications and to exercise appropriate controls with respect to the harmful effects such uses of the Antarctic Treaty Area may have;

Recalling that in accordance with these principles there has been established for the Antarctic a substantial series of measures for the protection, conservation and wise use of antarctic fauna and flora consisting of the Agreed Measures for the Conservation of Antarctic Fauna and Flora, the Convention for the Conservation of Antarctic Seals and the Convention on the Conservation of Antarctic Marine Living Resources;

Noting that the States involved in antarctic research activities are in the best position to assess potential environmental impacts of such activities and to develop assessment procedures which might, with benefit, be applied to determining whether the activities they plan to conduct are likely to have significant impacts;

Considering that a measure of comparability between such procedures might, in the future, become desirable;

Affirming that environmental assessment procedures should not prejudice one of the fundamental principles of the Antarctic Treaty providing for freedom of scientific investigation as set out in Article 2 of the Antarctic Treaty and that such procedures should not encroach upon nor prejudice provisions for the protection of the environment and the conservation of living resources contained in instruments that have been or may, in the future, be negotiated as parts of the Antarctic Treaty system;

Recommend to their Governments that:

(1) in relation to any scientific activity they plan to conduct, including the planned provision of logistic facilities to support such activity, they urge their respective

national organizations responsible for antarctic activities to continue to scrutinize the plans for such research and logistic activities, in accordance with procedures they have developed or may develop, to determine whether the planned activities are likely to have significant impacts;

(2) if a preliminary determination indicates that a planned research or logistic activity could have potentially significant impacts on the environment, their relevant agencies undertake a detailed environmental assessment, in accordance with procedures they have developed or may develop, with a view to determining the factors likely to cause such impacts and, if the seriousness of such impacts so indicates, to elaborating feasible research and logistic alternatives aimed at minimizing harmful effects on the environment. In the event that such an assessment is completed they notify other Consultative Parties;

(3) through their National Committees, they invite the Scientific Committee on Antarctic Research (SCAR) to offer:

(i) scientific advice regarding the definition of categories of research and logistic activity in Antarctica which might reasonably be expected to have a significant impact on the environment; and

(ii) bearing in mind, inter alia, the discussion at this Meeting as reflected in paragraphs 17 to 19 of its Report, such advice as seems to SCAR to be relevant to the elaboration of assessment procedures which may be applied by the relevant agencies of the Consultative Parties, on an experimental basis, with regard to research and logistic activity; and

(4) the question of Man's Impact on the Antarctic Environment should be considered further at the next Consultative Meeting.

XII-4. Man's Impact on the Antarctic Environment Code of Conduct on Waste Disposal

The Representatives,

Recalling Recommendation VIII-11;

Noting a general increase in awareness amongst Consultative Parties of the potential environmental impacts of the disposal of waste in the Antarctic region;

Noting that the increasing level and degree of complexity of Antarctic operations is likely to introduce into the Antarctic a

wider range of potentially environmentally damaging substances than previously;

Noting that improvements in logistics and technology increase the feasibility of on-site treatment of human and other waste, and of the removal of solid waste, residues and noxious substances from the Treaty area;

Recommend to their Governments that they seek the advice of their respective antarctic operating agencies as to:

(i) any problems which have been experienced in implementing the Code of Conduct for Antarctic Expeditions and Station Activities contained in the Annex of Recommendation VIII-11; and

(ii) the desirability and feasibility of revising the Code of Conduct in the light of the points noted above, particularly the increased potential for on-site treatment and removal of waste from the Treaty area.

XII-5. Sites of Special Scientific Interest

The Representatives,

Recalling Recommendations VIII-3, VIII-4 and X-6;

Noting that, pursuant to Recommendation X-6, the designation as Sites of Special Scientific Interest of the Sites numbered 1, 2, 3, 4, 5 and 6 will expire on 30 June 1985, and the designation of Site No. 8 will expire on 31 March 1985, before the probable date of the Thirteenth Antarctic Treaty Consultative Meeting, and that the designation of Site No. 7 expired on 30 June 1983;

Desirous that the designation of these sites as Sites of Special Scientific Interest not be allowed to expire before the Scientific Committee on Antarctic Research (SCAR) has reviewed the Sites and presented the results of its review to the Consultative Parties;

Noting the intention of SCAR to review all Sites of Special Scientific Interest at the XVIII meeting of SCAR in 1984 and to present the results of its comprehensive review to the Consultative Parties for consideration at the 13th Antarctic Treaty Consultative Meeting in 1985;

Recommend to their Governments that:

(1) the date of expiry of the following sites should be extended from 30 June 1985 to 31 December 1985:

Site No. 1: Cape Royds, Ross Island,

Site No. 2: Arrival Heights, Hut Point Peninsula, Ross Island,

Site No. 3: Barwick Valley, Victoria Land,

Site No. 4: Cape Crozier, Ross Island,

Site No. 5: Fildes Peninsula, King George Island, South Shetland Islands,

Site No. 6: Byers Peninsula, Livingston Island, South Shetland Islands;

(2) the date of expiry of Site No. 7: Haswell Island, should be extended from 30 June 1983 to 31 December 1985.

(3) the date of expiry of Site No. 8: Western Shore of Admiralty Bay, King George Island, should be extended from 31 March 1985 to 31 December 1985; and

(4) they use their best endeavours to ensure, in accordance with paragraphs 3 and 4 of Recommendation VIII-3, that the management plans of these sites are observed.

XII-6. Operation of the Antarctic Treaty System

The Representatives,

Noting that the Antarctic Treaty, based on principles of the United Nations Charter, in the interest of all mankind, establishes Antarctica as an area dedicated exclusively to peaceful purposes, to international harmony and to international scientific cooperation;

Noting further that the Antarctic Treaty, the numerous measures adopted in furtherance of the principles and objectives of the Treaty and other instruments and acts associated with it constitute a farsighted and effective system of international cooperation, which promotes international peace and security, increase in scientific knowledge and understanding, and effective environmental protection;

Desiring to involve the Contracting Parties to the Antarctic Treaty which are not Consultative Parties more closely with the Antarctic Treaty System;

Conscious of the value of increasing public knowledge of the achievements and operations of the Antarctic Treaty System;

Recalling Article III, paragraph 2 of the Antarctic Treaty which encourages cooperative working relations with those Specialized Agencies of the United Nations and international organizations having a scientific and technical interest in Antarctica;

Recommend to their Governments that:

(1) in addition to sending Consultative Parties certified copies of the Report as well as documents of Consultative Meetings as called for in Recommendation I-XIV, paragraph 1, the Government of the host country of each Consultative Meeting shall also send certified copies of the Report as well as documents of that meeting to all other Contracting Parties which were invited to that Meeting;

(2) in furtherance of Article III, paragraph 2, of the Treaty, the Government of the host country shall:

(a) on behalf of the Consultative Parties send a certified copy of the Final Report and Recommendations of regular Consultative Meetings to the Secretary General of the United Nations, and

(b) as and when the Representatives of the Consultative Parties consider it appropriate, draw the attention of any Specialized Agency of the United Nations or other international organizations having a scientific or technical interest in Antarctica to any part of the Report of the Consultative Meeting, or any information document submitted to the Meeting and made available to the public, relevant to the scientific or technical interest which that agency or organization has in Antarctica;

(3) the "Handbook of Measures in Furtherance of the Principles and Objectives of the Antarctic Treaty" be renamed the "Handbook of the Antarctic Treaty" and:

(a) be brought up to date by the host government as soon as possible after each Consultative Meeting,

(b) contain an introduction outlining the background and history of the Antarctic Treaty as well as a preface to each section as appropriate giving a brief background to the measures set out in that section. The host government of the XIIth Consultative Meeting will undertake the necessary consultations with a view to the early preparation of such introduction and prefaces, and

(c) contain the Final Report (excluding attachments and annexes) from each Consultative Meeting;

(4) (a) starting with the XIIIth regular Consultative Meeting, Delegations should indicate, when submitting an Information Document, if they intend that document to be publicly available;

(b) after the closure of the Meeting and provided no Consultative Party has objected, any Consultative Party or non-Consultative Party which has been invited to that Meeting may make such document

publicly available on such terms as it may prescribe;

(c) as regards Conference Documents or Information Documents of the I-XIIth Consultative Meeting, and Conference Documents of the XIIIth Consultative Meeting, and subsequent Meetings, as well as Information Documents that have not been identified in accordance with paragraph (a) above as intended to be publicly available, Consultative Parties will consider in what circumstances such Documents may be made publicly available, with a view to discussing the matter further at the XIIIth Consultative Meeting;

(5) invite the depository Government to examine the question of information about the Antarctic Treaty System, including publicly available documents arising from Consultative Meetings, with a view to identifying and cataloging publicly available information about the System and identifying the sources from which such information can be obtained; and

(6) "The Operation of the Antarctic Treaty System" be included on the Agenda of the XIII Consultative Meeting.

XII-7. Historic Sites and Monuments

The Representatives,

Recalling Recommendations I-IX, V-4, VI-14 and VII-9

Recommend to their Governments that the following historic monument be added to the "List of Historic Monuments Identified and Described by the Proposing Government or Governments" annexed to Recommendation VII-9 and that thereafter it be accorded the respect and protection required by the Recommendations recalled above:

44. Plaque erected at the temporary Indian station "Dakshin Gangotri," Princess Astrid Kyst, Dronning Maud Land, listing the names of the members of the First Indian Antarctic Expedition which landed nearby on 9 January 1982. (Lat. 70°45'S., Long. 11°38'E.)

XII-8. SCAR Assistance to Consultative Parties

The Representatives,

Recognizing that the Scientific Committee on Antarctic Research (SCAR) of the

International Council of Scientific Unions comprises a unique assemblage of knowledge and expertise in antarctic scientific fields;

Noting with appreciation the advice provided to the Antarctic Treaty Consultative Parties by SCAR in response to various requests,

Being aware that under its Constitution SCAR is charged with "furthering the coordination of scientific activity in Antarctica, with a view to framing a scientific program of circumpolar scope and significance";

Being aware that the assistance requested of SCAR by the Consultative Parties imposes additional demands on scarce resources;

Recommend to their Governments:

That they consider in the light of its expertise and past assistance any requests that may be made by their national committees for additional funding to meet costs to SCAR of responding to requests for advice by the Antarctic Treaty Consultative Parties.

Geological studies in the Patagonian Andes: R/V Hero Cruises 82-5 and 83-5

During May and June 1982 and July 1983, the scientific parties on the R/V *Hero* studied the geology and geophysics of the southern Andes between 46°40'S and 52°S; the table lists the dates and scientific personnel for these cruises. *Hero* operates in South American waters during the austral winter, when ice limits operations in antarctic waters.

Our scientific objectives were to provide information on various aspects of the geological and tectonic evolution of the southern Andes. Specifically, we wished to obtain data on the uplift history of this region, to study the petrological and geochemical evolution of the Patagonian batholith, and to study the regional gravity field. To meet these objectives, we conducted reconnaissance mapping of bedrock and surficial geology, collected gravity data primarily along east-west transects (figure 1), and collected numerous bedrock and surficial samples for laboratory analysis. This work also extends northward investigations of the tectonic evolution of the Scotia Arc.

Patagonian batholith

The Patagonian batholith, a linear outcrop of igneous rock along the Pacific margin of southern South America, extends northward from Cape Horn for more than 2,000 kilometers but rarely exceeds 100 kilometers in width. We made a number of transects through this batholith to obtain samples for geochronological and geochemical analyses.

Although the batholith is not mapped in detail, sampling over a wide area allowed us to define the considerable lithological variation that exists within the batholith. The most common lithologies encountered were medium- to coarse-grained biotite and biotite-hornblende tonalite and grandodiorite. Fairly mafic, fine- to medium-grained diorite also makes up a considerable portion of the batholith. Other, less abundant lithologies observed were K-feldspar-bearing granite, coarse-grained biotite tonalite, and gabbro. We mapped one peraluminous (garnet- and muscovite-bearing) granite near the south end of Isla Wellington.

Most of the batholith is homogeneous over wide areas (texturally massive), although we found some foliated deposits. Also, some large areas within the batholith are cut by numerous mafic dikes and irregular bodies of diabase.

Where we observed contact zones, most were sharp with little or no ring-shaped zones surrounding the igneous intrusion (contact metamorphic aureole). In the Fiordo Vargas area, however, we noted a wide contact zone between metamorphic Late Paleozoic basement rocks and a complex of tonalitic to dioritic plutons. At this locality, numerous igneous (mafic) and basement xenoliths are incorporated within the margin of the plutonic complex.

The Patagonian batholith has been eroded to a level deep enough so that little of its original cover is exposed. Nonetheless, an area of intermediate (andesitic) volcanic rocks, mapped in a longitudinally cen-

tral area, may represent a portion of this cover.

We collected over 250 samples from the batholith. Geochronological analyses—fission track, potassium-argon (K-Ar), rubidium-strontium (Rb-Sr), uranium-lead (U-Pb), and neodymium-samarium (Nd-Sm)—will give ages of the intrusion and cooling from which uplift rates and times will be estimated. Geochemical analyses (major and minor element and isotopic) will provide information on the petrological and geochemical evolution of the batholith and the underlying crust and mantle.

Pre-batholithic terranes

The Patagonian batholith intrudes a large terrane of variably metamorphosed

country rocks. During reconnaissance we mapped the metamorphic rocks east and west of the batholith and in roof pendants (remnants of older rocks overlying the batholith). Lithologies encountered include metamorphosed sandstone-shale sequences, mafic-ultramafic schist and gneiss, and marble. These sequences correlate with other pre-Late Jurassic basement complexes exposed elsewhere in the southern Andes.

We also sampled the basement terrane to the west of the batholith for geochronologic (Ar-Ar and Nd-Sm), isotopic, paleontologic, and paleomagnetic analyses.

Cenozoic geology

Because the scientific party of *Hero* cruise 79-5 had observed numerous Cenozoic up-

Personnel and cruise dates for *Hero* cruises 82-5 and 83-5.

R/V <i>Hero</i> cruise:	82-5	83-5
Cruise Dates	11 May to 10 June 1982	5-29 July 1983
Cruise Track	Punta Arenas, Chile to Punta Arenas, Chile	Punta Arenas, Chile to Puerto Montt, Chile
Chief Scientist	Eric Nelson Co-Principal Investigator Geology Department Colorado School of Mines Golden, Colorado	Eric Nelson
Other Scientists	Randall Forsythe Co-Principal Investigator Geology Department, Rutgers University, New Brunswick New Jersey Constantino Mpodosis Servicio Nacional de Geología y Minería, Santiago, Chile Karleen Davis Department of Geological Sciences State University of New York Albany, New York Jay Stravers Institute of Arctic and Alpine Research University of Colorado, Boulder, Colorado	Randall Forsythe Hannes Brueckner Lamont-Doherty Geological Observatory, Palisades, N.Y. and Department Earth & Environmental Sciences Queens College New York, New York Miguel Herve Servicio Nacional de Geología y Minería, Santiago, Chile Eric Leonard Geology Department Colorado College Colorado Springs, Colorado Salvador Harambour Geological Assistant University of Chile Santiago, Chile Jose Manuel Soffia Geological Assistant University of Chile Santiago, Chile

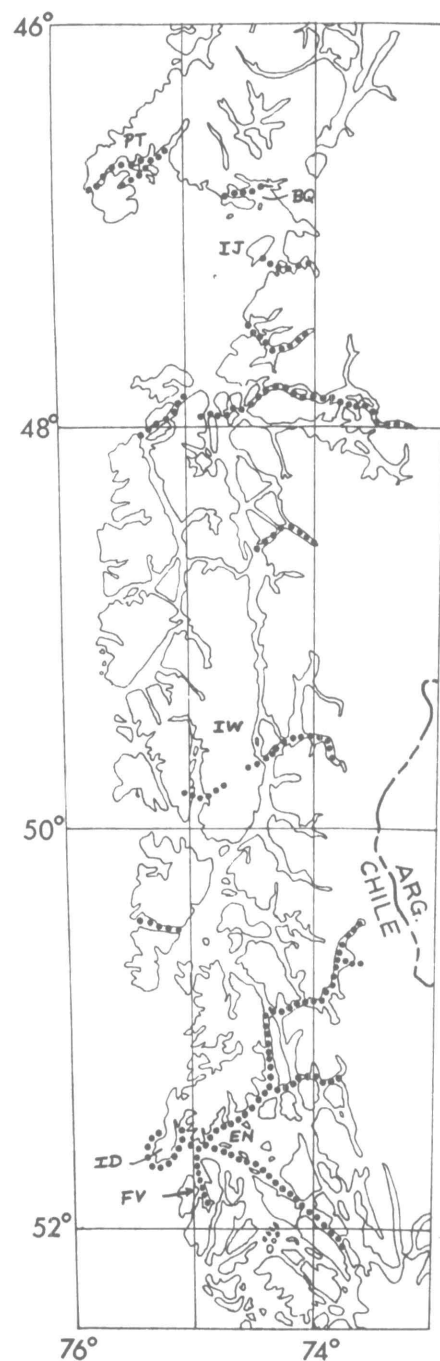


Figure 1. Partial ship track of R/V *Hero* during cruises 82-5 and 83-5. Dotted lines represent transects along which geological and geophysical data were collected. The abbreviations on this figure indicate the following sites: IW (Isla Wellington), FV (Fiordo Vargas), ID (Isla Diego de Almagro), EN (Estrecho Nelson), IJ (Isla Javier), PT (Península Taitao), and BQ (Bahía San Quintín).

lifted features, we paid considerable attention to Cenozoic deposits and erosional features (such as terraces and ice-carved surfaces) during cruises 82-5 and 83-5. We measured over 100 ice-flow directions (figure 2); these measurements suggest that the present fjordland topography strongly controlled the direction of ice flow over

most of the area during the last glacial maximum. Most of the high peaks in the area show evidence of having been glaciated. This suggests that an extensive ice sheet may have covered the area at one time.

Other erosional features observed include uplifted wave(?) cut terraces and notches cut into exposures of Late Paleozoic limestone. We used a sextant and the ship's radar to measure the elevations of some remarkably planar, high-elevation terraces along the rugged southwestern margin of Isla Diego de Almagro. The three most

prominent levels were 246, 197, and 143 meters above sea level. A lower but more extensive terrace (approximately 10 to 20 meters above sea level) was observed in the area of Estrecho Nelson. The origin of this extensive terrace, as well as the high Pacific-margin terraces, remains enigmatic. Although we recognized numerous other Pacific-margin terraces and uplifted features on aerial photos between 48° and 50° south latitude, we were unable to visit these areas because of mechanical problems with the *Hero* and a lack of official Chilean permission to navigate along some critical access routes.

Considering the size of the area studied, we observed very few depositional glacial features, even though the area appears to have undergone extensive glaciation. Erratic boulders and gravels are almost entirely locally derived except along the Pacific margin. In this area we discovered enigmatic clasts of porphyritic volcanic rocks. Surficial glacial and glaciomarine deposits that we mapped and sampled include the following:

- till
- glaciomarine diamict
- glaciomarine gravels
- ice contact gravels (kame terrace)
- ice-dammed lake delta sands and varved clays
- marine deltaic sands and gravels (bottomset, foreset, and topset beds)
- marine beach sands and gravels
- shell-bearing marine clays
- peat and other organics

We collected over 110 samples from these deposits. Preliminary radiocarbon ages of 1,570 and 3,650 years were obtained from shell samples in terraces measured at 2.0 and 7.5 meters above sea level respectively. Amino acid racemization, biostratigraphic (palynological), and further radiocarbon analyses will help build the Late Quaternary glacial chronology of the region.

In the Golfo de Penas area we mapped major Tertiary and Quaternary clastic sedimentary deposits. A sequence of faulted and tilted marine mudstones, siltstones, and sandstones were found on Isla Javier and in the Peninsula Taitao area. In the Taitao area portions of the marine strata are conformably overlain by submarine, intermediate volcanic units. The probable basal unit of this section is a very coarse conglomerate containing predominantly clasts of the underlying pre-Late Jurassic basement. Preliminary micropaleontological data suggest that at least some of the marine strata are no older than middle Miocene (R.K. Olson, personal communication, 1983).

Figure 2. Quaternary ice flow directions. Line with dot indicates known flow orientation, but flow-sense is unknown.

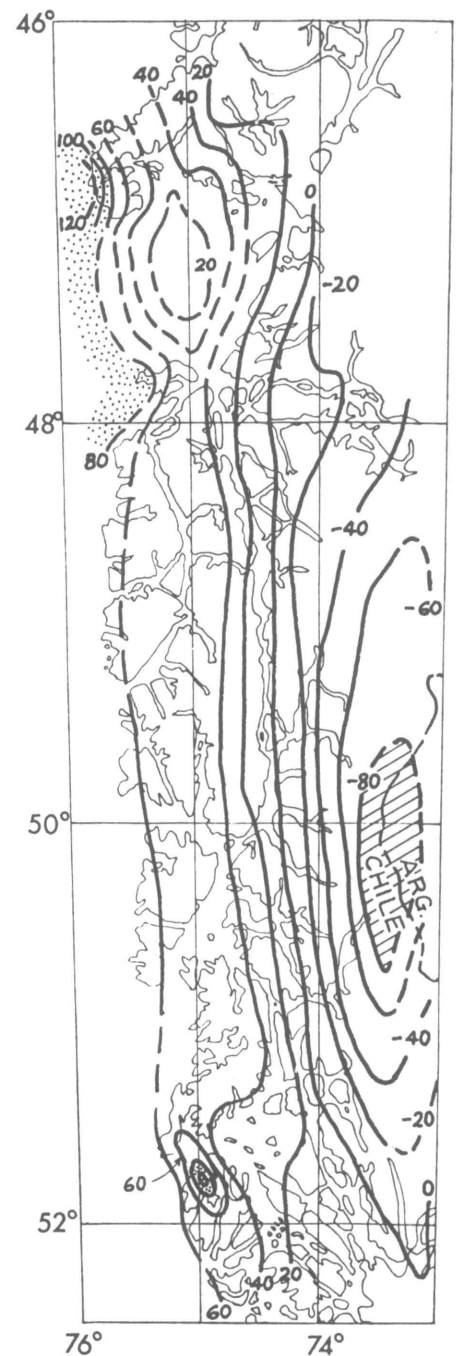
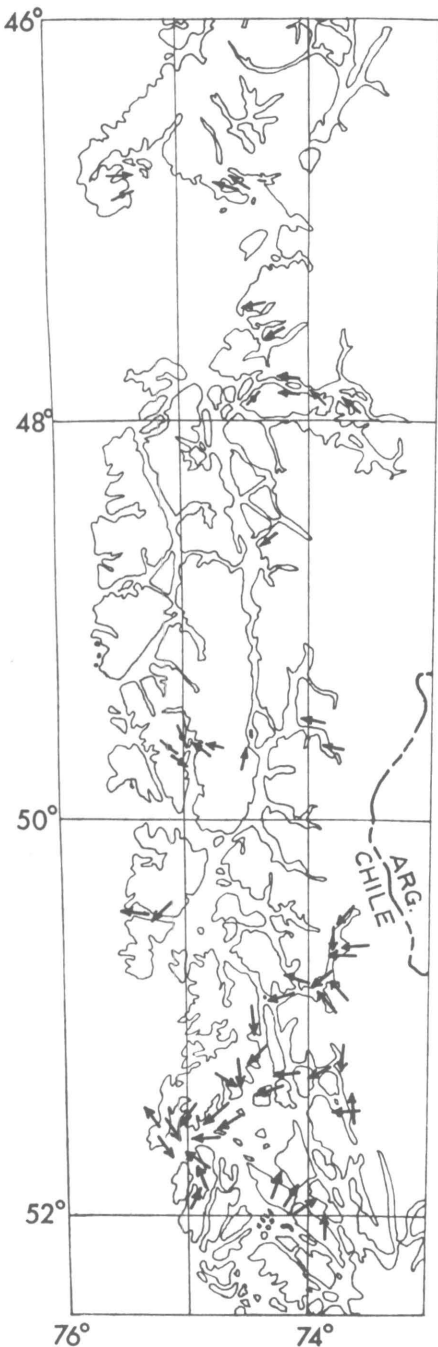


Figure 3. Generalized Bouguer gravity anomaly map of a portion of the southern Andes. Contour interval = 20 mgals. Areas with dots indicate values greater than +80 mgals; those with diagonal slashes indicate values less than -80 mgals.

This sequence of clastic and volcanic rocks is cut by silicic-to-intermediate epizonal intrusions. A sequence of horizontal, poorly lithified, Quaternary mudstones and sandstones was also mapped in the Bahia San Quintin area. These rocks are probably of glaciolacustrine origin and may or may not have been uplifted.

We collected samples in these Cenozoic sequences from 18 sites for pollen and foraminifera studies and from 5 sites for

macrofossil studies. Samples from the Cenozoic volcanic and plutonic rocks presently are being analyzed for major and trace element abundances. Preliminary data suggest that these rocks have a calc-alkaline affinity.

Structural data

Mesozoic and Cenozoic ductile and brittle simple shear deformations have resulted in a complex fault and fracture pattern in the region. Immediately south of the Golfo de Penas region, mesoscopic east/west-trending faults predominate and have mainly right lateral offset. These faults cut most plutonic rocks in the area and are probably Cenozoic in age. North of the Golfo de Penas, mesoscopic north/west-trending faults predominate and have both normal (e.g., on Isla Javier) and left lateral (e.g., Taitao area) components of movement. These faults cut Tertiary and Quaternary(?) strata and are likely to be systematically related to the development of Cenozoic depositional centers in the Golfo de Penas.

Gravity data

To study the large-scale crustal structure of the southern Andes we took over 400 gravity readings along nine generally east-west transects (figure 1). The results of the gravity survey show both regional and local variations in the Bouguer anomaly field (figure 3). Bouguer anomalies are derived by correcting the observed gravity for latitude, variations in elevation, and the mass of material between the observation site and sea level. Bouguer anomalies range from -80 to +120 milligals (mgal) and are the most extreme values yet measured in this region of the Andes. The lowest negative anomalies are located along the topographic axis of the Andes, and reflect the great crustal thickness below this axis. The highest positive anomalies are located over pre-late Jurassic, mafic-ultramafic basement complexes (unusually dense rocks), which may partially account for the high values.

Regionally, anomaly values generally increase from east to west along most profiles located west of the Andean topographic divide. Regional north-south gradients in the Bouguer field suggest that the Andes have major variations in crustal thickness, with minimums around 47-48°S and 52-53°S and a maximum at 50°S (figure 3). Abrupt north-south variations in the field at about 48°S may indicate a major east-west structural boundary in the Andes. Other local anomalies, suggestive of major changes in crustal structure, exist over pre-Late Jurassic mafic and ultramafic complexes of the Estrecho Nelson area, over Tertiary strata

on Peninsula Taitao, and over the extreme western portion of Peninsula Taitao (figure 2).

Conclusion

During *Hero* cruises 82-5 and 83-5 we made numerous geological and geophysical observations that included bedrock and structural mapping in the Patagonian batholith, in the pre-Late Jurassic basement, and in Cenozoic supracrustal sequences. Various laboratory analyses are underway on the bedrock and surficial samples collected during the cruises. We have produced the first generalized Bouguer anomaly map of the southern Andes from extensive measurement of the regional gravity field.

These data, when combined with data from past and planned *Hero* cruises near the southern Andes, will add significantly to our understanding of the complex geological evolution of this remote region. From these data we are beginning to develop conceptual models for such geologic and tectonic processes as the origin of granitic batholiths, the geological effects on the continent of oceanic ridge-trench collision,

and the mechanisms for uplift and segmentation in Andean-type orogens.

NSF research grants EAR 82-06646 to E. Nelson, EAR 82-06100 to R. Forsthye, and EAR 83-07604 to E. Nelson and D. Elthon are supporting this work. *Hero* cruises in Chile's 200-nautical-mile zone are conducted with the assistance and permission of the Chilean government. In June 1983 the U. S. and Chilean governments signed an agreement which outlines a cooperative plan for research conducted aboard *Hero*.

—Eric Nelson, Geology Department, Colorado School of Mines, Golden, Colorado 80401, and Randall Forsythe, Department of Geological Sciences, Rutgers University, New Brunswick, New Jersey 08903.

Reference

- Olson, R. K. 1983. Personal communication. (Department of Geological Sciences, Rutgers University, New Brunswick, New Jersey 08903.)

Estimated ages and temperatures of South Pole ice

Ice-coring has become a major component of the U.S. research program at the South Pole. We carried out a simple model simulation of the history of the South Pole ice; our results are reported in this note. We based the model on the assumption that the relevant sector of the east antarctic ice sheet is in a state of zero net mass balance. The results, therefore, are unlikely to match exactly data acquired in the field but should define orders of magnitude to be expected from actual core and borehole measurements.

Data

We constructed the topography for the simulation from the 1:15-million-scale map of the ice sheet surface and bedrock elevations published in the Soviet *Atlas of Antarctica* (Bakayev, 1966). Figure 1 shows flowlines through South Pole. The heavy,

full line in the figure is constructed orthogonally to the surface elevation contours and extends back 980 kilometers to a point near 82°S 71°E on the antarctic plateau above the western edge of the Gamburtsev Subglacial Mountains (80°30'S 76°E). The surface and bedrock elevation profiles of the South Pole flowline are shown in figure 2. An alternative possibility, that the South Pole ice comes from the secondary "Titan Dome" 200 kilometers to the south (heavy dashed line) was also investigated but must be discounted because of mass flux considerations discussed later.

The accumulation values along the line are not well known; therefore, they have been constructed to match the latest South Pole accumulation estimate (8.8 centimeters of ice per year) obtained by A. Gow (personal communication) from a 200-meter ice core extracted in 1981 (Kuivinen, Holdsworth, and Gow 1983). Over most of the central plateau, a low value (2 cen-

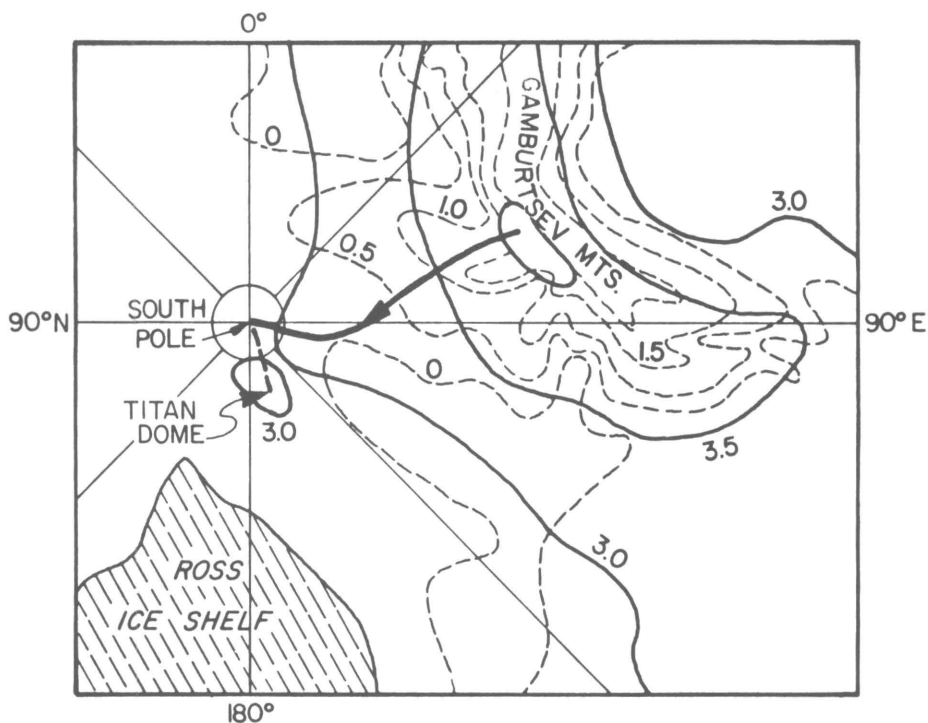


Figure 1. Inferred ice flowlines through the South Pole and surface (solid) and bedrock (broken) elevation contours (in kilometers) used in the model. The heavy dashed line between the South Pole and Titan Dome indicates another possible source for South Pole ice. McInnes and Radok rejected Titan Dome as a source because the average accumulation of ice at the South Pole would have to be twice the observed rate if the ice came from this site.

timeters of ice per year) can be assumed. With these constraints considered the accumulation profile along the flowline was drawn to bring the observed ice flow velocity at the pole in accord with the modeled "balance velocity" (see below). The accumulation values used are given by the top row of numbers in figure 2. Their rapid increase near the pole needs independent confirmation; it could represent the transition from the continental regime of East Antarctica to the more oceanic condition of West Antarctica.

For the final input parameter, we assumed that the surface temperature along the flowline rises from -57°C on the plateau to the observed South Pole temperature of -49.3°C (Schwerdtfeger, 1970). This corresponds to a plausible rise in temperature of 7.7°C for a surface drop of 1,310 meters.

Results

From these data we derived the following:

1) The "balance velocity," which keeps the ice flow in exact balance with the accumulation, implies that for any point on the flowline the mass passing the unit-width vertical column through the ice must be

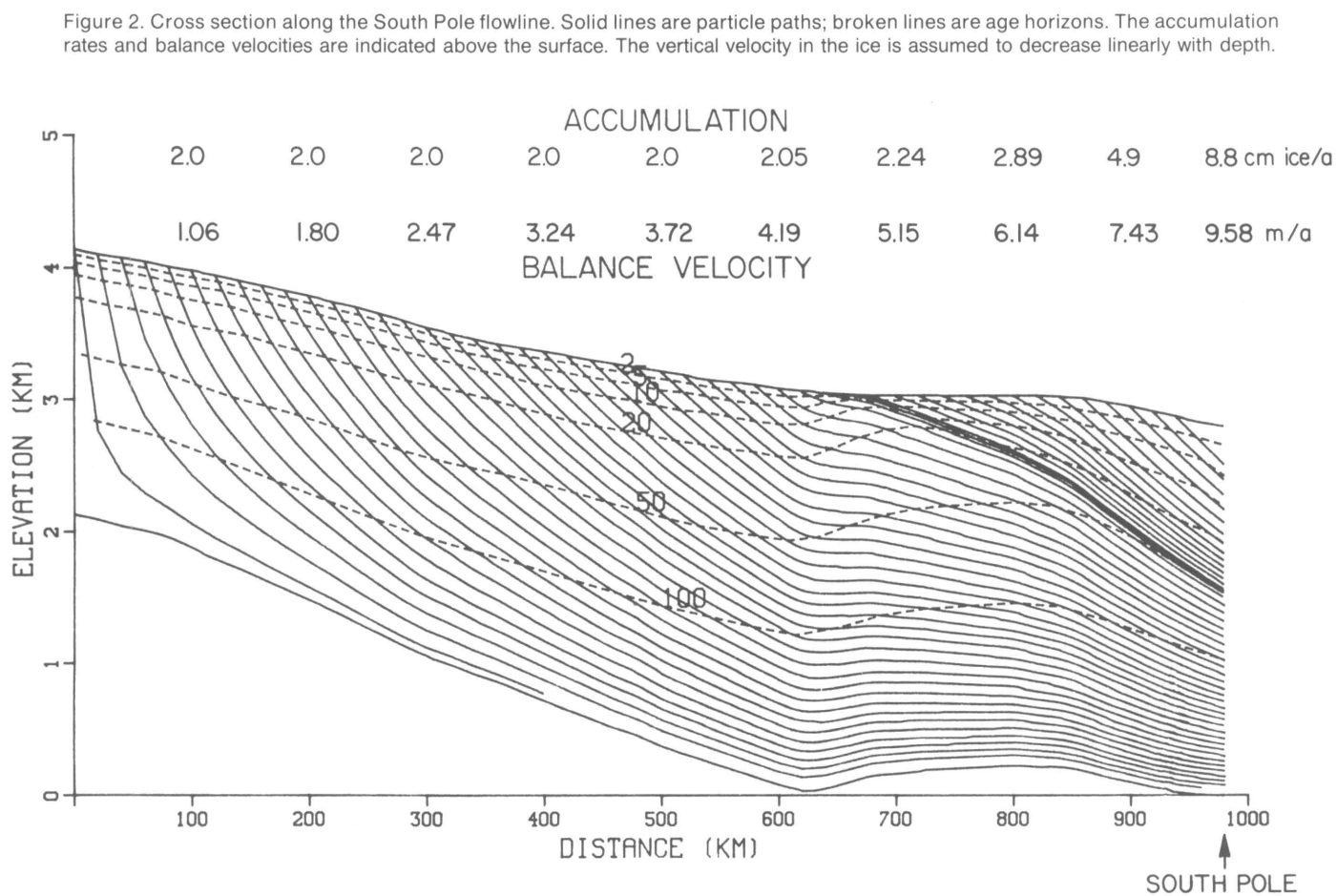


Figure 2. Cross section along the South Pole flowline. Solid lines are particle paths; broken lines are age horizons. The accumulation rates and balance velocities are indicated above the surface. The vertical velocity in the ice is assumed to decrease linearly with depth.

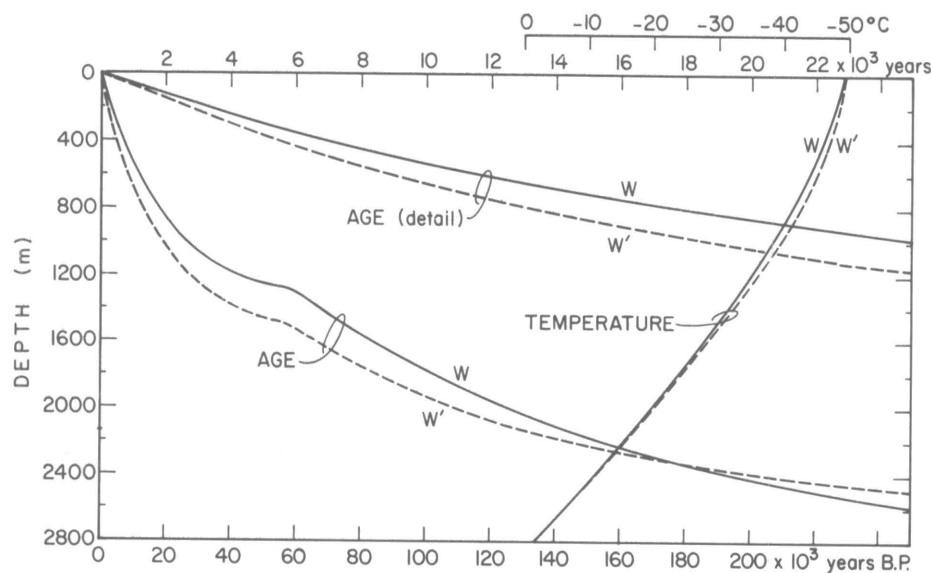


Figure 3. Estimated ages and temperatures of South Pole ice. The curves labelled w and w' have been computed with different assumptions for the vertical velocity in the ice (see text).

equal to the total surface accumulation upstream of that point. For the South Pole flowline, the values of the balance velocity are given in the second row of numbers above the surface elevation profile in figure 2. They increase from a nominal 0.1 meter per year at the start of the flowline to 9.6 meters per year at the Pole—a value close to the measured 10-meters-per-year displacement (Henderson, 1983). This agreement was achieved by making the accumulation rate increase with the tenth power of distance along the flowline from 2 centimeters of ice per year at $x = 0$ to 8.8 centimeters of ice per year at the pole ($x = 980$ kilometers). The corresponding analysis for the alternative flowline originating from the "Titan Dome" showed that its average accumulation rate would have to be almost twice the observed South Pole rate to produce the observed mass flux at the pole.

2) The paths taken by the ice particles in a South Pole ice core, since their deposition on the ice sheet surface, are constructed by adding, for each point of the cross section, the horizontal displacement (the balance velocity) to a vertical displacement, which equals the accumulation rate at the surface and is zero at bedrock. We made two alternative assumptions for the decrease of the vertical velocity inside the ice. The first, used to construct the particle paths and age isochrones in figure 2, was a steady decrease in the vertical velocity w from the surface to the bedrock. The second, suggested by Budd and others (1976), made the vertical velocity w' decrease at the same relative rate as the horizontal velocity in a deforming ice sheet.

Because the two cross sections constructed with these assumptions have similar appearances, only the linear profile of vertical velocity (w) is reproduced as figure 2. A special feature is a marked confluence of particle trajectories running from the surface 300 kilometers upstream to a depth of around 1,000 meters at the pole. This is mainly a consequence of the rapid rise in accumulation rate that must be postulated to achieve a realistic balance velocity at the pole. It will be interesting to see if the confluence shows up as a change in core features at that depth.

The different age-depth scales (labelled w and w') derived from these assumptions are given in figure 3. Their irregularities mark the depths of the confluent trajectories. The substitution of w' for w lowers the inferred age of the ice at a given shallow depth and increases that of the deeper ice. However, for the deeper ice the assumption of steady state balance becomes increasingly unrealistic. An independent check on the estimated ages of the shallow ice is provided by recent measurements on the 200-meter core extracted at the South Pole in 1981 (Kuivinen, Holdsworth, and Gow, 1983). The layering in the core gives an age of about 2,000 years for the ice at 200 meters, somewhat less than the w' -derived age shown in figure 3.

3) We calculated the temperature field of the flowline cross section from the equation for heat conduction of moving ice, following Budd and others (1970, 1971). Only the resulting vertical temperature profile for the South Pole is shown in figure 3. This profile suggests that the basal ice is

at the pressure melting point at the pole; the onset of basal melting occurs 610 kilometers from the pole.

Conclusion

Our results illustrate how using simple ice-sheet models can compensate for the lack of concrete ice age and temperature data from Antarctica. Although the results will not agree exactly with data gathered in field studies, they provide a yardstick for future observations. Moreover, such observations will confirm or refute the basic steady-state assumption used in our model.

—Barry McInnes and Uwe Radok, Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, Colorado 80309. Dr. McInnes is now at the Meteorology Department, University of Melbourne, Australia.

References

- Bakayev, V.G. (ed.) 1966. *Atlas of Antarctica*. Main Administration of Geodesy and Cartography of the Ministry of Geology, USSR.
- Budd, W.F., D. Jensen, and U. Radok. 1970; 1971. Derived physical characteristics of the antarctic ice sheet. Publication no. 18, Meteorology Department, University of Melbourne, and Publication no. 120, Australian National Antarctic Research Expeditions.
- Budd, W.F., N.W. Young, and G.R. Austin. 1976. Measured and computed temperature distributions in the Law Dome ice cap, Antarctica. *Journal of Glaciology*, 16(74), 99-110.
- Gow, A.J. 1984. Personal communication. (U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire 03755.)
- Henderson, T. 1983. Modeling the movement of the polar ice cap at the South Pole. U.S. Geological Survey polar research symposium abstracts, U.S.G.S. Circular no. 911, 21.
- Kuivinen, K.C., G.W. Holdsworth, and A.J. Gow. 1983. South Pole core drilling, 1981-1982. *Antarctic Journal of the United States*, 17 (5), 89-91.
- Schwerdtfeger, W. 1970. The climate of the Antarctic. In S. Orvig (ed.), *Climates of the Polar Regions*, World Survey of Climatology, Volume 14. Amsterdam: Elsevier Publishing Company.



NSF photo.

McMurdo Station's biological laboratory in the early 1960s. Since 1959 when it was built, additions have been made to the laboratory to provide scientists with more working space; it has been expanded from 960 square feet to 8,100 square feet with four separate laboratory areas. In 1972 the building was renamed the Eklund Biological Center in memory of polar biologist Carl R. Eklund.

Eklund Biological Center: supporting research for 25 years

At McMurdo Station on Ross Island stands a long, squat building known today as the Eklund Biological Center. Here, since 1959, scientists have carried on research under conditions that belie Antarctica's remoteness. During the 27 years since the International Geophysical Year (1957-1958), the National Science Foundation (NSF) has continually expanded and improved its ability to provide antarctic researchers with equipment and facilities.

A biological laboratory south of 60°S

The first permanent laboratory, complete with equipment and supplies, at McMurdo Station opened officially in April 1959. It was a 20- by 48-foot, prefabricated T-5 building, a structure well suited for the antarctic climate and widely used at Hallett and McMurdo Stations. Developed by the U. S. Army Corps of Engineers Engineering Research and Development Laboratories, the T-5 building resembles a shoebox and is made up of insulated wooden panels. These were assembled, coded, and disassembled in the United States before shipment to Antarctica where Navy construction personnel reassembled the panels. The Arctic

Institute of North America, under contract to the National Science Foundation (NSF), set up, outfitted, and managed this first laboratory during 1958 and 1959; George A. Llano was the project leader (Wohlschlag, 1963a.)

Under a similar NSF contract, Stanford University managed the laboratory from 1960 until October 1965. In 1960, under the direction of Stanford personnel, Navy construction workers erected an additional T-5, doubling the available laboratory space. Added to this 4,120-square-foot laboratory was a temporary Jamesway hut with 768 square feet for storage, packing, and shipping.

During the 1962-1963 austral summer the Jamesway and another temporary hut were removed and replaced by a 20- by 80-foot T-5 building that housed offices, a library, and a wet laboratory. A heated Jamesway was added to the complex for storage, and a dust-free microbiology laboratory was completed.

The laboratory was designed to accommodate a varied, continually changing research program. To increase flexibility research areas were not separated by walls but by an easily adjusted arrangement of cabinets,

tables, and desks for special equipment. Working spaces were provided with adequate fluorescent lighting, and the floors in all but the wet laboratory were tiled with vinyl-asbestos flooring. In the wet laboratory a mixture of epoxy resin and sand aggregate was used for a water proof covering.

During the laboratory's early years water was obtained from a 3,000-gallon snowmelter; later it was connected with McMurdo's water and sewerage system. Two diesel oil, jet-heaters supplied heat, although these eventually were replaced with a single, central heating system. The laboratory's electricity came from the general station power supply. (Wohlschlag, 1963a).

Both contracting institutions sought to provide equipment adequate to support biology investigations in this remote region. Among these items were

- permanently installed equipment—four stainless steel sinks, fume cupboard, and autoclave
- a 100-cubic-foot walk-in freezer, a 100-cubic-foot walk-in cooler, and two deep freeze chests
- 10 microscopes for dissecting work or fine cytological work with appropriate phase, ultraviolet, and photographic equipment
- three spectrophotometers

- a darkroom equipped for standard photographic and micro-photographic processing
- equipment for biomedical studies using radioactive elements—including centrifuges, analytical balances, Millipore filter apparatus, hematographic equipment, pH equipment, microtomes, blood chemistry equipment, and temperature recording units
- aquaria, for experiments requiring controlled temperatures between -2° and 4°C —two 50-gallon holding drums, eight 50-gallon aquaria, and one 200-gallon aquarium (Wohlschlag, 1963b).

Between 1965 and 1979 two other organizations managed McMurdo Station's laboratory. North Star Research and Development Institute operated the laboratory until 1968 when Holmes and Narver, Inc. (1968-1979) was awarded the management contract. While operating the laboratory, Holmes and Narver personnel upgraded the equipment, supplies, and laboratory building. They added to the laboratory's inventory several major pieces of equipment including several dissecting and compound microscopes, a scintillation counter, two spectrophotometers, an ultracentrifuge, and a freeze-dryer for tissue

sample work. In addition to renovating the laboratory's stock room, they improved the stocking system so that it was easier to manage and resupply necessary materials. The laboratory building was rewired because the electrical system had become a fire hazard, and the roof was resurfaced. Under their aegis, an aquarium Jamesway with several large fiberglass tanks and a small dive locker were constructed and added to the research support capability.

Eklund Biological Center

On 27 February 1972, the McMurdo biological laboratory became the Eklund Biological Center. It was renamed in memory of biologist Carl R. Eklund, who died in 1962. The selection of the laboratory as a memorial to Dr. Eklund acknowledged his dedication to polar research and his contribution to antarctic biology.

At the dedication ceremony, George A. Llano, NSF Office of Polar Programs manager for polar biology and medicine, noted: "The existence of this fine center for biological work is in no small measure due to the foresightedness of Carl, who, as a member of the Committee on Polar Research,

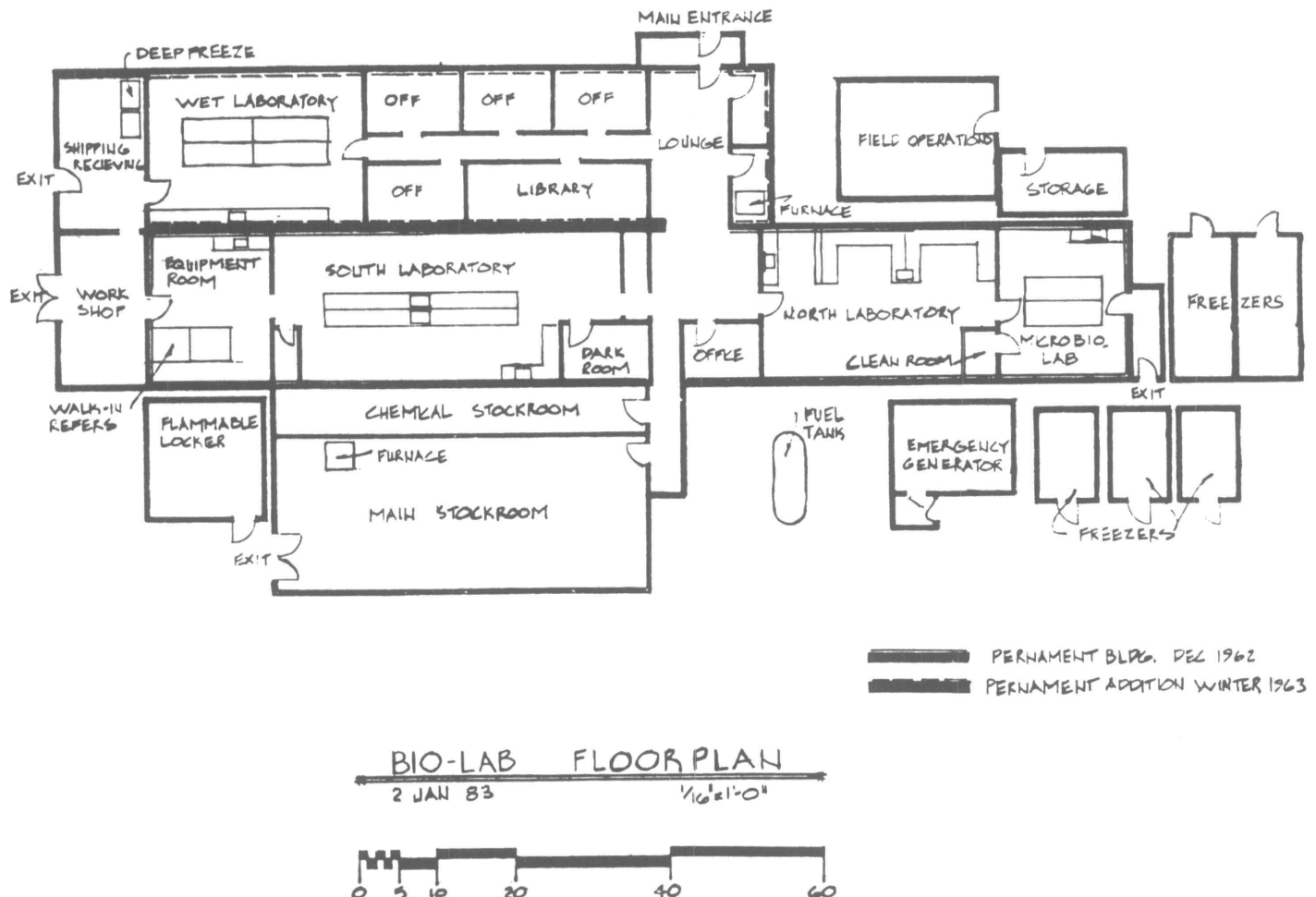
insisted on the construction of adequate laboratories as a primary means for advancing polar biology. He was concerned with both arctic and antarctic polar research, but Antarctica was undoubtedly his first love. . . ." (*Antarctic Journal*, 1972)

Today's biological research laboratory

In 1980, NSF awarded contract for support of research in Antarctica to ITT/Antarctic Services, Inc. (ANS). This contract includes the management and operation of Eklund Biological Center (EBC) and Thiel Earth Sciences Laboratory.

The original 960-square-foot biology laboratory now includes within its 8,100 square feet four separate laboratory areas. The smallest area, the microbiological laboratory, features a center work bench with low temperature incubators and an isolated room for "clean" work. The adjacent north laboratory provides additional incubators, an autoclave, a crushed ice machine, a fume hood, and one of two analytical weigh stations. The south laboratory offers a Perkin/Elmer 552 scanning spectrometer, a Virtis Mobile 11 freeze-dry unit, a Corning Mega-Pure glass still, and two walk-in re-

Eklund Biological Center floor plan, January 1983.



frigerators, as well as standard laboratory supplies.

Because use of radionuclides as biological tracers has increased, ANS installed a new Beckman model 6800 liquid scintillation counter in October 1983. This new unit, with a 200-vial capacity, has helped eliminate delays caused by the high demands placed on its predecessor (which is still in use).

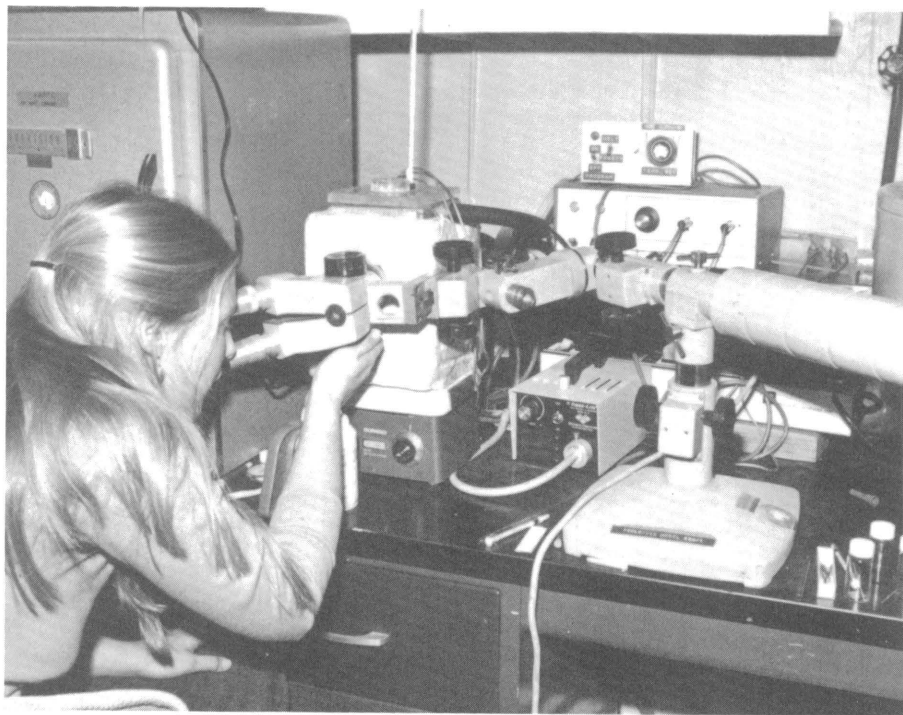
The wet laboratory hosts experiments ranging from fish dissections to chemical analysis. Its inventory includes a Beckman DB-G grating spectrophotometer, a Corning Flame Photometer, and a Wescor Vapor Pressor Osmometer.

Other equipment includes additional autoclaves, incubators, spectrophotometers, and osmometers, nine microscopes, three oscilloscopes, one cell disrupter, three centrifuges, and two portable, refrigerated aquaria.

Finally, the EBC has office space, general work areas, and a small library. The library contains reprints of antarctic biological literature and a microfilm and microfiche collection of publications listed in the *Antarctic Bibliography*.

Richard Cohen, a member of the Hunter College field party during the 1979-1980 austral summer, uses a photographic microscope at Eklund Biological Center. This group's research focused on protein synthesis in antarctic fish as a means of assessing metabolic adaptation to year-round subzero temperatures.

U. S. Navy photo (XAM-0062-11-79) by Douglas K. Nortell.



U. S. Navy photo (XAM-3066-11-79) by Douglas K. Nortell.

At Eklund Biological Center Martha Wolfe, who assisted biologist Arthur DeVries during the 1979-1980 austral summer, uses a freezing chamber to find the freezing point of glycoprotein antifreeze taken from the blood of fish.

The expanded scope and efforts of the U.S. Antarctic Research Program has changed the single-building mode of McMurdo-based biological research. The old Jamesway aquarium has been replaced by a more sophisticated modular structure, built during the 1983-1984 austral summer. The new aquarium includes a small lab separate from the main holding area as well as new and larger tanks. A larger dive locker, added to the Berg Field Center, provides research divers with most necessary equipment, except masks, fins, and dive suits. While some underwater photographic gear is available, divers should consider these stocks as secondary to their own cameras and strobe equipment.

Along with the aquarium and dive locker, nine portable fish huts enable scientists to collect and observe live specimens, activities which are critical for investigations of the marine environment. These wooden structures, built at McMurdo Station, vary in size from 12 by 12 feet to 12 by 20 feet; some of the larger ones have observation towers. They are towed by tracked vehicles (Nodwell 110s) to sites on the sea ice where biologists use them to collect fish samples, to study seals, and to dive beneath the ice. Because the huts are designed for use on the sea ice, the length of time that they will be deployed depends on the sea ice formation and deterioration. Although they could be used as early as June, their primary use is between October and De-

ember. All of the huts have provisions that could be used if an emergency would confine a science party to a hut.

Laboratory management

Maintaining a modern laboratory in an area as remote as Antarctica requires careful planning and management. During pre-season planning, the laboratory facilities manager begins by reviewing each grantee's space request. Based on this information the manager proposes a laboratory layout to the NSF.

Pre-season planning also must anticipate equipment and supply needs. Consequently, the principal investigator for each approved project must consider equipment and supply requirements far in advance of deployment. Complete lists of equipment, general laboratory supplies, and all required chemicals must be compiled along with current purchasing information (catalog numbers, descriptions of necessary equipment and supplies, and prices). These lists are submitted to the NSF for review, with a copy forwarded to the laboratory facilities manager for action. The manager identifies items that cannot be supplied from existing stocks and buys these. This detailed planning insures that the laboratory will be able to adequately support all projects planned for that season. Such advanced planning enabled the EBC to directly sup-

port 48 researchers conducting 10 biological projects during the 1983-1984 field season.

The laboratory manager also reviews proposals to identify any radionuclides destined to be used in projects at McMurdo Station. The use of such radioactive materials in Antarctica requires special precautions to avoid contaminating the environment and to ensure safety. Although each investigator or group of investigators using these materials ultimately is responsible for controlling and documenting their use, the Commander of the Naval Support Force, Antarctica, has specific responsibility for ensuring that precautions are taken and safety is assured. At McMurdo Station the EBC manager stores radioactive materials in a designated central storage area except when the isotopes are in use. Investigators must tell the manager where the isotopes will be used and return them to storage after each use. Specific information on using radioactive materials in Antarctica can be obtained from NSF's Division of Polar Programs.

Continued growth

New equipment will be added to the laboratory's stock during the 1984-1985 austral summer. These additions include two Labconco radioisotope fume hoods, another Radiometer/Copenhagen pH meter (model PHM-84), and two model 815 Precision low temperature incubators. Five new electronic balances will replace the units currently in use. Among the five are a Mettler AE163 for analytical weighing, a PE1600 for general use, and a PL16 for heavier loads. The addition of these machines should make an already well equipped laboratory even more able to support research.

Readers should direct questions about the biological laboratory and its equipment to the laboratory facilities manager at ITT/Antarctic Services, Inc.

—John Wood, Laboratory Facilities Manager, ITT/Antarctic Services, 621 Industrial Avenue, Paramus, New Jersey 07652.

References

- Carl R. Eklund Biological Center dedicated at McMurdo Station. 1972. *Antarctic Journal of the United States*, 7(2): 68.
- Wohlschlag, Donald E. 1963a. Biological research facilities at McMurdo Station. *Bulletin of the U. S. Antarctic Projects Officer*, 5(1): 17-21.
- Wohlschlag, Donald E. 1963b. The biological laboratory and field research facilities at the United States "McMurdo" Station, Antarctica. *Polar Record*, 11(75): 713-718.

Ice cores available for research

Through the investigation of ice cores, scientists have an opportunity to reconstruct climatic conditions and the composition of the atmosphere over several thousand years. Ice drilled from the ice sheets of Greenland and Antarctica already has provided significant information. Scientists have tested these cores for physical and mechanical properties, entrapped gases and foreign particles, dissolved solids, stable and radioactive isotopes, and meteorological data such as accumulation rates.

Since 1957, 16 ice cores (see table) have been drilled in Greenland and Antarctica with support from the National Science Foundation. Eleven of these were taken from depths greater than 200 meters, but only three (two from Greenland and one from Antarctica) have penetrated the ice sheets to bedrock. Although portions of these cores have been subjected to destructive testing, sections are still available for study.

The State University of New York at Buffalo, under a National Science Foundation contract (DPP 75-08512), operates the facility at which these cores are stored. The Ice Core Storage Facility at the Department of Geological Sciences not only stores the cores but also maintains a catalog of core availability and use. With NSF approval, the facility provides samples to qualified scientists. Procedures for acquiring ice cores are described briefly below. A catalog containing detailed information on the cores available for study is available

from the Curator, Ice Core Storage Facility, Department of Geological Sciences, State University of New York at Buffalo, 4240 Ridge Lea Road, Amherst, New York 14226.

Who can obtain ice cores

The fundamental criterion for approving use of ice cores is the availability of suitable core samples for proposed investigations. Interested scientists should consult the facility's curator about specific requirements for their investigations before submitting any request.

Before approving a scientist's request for samples, NSF considers the scientific merit of the proposed study to judge whether or not the request represents prudent use of the available core. Scientists receiving NSF funds for research involving ice-core studies automatically have access to the facility but must submit a request form and obtain approval before acquiring specific samples. Also, for 1 year after acquisition, requests from investigators who helped collect the ice cores are given preference.

NSF supports ice-core studies through its normal research funding system. Information on research opportunities in the Arctic and Antarctic may be obtained from the Polar Information Program, Division of Polar Programs, National Science Foundation, Washington, D.C. 20550.

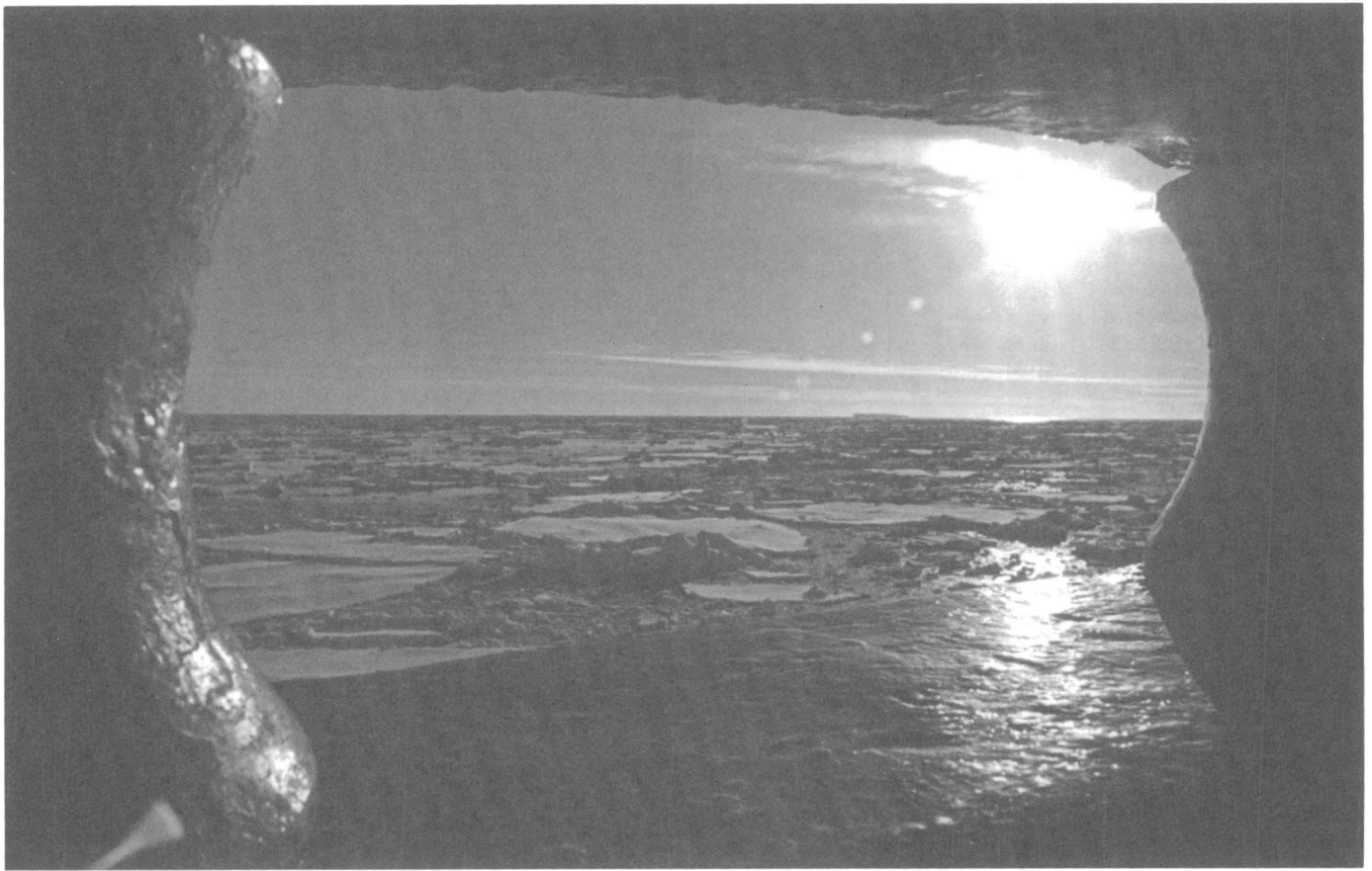
How to obtain cores

After preliminary consultation with the curator of the Ice Core Storage Facility, scientists submit a sample request form (in the booklet available from the State

Deep ice core drilling in Greenland and Antarctica.*

Year drilled	Method of drilling	Depth of drilling in meters	Location
1957	dry bored	411	Site II, Greenland
1961	thermal	185	Camp Century, Greenland
1962	thermal	237	Camp Century, Greenland
1963-66	thermal & eletromechanical	1,390	Camp Century, Greenland
1971	thermal	372	Dye-3, Greenland
1973	thermal	398	Milcent, Greenland
1974	thermal	405	Crete, Greenland
1977	dry bored	84	Dye-2, Greenland
1979-81	electromechanical	2,037	Dye-3, Greenland
1957	thermal	138	Old Byrd, Antarctica
1958	rotary	254	Little America V, Antarctica
1968	thermal & eletromechanical	2,164	Byrd Station, Antarctica
1971	thermal	380	Byrd Station, Antarctica
1976	dry bored	104	J-9, Antarctica
1977	wireline	170	J-9, Antarctica
1978	thermal	416	J-9, Antarctica

* From *Ice core samples from Greenland and Antarctica*, Ice Core Storage Facility and Information Exchange, Department of Geological Sciences, State University of New York at Buffalo.



U. S. Coast Guard photo by Milt Putnam.

Taken from the deck of the U. S. Coast Guard icebreaker *Southwind*, this photograph shows February sea ice in the Bellingshausen Sea. Each year antarctic sea ice fluctuates from 4 million square kilometers in February to 20 million square kilometers in September. Although scientists have observed and studied sea ice, the causes of ice-cover variations and related effects have remained elusive. In 1983 the National Aeronautics and Space Administration published a compilation of sea ice data acquired by the satellite Nimbus 5. These data cover only 4 years, but by analyzing them scientists have obtained new understanding of sea ice variations.

University of New York at Buffalo) to the ice core facility with copies to the NSF Division of Polar Programs (DPP). The curator determines which cores are available and forwards this information with the request form to DPP for evaluation. Before approving or denying a request, the chief scientist of DPP reviews the request and evaluates the curator's comments and the scientific merit of the research. If a request is denied, the scientist can revise and resubmit the request for evaluation; in such cases the scientist may wish to consult with DPP's chief scientist or the ice core facility curator.

Approved requests are for one-time access to the facility. Investigators must use the samples within 1 year or return them; samples not used during laboratory analysis also should be returned to the facility. Investigators are required within 1 year to provide the curator with a brief report of their work and should follow up this report with two reprints of any work published resulting from their studies. Subsequent requests for samples will not be filled until these reports are submitted.

Bibliographic information

Ice-core studies and related work have resulted in numerous published papers. In one literature review, P. D. MacKinnon cites 345 papers on ice-core research (Ice cores. *Glaciological Data*, May 1980. World Data Center A for Glaciology—Snow and Ice, Institute of Arctic and Alpine Research, University of Colorado, Boulder, Colorado 80309). Another source of information on antarctic research results is the *Antarctic Bibliography*, compiled and published by the Library of Congress for NSF.

NASA publishes new sea ice data compilation

Sea ice, which covers 7 percent of the world's oceans, has a significant role in the global climate system. When ocean water

freezes or melts, various interactive physical processes (wind stress, ocean-heat flux, solar radiation, cloud cover, ocean currents, and others) are involved. Regional and global changes in ice cover influence oceanic and atmospheric conditions; changes in the oceans or atmosphere, in turn, influence the distribution and extent of sea ice. Antarctic sea ice, with its dramatic seasonal fluctuations from 4 million square kilometers in February to 20 million square kilometers in September, is important to such oceanic processes as water circulation and nutrient levels and to the global heat balance.

Scientists have observed and studied sea ice, yet the causes of ice-cover variations and their related effects often have remained elusive. In 1983 the National Aeronautics and Space Administration published *Antarctic sea ice, 1973-1976: Satellite passive-microwave observations*, a data compilation obtained by the satellite Nimbus 5. In the book's preface William W. Kellogg of the National Center for Atmospheric Research notes that this volume represents a "striking step forward in both the technology of remote sensing of the Earth's environment from

satellites and the provision of new and important geophysical data on the Antarctic."

The 206-page NASA volume presents the investigation's results in an introduction and four chapters—general physical characteristics of the southern ocean, theory and observations of microwave emissions and derived sea ice characteristics, sea ice seasonal growth/decay cycle, and monthly sea ice concentrations. Chapters 3, 4, and 5 include maps for brightness temperatures for each of the 4 years, 4-year averages of mean monthly sea ice concentrations, and mean monthly sea ice concentrations (derived from the brightness temperatures), respectively. Chapters 4 and 5 graph aspects of sea ice cover for the whole southern ocean and for five oceanic sectors—Weddell Sea, Bellingshausen-Amundsen Seas, Ross Sea, the Pacific Ocean, and Indian Ocean sectors.

Three appendixes supplement the book. Appendix A describes how the data were processed, compiled, and mapped; Appendix B includes gray-scale images and contour versions of the ice concentration maps in Chapters 4 and 5; Appendix C presents sample distributions of the area of sea ice as a function of sea ice concentrations.

Passive-microwave data

Nimbus 5, launched in December 1972, carried an Electrically Scanning Microwave Radiometer (ESMR), a passive-microwave detection instrument. Previously this instrument had been tested aboard airplanes flying over the Arctic. For 41 months during the next 4 years the ESMR instrument recorded the first all-weather, day-or-night observations of the south polar region.

ESMR detects thermal microwave emissions, radiation naturally emitted from the Earth's surface. Unlike visible and infrared radiation, microwave radiation is not reflected from or absorbed by clouds. The intensity of microwave radiation is expressed as a brightness temperature, which is proportional to an object's temperature but is influenced by its physical properties. To study sea ice, scientists combine the known physical properties of sea ice with the observed microwave radiance and determine sea-ice concentrations quantitatively. They are also able to differentiate between sea ice forms such as new ice, first-year ice, multiyear ice, or summer ice and between ice and open water.

The antarctic sea ice data are unique for "(1) their comprehensive temporal and spatial coverage, and (2) their information regarding the amount of open water within the ice pack." From these data the NASA scientists have produced a complete map of southern ocean brightness temperatures for 3-day periods from 1973 through 1976;

data from 3 days of the satellite's orbit were necessary to obtain adequate spatial coverage of the Antarctic. There are some gaps due to invalid or lost data.

The resolution of the ESMR sensor was 30 kilometers. The scientists averaged the monthly brightness temperature for 30-by 30-kilometer areas to derive the monthly sea ice concentration, which are based on the percentage of the area covered by sea ice.

This NASA publication illustrates the potential information that a long-term record of global sea ice concentration could have for climate studies. Although this record covers only 4 years, data analysis has provided new insights into the nature of sea ice cover and variation.

During the 4 years studied, total sea ice coverage decreased by 10 percent of the annual mean, but the decrease was not evenly distributed around the continent. It decreased significantly in the Weddell and Ross Seas sectors, while increasing in the Bellingshausen-Amundsen Seas Sector. Within the seasonal ice pack zone ice concentrations varied from 50 to 80 percent,

indicating that more open water exists in leads and polynyas than had been known previously. One contributor to the overall decrease in sea ice was the large, open-water polynya in the Weddell Sea Sector during winter for 3 years; this polynya accounted for a 23-percent decrease in Weddell Sea ice. "The high degree of interannual variability of sea ice precludes the determination of long-term trends from such a short record, but the images in this document demonstrate that satellite microwave data provide unique information on large-scale sea ice conditions . . . that [are] needed for determining climatic conditions in polar regions and possible global climate changes."

Antarctic sea ice, 1973-1976: Satellite passive-microwave observations (NASA SP-459) is for sale by the Government Printing Office in Washington, D.C. When ordering, cite GPO stock number GPO-033-000-00887-2; the price is \$21. Data also are available on magnetic tapes from the World Data Center A for Rockets and Satellites/National Space Science Data Center, Greenbelt, Maryland 20771 and the World Data Center A for Glaciology, Boulder, Colorado 80309.

A tracked vehicle drives away from a hut on McMurdo Sound sea ice. From these huts biologists collect fish for study, dive underneath the sea ice, and observe seals. The wooden structures, which are built at McMurdo Station, range in size from 12 by 12 feet to 12 by 20 feet and are towed by tracked vehicles to the study site.

NSF photo by Russ Kinne.





U. S. Navy photo (90385-12-78) by A. Jackson.

Scientists and support personnel load a ski-equipped Hercules airplane near the Dufek Massif (82°36'S 52°30'W) in December 1978. The 27-mile-long massif is west of the Forrestal Range in the northern part of the Pensacola Mountains; it is an outcropping of the Dufek intrusion, which may be rich in minerals. Geophysical surveys conducted over the last two decades have provided geologists with some information about the minerals in this region, but because most of the region is covered by ice, the existence and abundances of mineral resources is unknown. At present these data are insufficient to assess the intrusion's resource potential.

U.S. Geological Survey geologists review potential petroleum and mineral resources

What are the potential petroleum and mineral resources of Antarctica? U. S. Geological Survey (USGS) geologists raise this question in a 1983 publication, *Petroleum and mineral resources of Antarctica*. Produced in cooperation with the National Science Foundation, the 75-page book comprises three reports on petroleum resources, mineral occurrences in Antarctica, and the possible resources of the Dufek Massif. The book was edited by John C. Behrendt, U. S. Geological Survey.

Along with other U.S. scientists, USGS geologists have conducted research in Antarctica since 1947, and geologists and geophysicists of various nations have collected data since the International Geophysical Year (1957-1958). Since 1976, several countries have conducted state-of-the-art multichannel seismic reflection and aero-

magnetic surveys over the continental shelf. Although these investigations have provided much information, the nature and extent of petroleum and mineral resources in Antarctica and beneath the surrounding oceans is still undefined.

The first report, "Are there petroleum resources in Antarctica?" by John C. Behrendt, emphasizes that the "only mineral commodity with the possibility of exploitation within the next two or three decades is petroleum." However, the author points out that there is no direct information on petroleum reserves beneath the continental shelves or on land beneath the ice sheet. Based on available geological and geophysical data and on inferences made from Gondwana reconstructions, Behrendt points to the most likely areas for petroleum reserves—areas bordering on the Ross,

Amundsen, Bellingshausen, and Weddell Seas in West Antarctica and near the Amery Ice Shelf in East Antarctica. He cautions that comparisons with oil-rich areas that previously made up Gondwana can lead to false assumptions; in many cases petroleum-bearing rocks occur in strata that postdate the Gondwana breakup. In his article Behrendt reviews geophysical data, drilling studies (particularly the Deep Sea Drilling Project), and potential environmental hazards.

"Mineral occurrences of Antarctica," by Peter D. Rowley, Paul L. Williams, and Douglas E. Pride, reviews the available data on minerals and discusses their significance. Among the metallic and nonmetallic minerals considered are iron, copper, molybdenum, nickel, chromium, cobalt, uranium, thorium, precious metals (gold, silver, and platinum), mica, graphite, phosphate, and coal. Although many of these minerals can be found throughout the continent, "nearly all occurrences. . . are small and isolated, and presently have no commercial importance." The authors cite coal and iron in the Prince Charles Mountains (72°S 67°E) and coal in the Transantarctic Mountains as possible resources "if located on another continent." The antarctic environment, high mining costs, and the relatively sparse amount of geologic and geophysical data make any of the potential resources economically unattractive for exploitation.

The final report, "The Dufek intrusion of Antarctica and a survey of its minor metals and possible resources" by Arthur B. Ford, describes the intrusion and the various resources that might occur there. Located in East Antarctica's Pensacola Mountains, the Dufek intrusion is "one of the world's largest differentiated, layered mafic igneous complexes." It "approaches South Africa's Bushveld Complex in size and is an order of magnitude larger than any other known body of this type."

Although geophysical surveys of the intrusion, which was discovered in 1957, have not completely defined its perimeters, they do suggest that its area is greater than 50,000 square kilometers. The Survey has conducted three studies of the intrusion; 1978-1979 aeromagnetic geophysical surveys of the Pensacola Mountains and the southern Forrestal Range extended earlier studies and attempted to determine how far the intrusion extends under the ice along the southern margins of the Ronne and Filchner ice shelves. Soviet scientists also have conducted geological and geophysical surveys of the intrusion, but these data were not available to the author. Speculation based on comparisons with similar intrusions suggests that the Dufek intrusion might include chromium, copper, nickel, vanadium, titanium, iron, and platinum-

group metals. Because most of the intrusion is covered by ice, the existence and abundances of these minerals is unknown. Ford points out that the available data are inadequate to assess the resource potential. "The extremely limited amount of geochemical data and lack of resource-oriented field study prevent estimation of either potential abundances or probability of occurrence of such resources at the present time."

The outlook of these authors for mineral exploitation in Antarctica is summed up in John Behrendt's opening sentence: "No known petroleum or mineral resources occur in Antarctica."

Petroleum and mineral resources of Antarctica (Geological Survey Circular 909) is available, upon request, from the Branch of Distribution, U. S. Geological Survey, 604 South Pickett Street, Alexandria, Virginia 22304.

Richard Tillson of the Polar Ice Coring Office (University of Nebraska) puts an ice core into a shipping container. This core was drilled in 1979 at Dome C in East Antarctica. Ice cores like this one are returned to the United States so that scientists can test the ice for physical and mechanical properties, entrapped gases and foreign particles, dissolved solids, stable and radioactive isotopes, and meteorological data such as accumulation rates.

U. S. Navy photo (90280-12-78) by Thomas E. McCabe, Jr.



NSF photo by Russ Kinne.

Biologists check radio-tagged Weddell seals on McMurdo Sound sea ice.

Target date for antarctic proposals

June 1, 1984, is the target date for receipt of proposals for research in Antarctica during the 1985-1986 austral summer or study of antarctic data in the United States during 1985. U. S. scientists should submit their proposals to the National Science Foundation's Central Processing Section. Proposals, with project descriptions no longer than 15 single-spaced pages, should be prepared according to the instructions in a preparation kit available from the Division of Polar Programs (202/357-7817) and should be submitted by the scientist's employing organization.

The antarctic proposal preparation kit includes the NSF booklet *Grants for Scientific and Engineering Research* (NSF 83-57), descriptions of research opportunities and activities, and all necessary forms and instructions. Copies are available from the Polar Information Program, Division of Polar Programs, National Science Foundation, Washington, D. C. 20550 (telephone, 202/357-7817). Questions about specific research programs should be directed to the program manager of that scientific discipline at the Division of Polar Programs.

For antarctic research at least 15 months is required for proposal review and for logistics and support planning. Because research in Antarctica is expeditionary, operational and logistics planning are considered from the beginning of the review process. In the proposal such requirements for the research should be addressed fully. For investigators who have not worked previously in Antarctica, contact should be made with the Division of Polar Programs operations section.

Scientists are reminded that projects requiring large amounts of equipment may not be fielded until 1 year later than the 1985-1986 austral summer, so that equipment may be transported by ship rather than by airplane.



Hungary joins Treaty nations

On 27 January 1984 Hungary became the 29th country to recognize the Antarctic Treaty when it acceded to the Treaty. Bulgaria, Czechoslovakia, Denmark, the German Democratic Republic, Italy, the Netherlands, Papua New Guinea, the People's Republic of China, Peru, Romania, Spain, and Uruguay are the other acceding nations. These countries agree to abide by the Treaty, but do not participate in its operation.

The contracting nations, or consultative parties, all of which were original treaty signatories or have substantial programs in Antarctica, are Argentina, Australia, Belgium, Brazil, Chile, the Federal Republic of Germany, France, India, Japan, New Zealand, Norway, Poland, the Republic of South Africa, the Union of Soviet Socialist Republics, the United Kingdom, and the United States of America. Representatives of these nations participate in periodic consultative meetings to formulate recommendations aimed at furthering the objectives of the Treaty.

Any nation may accede to the Treaty, and nations conducting substantial research in Antarctica may become consultative parties.

Translation published

Problems of the Arctic and Antarctic, 55 (1984, TT 82-00-103) has been translated from Russian for the National Science Foundation and may be purchased from the National Technical Information Service (NTIS).

This 167-page volume, edited by V. V. Ivanov, is based on reports presented and discussed during the All-Union Conference held at the Arctic and Antarctic Scientific Research Institute in November 1976. The book's 15 papers focus on possible changes in natural conditions (especially ice, hydrologic, hydrochemical, and meteorological regimes) in the rivers and estuaries of the western Siberian Arctic. The opening article reviews studies that evaluate possible changes in these regions if water from the rivers is diverted; it also describes some methods for predicting such changes. Five papers consider the status of hydrologic and bed regimes of the lower reaches and estuaries of the rivers. Focusing on the River Ob, these authors evaluate the potential changes in hydrologic regime and suggest areas for future research. A sec-

ond group of papers deals with water and heat balances of the land hydrosphere-atmosphere system in the lower Ob and how these relate to economic pressures and regional climate change. Other topics are the hydrochemical regime of western Siberian rivers and the Kara Sea, peculiarities of the Arctic Ocean hydrologic regime, and possible trends caused by partial withdrawal of discharges from Siberian rivers into the Arctic ocean. The volume concludes with articles discussing the influence of river bed changes on navigation and the potential effect on the fishing industry if water discharging from the lower Ob is partially withdrawn.

The National Science Foundation acquired the translation from Amerind, a New Delhi contractor paid using excess Indian currencies held by the United States. Scientists are encouraged to suggest titles of significant works for translation. Suggestions in letter form should contain full bibliographic information on the titles, evaluation of the work's scientific importance, and description of the anticipated audience in and benefit to the United States. The letter should be sent to the Polar Information Program, Division of Polar Programs, National Science Foundation, Washington, D. C. 20550. Usually more than a year is required for translation and publication.

When ordering books from NTIS (5852 Port Royal Road, Springfield, Virginia 22151;

telephone 703/487-4835), cite the TT number. Because prices change periodically, please contact NTIS for current information before ordering. A list of other books translated and published in this program appeared in the March 1981 issue of the *Antarctic Journal of the United States*; an updated copy of this list is available from the Polar Information Program.

For the record . . .

Personnel at Amundsen-Scott South Pole Station reported that November 1983 was the coldest November since the station opened in 1957. The monthly climate summary revealed that the average temperature was -43.1°C – -4.7°C below the 26-year average for November at this station. During the month temperatures ranged from -33.8°C (22 November) to -55.1°C (1 November).

In 1957, the station's first year of occupation, the average temperature for November was -37.2°C . The maximum temperature for that month was -19.4°C (22 November); and the minimum, -48.3°C (1 November).

Foundation awards of funds for antarctic projects, 1 October to 31 December 1983

Following is a list of National Science Foundation antarctic awards made from 1 October to 31 December 1983. Each item contains the name of the principal investigator or project manager, his or her institution, a shortened title of the project, the award number, and the amount awarded. If an investigator received a joint award from more than one Foundation program, the antarctic program funds are listed first, and the total amount of the award is listed in parentheses. Awards initiated by the Division of Polar Programs contain the prefix DPP and those by the Division of Ocean Sciences the prefix OCE in the award number.

Glaciology

Oeschger, Hans. University of Bern, Bern, Switzerland. Gas analysis, analysis of radioactive isotopes, and processing of ice cores from South Pole. DPP 82-10926. \$80,900.

Atmosphere sciences

Wood, Frank B. University of Florida, Gainesville, Florida. Automated photometry of selected stars at the South Pole. DPP 82-17830. \$9,886.

Biological and medical sciences

Erickson, Albert W. University of Washington, Seattle, Washington. Population studies of seals in the ice-edge zone of the southern ocean. DPP 82-18339. \$49,932.

Hollin, John T. University of Colorado, Boulder, Colorado. Sea level test for antarctic ice disintegrations and surges. DPP 83-07160. \$93,563.

Holm-Hansen, Osmund. University of California, La Jolla, California. Antarctic marine ecosystem research at the ice-edge zone (AMERIEZ): Growth, feeding, and early development of krill. DPP 82-19147. \$75,000.

Landrum, Betty J. Smithsonian Institution, Washington, D.C. Cooperative systematic studies and analysis of polar biological materials. DPP 82-14878. \$93,645.

Robison, Bruce H. University of California, Santa Barbara, California. Trophodynamics of the mesopelagic fauna in southern Drake Passage. DPP 81-19621. \$9,699.

Zapol, Warren M. Massachusetts General Hospital, Boston, Massachusetts. Computer studies of free diving Weddell seals: fetal and maternal blood gas tensions and intermediary metabolites. DPP 81-00212. \$19,925.

Earth sciences

Quaide, William L. National Aeronautics and Space Administration, Washington, D.C. Support of Lunar and Planetary Institute for advisory services on, curation and distribution of, and dissemination of information about antarctic meteorites. DPP 83-04943. \$6,470.

Rowell, Albert J. University of Kansas Center for Research, Inc., Lawrence, Kansas. Stratigraphic evolution and tectonic setting of the carbonate platforms of the Ross sequence, Transantarctic Mountains. DPP 83-17966. \$9,610.

Meteorology

Ohtake, Takeshi. University of Alaska, Fairbanks, Alaska. Hygroscopic aerosols related to the formation of ice crystals in the atmosphere. DPP 83-03964. \$73,819.

Ocean sciences

Fanning, Kent A. University of South Florida, Tampa, Florida. Plankton and the marine geochemistry of radium, germanium, and barium. DPP 82-14213. \$1,500.

Fisher, Robert L. University of California, La Jolla, California. Structural and petrologic study of the plate boundary in the southwesternmost Indian Ocean. DPP 81-17702. \$130,813.

Foster, Theodore D. University of California, Santa Cruz, California. A physical-chemical reconnaissance of a deep-water formation region off Antarctica. \$184,106.

Abbott, J. Lynn. University of California, La Jolla, California. Shipboard technician support. OCE 83-16603. \$79,272. (\$399,913).

Support and services

Becker, Robert A. ITT/Antarctic Services, Inc., Paramus, New Jersey. Support of the United States Antarctic Research Program during the 1983-1984 austral summer. DPP 80-03801. \$12,000,000.

Becker, Robert A. ITT/Antarctic Services, Inc., Paramus, New Jersey. Support of research programs on the USCG ice-breaker *Westwind* and the R/V *Melville* during the antarctic marine ecosystem

research of the ice-edge zone project and *Melville* programs during legs 5 and 6. DPP 80-03801. \$244,000.

Shoemaker, Brian G. Department of Defense, Washington, D.C. Logistics support of the U.S. program in Antarctica. DPP 76-10886. \$30,000,000.

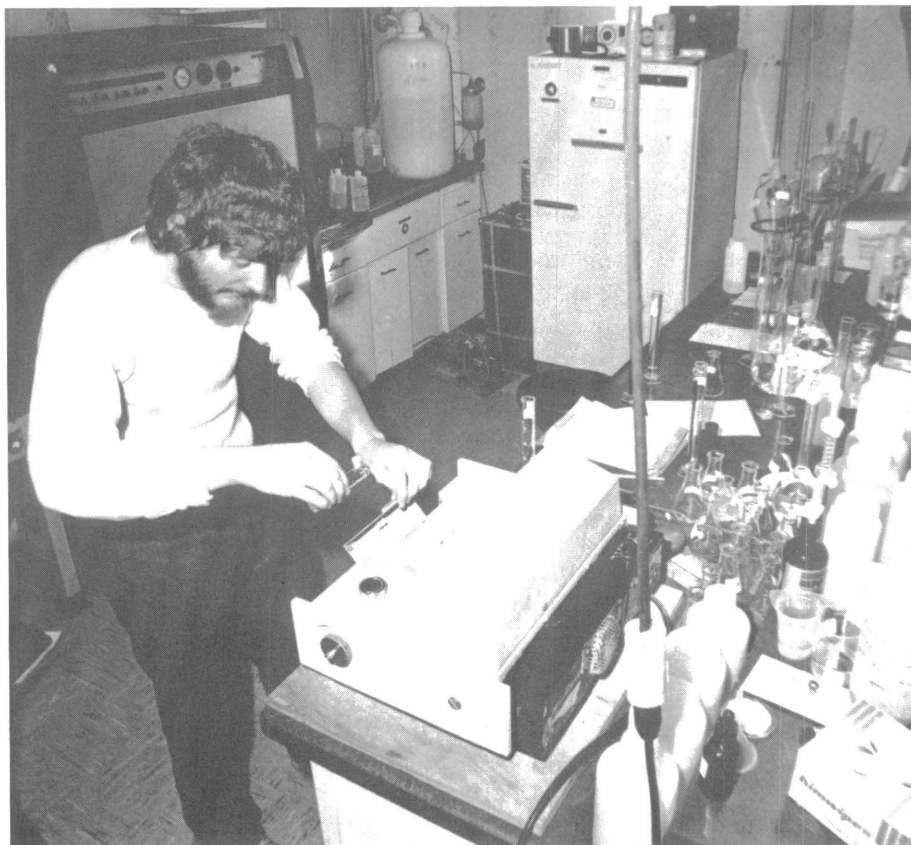
Shor, George G. University of California, La Jolla, California. Ship operations support for the R/V *Melville*. OCE 80-24472. \$598,842.

Correction

Brief descriptions of projects planned for the 1983-1984 austral summer appeared in the September 1983 issue of the *Antarctic Journal*. On page 4, the entry for "Growth patterns in antarctic fish" failed to indicate that Richard L. Radtke, Hawaii Institute of Marine Biology (University of Hawaii), is co-principal investigator with Timothy E. Targett, Skidaway Institute of Oceanography.

Don Canfield, from Miami University, prepares to analyze samples for phosphate levels. In this project conducted during the 1980-1981 austral summer, scientists studied water samples taken from the Onyx River and Lake Vanda in southern Victoria Land's ice-free valleys. Among their objectives were to determine whether trace metals and nutrients are being recycled and how this influences the lake's ability to support life.

U. S. Navy photo (XAM-0493B-12-80) by Harry E. Weddington.



Weather at U.S. stations

Feature	November 1983				December 1983				January 1984			
	McMurdo	Palmer	Siple	South Pole	McMurdo	Palmer	Siple	South Pole	McMurdo	Palmer	Siple**	South Pole
Average temperature (°C)	- 9.3	0.3	-21.2	-43.1	- 3.5	1.8	-13.7	-29.2	- 2.6	2.9		-27.6
Temperature maximum (°C) (date)	- 0.5 (30)	7.3 (17)	- 7.6 (24)	-33.8 (22)	7.0 (15)	8.7 (12)	- 4.1 (24)	-24.0 (27)	6.1 (21)	7.2 (15)		-19.0 (18)
Temperature minimum (°C) (date)	-15.0 (4)	-5.7 (22)	-36.4 (1)	-55.1 (1)	-15.7 (8)	-3.2 (18)	-24.2 (2)	-38.9 (1)	-10.6 (12)	-2.0 (16)		-33.5 (31)
Average station pressure (mb)	975.9	977.3	855.2	675.9	987.8	977.6	859.3	686.4	995.6	986.7		693.4
Pressure maximum (mb) (date)	991.9 (13)	997.1 (30)	865.1 (30)	684.05 (15)	1002.8 (23)	874.3 (11)	698.4 (12)	1010.6 (13)	1020.6 (20)	1020.6 (31)		708.6 (20)
Pressure minimum (mb) (date)	958.3 (5)	948.7 (13)	846.4 (6)	668.3 (4)	972.2 (29)	965.5 (6)	850.9 (6)	680.2 (6)	981.2 (1)	968.2 (10)		680.5 (1)
Snowfall (mm)	27.9	223.5	219.9	Trace	17.8	213.4	51.0	Trace	66.0	0.0		Trace
Prevailing wind direction	070°	355°	135°	045°	050°	305°	130°	020°	060°	300°		360°
Average wind (m/sec)	5.2	5.8	4.8	2.3	4.1	3.5	5.4	3.5	5.0	5.9		4.2
Fastest wind (m/sec) (date)	23.7 (3) 050°	28.3 (19) 120°	23.2 (14) 140°	8.7 (22) 045°	23.7 (7) 050°	26.3* (5) 020°	20.1 (13) 140°	10.8 (4) 020°	18.3 (26) 120°	14.4 (10) 120°		11.8 (14) 360°
Average sky cover	7.1	7.9/10	7.3	6.2	5.8	8.8/10	7.5	5.0	5.7	8/10		
Number clear days	4	0	4	9.8	3	0	4.7	14.2	0	3		10
Number partly cloudy days	6	14.8	4	3.8	15	12	3.8	3.5	11	13		4
Number cloudy days	20	15.2	22	16.4	13	18	22.3	13.3	20	15		17
Number days with visibility less than 0.4 km.	0.15	--	6.5	0	0	--	10.8	0	0	--		1.1

Prepared from information received by teletype from the stations. Locations: McMurdo 77°51'S 166°40'E, Palmer 64°46'S 64°3'W, Siple 75°55'S 83°55'W, Amundsen-Scott South Pole 90°S. Elevations: McMurdo sea level, Palmer sea level, Siple 1054 meters, Amundsen-Scott South Pole 2835 meters. For prior data and daily logs, contact National Climate Center, Asheville, North Carolina 28801.

* Also on 15 December from 340°.

** Siple Station closed before the end of January 1984; no monthly summary is available.

National Science Foundation

Washington, D.C. 20550

Official Business

PENALTY FOR PRIVATE USE, \$300

RETURN THIS COVER SHEET TO ROOM 233, IF YOU DO NOT WISH TO RECEIVE THIS MATERIAL , OR IF CHANGE OF ADDRESS IS NEEDED (INDICATE CHANGE, INCLUDING ZIP CODE).

Postage and Fees Paid
National Science Foundation

THIRD CLASS
Bulk Rate

