



## NEWSLETTER FOR THE

# Canadian Antarctic Research Network

## “Ministerial on Ice”

An International Conference in Antarctica, January 1999

### Hon. David Anderson and John C. Davis

Ministers and officials from 23 countries participated in an intensive program of meetings and information sessions in Antarctica in January of 1999. Dubbed the “Ministerial on Ice”, the event brought together Ministers and officials from Antarctic Treaty Parties to gain familiarity with the Ross Sea region and to review a number of important matters related to the Treaty. The meetings also provided an opportunity to discuss issues related to international co-operation, conservation, and governance of the world’s oceans and ocean resources, and how countries might work together on those important initiatives.

Our trip was staged from Christchurch, New Zealand, where we were “kitted out” with full Antarctic gear at the International Antarctic Centre and then flown by Royal New Zealand Airforce C-130 Hercules aircraft to the Pegasus runway on the Ross Ice Shelf. The group was housed at McMurdo and Scott bases and was supported by a collaborative effort involving the New Zealand, U.S., and Italian governments who did everything they could to arrange logistics, accommodations, transportation, meals, and other necessities to make the

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Canadian Fisheries Minister David Anderson (right) and John Davis, Assistant Deputy Minister (Science), Fisheries and Oceans Canada, pose in front of the Canada Glacier, Antarctica.

visit a success. It was no mean feat to deal with the visit of such a large group (roughly 50 people) and have everything run smoothly, safely, and efficiently.

This meeting proved an excellent opportunity to familiarize ourselves with the issues relating to the Antarctic Treaty as well as with the scientific activities in the region. An important perspective for us was the parallel between Canadian Arctic science and Antarctic science, and the need to forge linkages between scientists and organizations working in polar regions. In this regard, the Arctic Council's activities, and those of the Canadian Polar Commission and the Canadian Committee for Antarctic Research are very important. We were therefore very pleased when a number of participants in the scientific workshop sessions highlighted the need for co-operation and exchange of information between scientists working in the Antarctic and Arctic. Although our focus, first and foremost, must be on scientific studies in the Canadian Arctic, we wished to emphasize our interest in fostering more active collaboration and exchange between polar scientists.

The meeting provided members of the party with the opportunity to visit some of the important research sites in Antarctica, including the Dry Valleys region, marine-life study areas, and the Italian Terra Nova Base. Participants also visited historic landmarks, including Scott's Hut at Cape Evans, Shackleton's Hut at Cape Royds, and Scott's Discovery Hut. We posed for a picture at the Canada Glacier (see illustration) and took a flag to Canadian researchers Marianne Douglas, Peter Doran, Paul Langevin, and Derek Mueller, who are studying glaciology and ecosystem dynamics in the area.

At the scientific workshop sessions we had the chance to hear a number of interesting presentations. These included a review of the rationale for scientific work in Antarctica, a discussion of its relevance and importance given issues such as ozone depletion, climate change, heritage, and preservation of Antarctica's unique marine biota, and a perspective on the future direction of Antarctic research.

Speakers from New Zealand, the United States, and Italy provided these presentations, and there was active discussion involving the participants.

At the conclusion of the meeting, participants approved a joint communiqué which emphasized the achievements of the Treaty and stressed the importance of the entry into force of the Protocol on Environmental Protection (Madrid Protocol). The communiqué emphasizes the importance of international co-operation in matters such as climate change studies, and cites the significance of work on the conservation of Antarctic living marine resources and integrated marine and terrestrial ecosystem work. There was lively discussion of the threat posed by continuing illegal, unregulated, and unreported fishing activities for "toothfish", a species of concern to a number of the parties.

Overall, this was a very successful and fascinating visit, truly the "trip of a lifetime" for both of us. We were extremely impressed with the work being done and its relevance to important issues such as environmental impacts and climate change which are of interest to Canadians. It is also evident that Canadians have been very active in the Antarctic for many years and continue to play an important role there, both in terms of science and, increasingly, private-sector tourism and resource development. We are most grateful to the Hon. Simon Upton of New Zealand and our New Zealand, Italian, and U.S. hosts who supported the visit and provided the opportunity to better understand Antarctic science and the issues related to the Antarctic Treaty. We also appreciate the useful briefing material Professor Warwick Vincent and his CCAR colleagues provided prior to the trip. It is indeed gratifying to know that CCAR and the Canadian Antarctic Research Network are upholding a long tradition, and we wish your organization well in its efforts to promote liaison in polar science activities.

**The Hon. David Anderson is Minister of Fisheries and Oceans.  
John C. Davis is Assistant Deputy Minister (Science), Fisheries  
and Oceans Canada.**

## Message from the CPC Chair

### The Canadian Polar Commission: A Strategic Road Map 1999–2000

**Mike Robinson**

On February 10, 1999, the federal government announced the new board of directors for the Canadian Polar Commission (CPC). At the time of the appointments, Jane Stewart, then Minister of Indian Affairs and Northern Development, stated that, "The high quality of the new Board of Directors is a reflection of the wide-ranging input we sought and received from stakeholders, including Aboriginal and northern organizations and the scientific community." Minister Stewart outlined some of the key recommendations made by stakeholders and what she viewed as priorities for the Commission. The board should: set priorities and establish a strategic vision for itself and the Commission with both short-term goals and longer-term objectives; enhance communications with its constituencies, including finding new ways to connect northerners to the work of the Commission; and continue to ensure the efficient use of its resources.

As a result of the direction given by Minister Stewart, the board and staff of the CPC met in March to develop collectively a "strategic roadmap" for the Commission's next three-year term. Drawn from the Canadian Polar Commission Act (February 1991), the document outlines the guiding principles under which the Commission will act and sets out a number of objectives; key among these are the development of mechanisms for regular reporting on the state of Canadian polar science, creation of a Canadian Polar Information Network (CPIN), and establishment of the Commission as a vital proponent of polar knowledge both in Canada and throughout the circumpolar world.

While the North remains a primary focus of the Commission's work, an important aspect is the promotion of Antarctic and bipolar science. With input from the Canadian Committee on Antarctic Research (CCAR), the Commission will work with Canada's Antarctic research community to: raise awareness of Antarctic issues among policy makers, funding agencies, and the science community in general; promote Canadian Antarctic research in the media; explore new opportunities for joint Arctic and Antarctic research; actively

promote Canadian interests within multinational organizations such as SCAR and COMNAP; and encourage bipolar studies within Canadian universities.

The Commission's development of polar knowledge indicators will also provide important insights into the strength of Canada's current commitment to high-latitude science. Derived in consultation with polar knowledge practitioners in northern and southern Canada, the indicators will complement the Commission's ongoing analyses of key trends and common concerns, and provide a valuable input into the public policy process. The Commission's initial indicators report, scheduled for release in the spring of 2000, will be distributed to decision makers and the research community, and posted on the Commission's web site at [www.polarcom.gc.ca](http://www.polarcom.gc.ca).

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**Mike Robinson is Chairperson of the Canadian Polar Commission.**

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## Message from the CCAR Chair

### Working in Partnership for Antarctic and Bipolar Science

**Warwick Vincent**

This year marks the beginning of a three-year term of office for the newly appointed board of the Canadian Polar Commission (CPC), the sponsoring organization for the Canadian Committee for Antarctic Research (CCAR), and Canada's adhering body to the international Scientific Committee on Antarctic Research (SCAR). The new CPC is chaired by Mike Robinson (Executive Director of the Arctic Institute of North America, Calgary) who has designated board members Richard Binder (Inuvik) and Wayne Adams (Halifax) as CCAR's contact points for bipolar liaison on marine harvesting and environmental affairs respectively.

The CPC plays a unique bipolar role in the Canadian federal government system. Under the terms of the Canadian Polar Commission Act (1991), its purpose is to promote the development and dissemination of knowledge in respect to the Canadian North, the circumpolar Arctic region, and Antarctica. This broad polar

mandate gives prominence to scientific research, the acquisition and transfer of knowledge about the polar regions, and international co-operation in these endeavours. This is very much in line with the objectives of SCAR and CCAR, and we look forward to continuing to help the new CPC achieve its mandate in full.

A second major Antarctic event for Canada was the visit by Minister David Anderson and his Assistant Deputy Minister (Science), John Davis, to the “Ministerial on Ice” event sponsored by Antarctica New Zealand in January of this year. We believe that this is the first time a member of the Canadian government has visited the Antarctic continent. I was especially pleased that their New Zealand hosts were able to arrange a visit to the McMurdo Dry Valleys where Canadians have been conducting research since 1911, and which bear several place names referring to Canada and Canadian scientists.

One of CCAR’s primary activities over the last few months has been to formulate a draft strategy for Canadian Antarctic and bipolar science. This planning document will ultimately guide our future priorities for research in the Antarctic region, and for the acquisition of new resources to undertake such research. It is therefore essential that the strategy reflect the views of the full breadth of the Canadian Antarctic/bipolar science community and other interested parties. This document will be widely circulated as a “discussion paper” for comment later in the year; however, if you would like to comment on a draft version at this early stage, please contact Dr. Olav Loken at the CCAR secretariat or myself (see address p. 12). We will be pleased to send you a copy and to receive your input.

**Warwick F. Vincent is Chair of the Canadian Committee for Antarctic Research.**

## Forum of Arctic Research Operators

### Bonni Hrycyk

During the Arctic Science Summit Week in Tromsø, Norway, in April, representatives from 14 countries agreed to establish the Forum of Arctic Research Operators (FARO) as a mechanism to promote international co-operation and collaboration among Arctic science support agencies. Bonni Hrycyk, Director of Canada’s Polar Continental Shelf Project, was elected Chair of the Forum.

While the context in which FARO operates differs in many ways from COMNAP’s Antarctic science research support system, the driving forces are similar in terms of encouraging and facilitating operational support for scientific research through international collaboration for all involved in Arctic research.

Each member country—Canada, China, Denmark, Germany, Iceland, Italy, Japan, Netherlands, Norway, Poland, Russia, Sweden, the United Kingdom, and the United States—attending the Tromsø meeting will designate one or two national representatives to participate in FARO. The national representative(s) will, in turn, serve as a link to and for other operators in their own countries.

A small working group comprising Canada, Norway, the United States, and Sweden will be working together in the coming weeks and months to revise FARO’s terms of reference and to identify possible collaborative activities for FARO to consider. Some initial ideas include establishment of a circumarctic network of ecological observatories to help serve the needs, among others, of the Arctic Monitoring and Assessment Programme (AMAP), and organization of a seminar on technology.

During its early stages, FARO—which is the Spanish word for “lighthouse”—will be supported through the IASC Secretariat. The next meeting is planned for the Arctic Science Summit Week in Cambridge, U.K., in early April 2000.

**Bonni Hrycyk is Director of the Polar Continental Shelf Project.**

## XXIII Antarctic Treaty Consultative Meeting

### Fred Roots

The 23<sup>rd</sup> meeting of Antarctic Treaty Consultative Parties (XXIII ATCM) was held in Lima, Peru, May 24 to June 4, 1999. As with all ATCMs for the past 10 years or so, Non-Consultative Parties (of which Canada is one) were also invited to participate.

The 1999 meeting was attended by all 27 Consultative Parties to the Treaty. Representatives from the Non-Consultative Parties were also present, although only Canada and Colombia attended all technical sessions. Venezuela acceded to the Treaty in March 1999 as a Non-Consultative Party. There are now 44 countries adhering to the Antarctic Treaty. This meeting marked the 40th anniversary of the signing of the Treaty, and there were a number of ceremonial events to celebrate the occasion, including a reception at the Government Palace, hosted and addressed by President Alberto Fujimori of Peru.

Canada was represented by Elaine Koren, Deputy Director, Aboriginal and Circumpolar Affairs, Department of Foreign Affairs and International Trade, and Dr. Fred Roots, Environment Canada.

XXIII ATCM was important in the evolution of Antarctic Treaty Meetings because it was held a full year after the Protocol on Environmental Protection had come into force, allowing for an assessment of the implementation and effectiveness of what is perhaps the most comprehensive international instrument for protection of the environment yet attempted. The implementation is, of course, carried out by the respective countries sponsoring and participating in Antarctic activities, through domestic laws and regulations that each must put in place to ratify or adhere to the Protocol. The international instrument for reviewing and assessing the operation and effectiveness of the Protocol is the Committee on Environmental Protection (CEP), on which all countries adhering to the Protocol have membership. The CEP held its second meeting in Lima—the founding meeting was held in 1998 at XXII ATCM in Tromsø—and this meeting occupied the first full week of XXIII ATCM. At the same time, a parallel set of discussions during the first week was devoted to examination of the legal aspects of determining and enforcing liability for environmental infraction or

damages under the Protocol; when completed, this work will form a legal annex to the Protocol.

As Canada has not yet adhered to the Protocol on Environmental Protection, it is not qualified to be a member of the CEP; however, Canadian representatives were clearly welcomed and encouraged to attend the discussions as observers. By the same token, Canada, not having committed to the Protocol, could not participate actively in discussions on the practicalities of liability. As a result, Canadian participation in these two important developments of the Antarctic Treaty System was largely passive, in contrast to our more vigorous role in the common subject fields before the Protocol came into force.

A workshop on Antarctic Protected Areas held immediately prior to XXIII ATCM made considerable progress in identifying ideas about categorizing such areas, in listing criteria and processes for their establishment, and on the development of management plans. Experience gained in dealing with similar issues in the Arctic proved useful.

### Other ATCM Notes

The meeting adopted several recommendations from the CEP regarding its *modus operandi*, notably the “Guidelines for Environmental Impact Assessment in Antarctica”.

Canada reported on recent developments in the Arctic, especially Arctic Council activities of interest to the ATCM. Delegates stressed the benefits of a bipolar approach to polar science.

The ATCM discussed Antarctic tourism and, with a clear message to Canada, urged, “...Parties... particularly those with Antarctic tourist activities organized in their territory, to adhere to the Protocol [on Environmental Protection] as soon as possible.”

The ATCM requested SCAR to conduct a review of the Specially Protected Species list and to advise on desirable revisions. This is required since:

- 1) Antarctic fur seals, threatened by extinction when the list was drawn up in 1964, are now so numerous in some areas that they pose a threat to the ecological balance, and
- 2) there is an alarmingly high mortality rate among penguins in some areas.

The ATCM noted that overfishing in the Southern Ocean is becoming a serious problem. Species such as the Patagonian toothfish, which constitutes one of the world's last major unregulated stocks, are being rapidly depleted.

It was decided to develop an set of guidelines for Antarctic shipping rather than modify the proposed bipolar *Polar Code* developed by the International Maritime Organization (IMO) with considerable Canadian input.

There was discussion on the effect of the declining number of stations collecting upper atmosphere data in the Antarctic. The U.S. South Pole station is the only one in the interior of the continent, and an Argentine station is the only one on the Antarctic Peninsula that collects such data.

For further information on XXIII ATCM, contact: Dr. Fred Roots, Environment Canada, Tel.: (819) 997-2393; Fax: (819) 997-5813.

**Fred Roots is Science Adviser Emeritus with Environment Canada.**

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## Current Psychological Studies in Antarctica

### Peter Suedfeld

My current research activity involves two international projects. One is the development of a standard psychological battery to be used in the selection of personnel for Antarctic winter-over appointments (Grant et al., 1999). During the past 40 years or so of intensive work throughout the austral winter, selection procedures and instruments have evolved from an almost total emphasis on training and expertise for particular jobs (e.g., construction, cooking, radio operation) to the use of psychiatric "select-out" criteria such as a history of substance abuse or psychotic episodes, to the increasingly sophisticated use of various kinds of tests and interviews.

However, there has been little systematic research on identifying the instruments that best differentiate individuals whose Antarctic work and adaptation are excellent, from those who are

adequate (and "in-between"), as opposed to noting and rejecting those likely to fall below the "adequate" mark. Further, all of the national programs have put together their own selection procedures, ranging from the highly intuitive (e.g., experienced Antarcticans making decisions based on an interview and biographic record) to the highly scientific (e.g., using a range of psychometric measures).

The current project has assembled a battery of psychological instruments specifically designed to tap aspects of personality, social interaction style, motivation, and problem-solving that seem to be relevant to living and working in polar winter conditions. The battery was put together by an interdisciplinary and international team comprised of researchers with long experience working with polar and space crews, and with first-hand Antarctic experience. The battery will be tested first by the British Antarctic Survey, which will administer it to all of its applicants; at the end of the austral winter, their adaptation and job performance will be evaluated and the predictive power of each test in the battery will be assessed (correlation between test scores and adaptation, performance, or both, depending on the test). This procedure will be repeated and refined in a number of national Antarctic programs to develop an optimal battery, available for use in relevant languages.

The second project is the quantitative content analysis of nine diaries, kept by the leaders and medical officers of the French stations Dumont D'Urville (Adelie Land), Port-aux-Français (Kerguelen Island), Alfred Faure (Crozet Island), Martin-de-Vivies (Amsterdam Island), and the medical officer of an Antarctic traverse. Unlike the diaries of early explorers, these were maintained from the beginning for the purpose of research, and the diarists were given a list of issues of particular interest. A total of 1,810 diary entries were made, translated into English, categorized, and coded as they communicated positive, neutral, or negative affect. A number of interesting findings have been made. The most frequent topic mentioned was Group Interaction, within which Interpersonal Conflict was the most frequent subcategory, centering around the exaggeration of trivial issues and problems with crew relief/switchover. The other subcategories were positive: Celebrations, Teamwork, and Group Discussion. The most important positive values were in the categories



of Recreation and Leisure, Food Preparation, and Adjustment; most negative were Equipment, Sleep, Organization–Management, Medical Support, Outside Communications, and Group Interaction. Diarists also noted as negative the pattern of alternating periods of intense work and inactivity, the latter exacerbated by bad weather. These patterns should alert management and station leaders to potential sources of satisfaction on the one hand, and unhappiness on the other, indicating the need to prepare countermeasures.

Time-lines showed interesting differences, for which theoretical explanations are needed. Comparing short- and long-duration missions (with 180 days as the break-point), the former were perceived significantly more negatively. There was a third-quarter decline in positive ratings at Dumont D'Urville, with a decline in the fourth quarter on the islands. Negative experiences peaked in the second quarter period of the mission for leaders, and in the third quarter for physicians.

More of the results, and their interpretation, can be found in Stuster et al. (1999); the material is now being prepared for publication. It is also hoped to expand this methodology to other current and future stations, and to the analysis of the diaries of previous Antarctic teams.

#### References:

- Grant, I., Palinkas, L., Suedfeld, P., Eriksen, H.R., & Ursin, H. (1999). "SOAP: Selection of Antarctic Personnel". Bergen, Norway: Univ. of Bergen. 26p.
- Stuster, J., Bachelard, C., & Suedfeld, P. (1999). "In the wake of the Astrolabe: Review and analysis of diaries maintained by the leaders and physicians of French remote duty stations". Santa Barbara, CA: ANACAPA Sciences.

**Peter Suedfeld is former Chair of the Canadian Committee for Antarctic Research.**

## Arctic and Antarctic Data Management: The Bipolar Context

Alan Saunders



The Canadian Polar Commission played host to the first joint meeting on polar data management June 7–10, 1999, in Ottawa. "Arctic and Antarctic Data Management: The Bipolar Context" brought together representatives of the International Arctic Data Directory (ADD) Council and the Joint Committee on Antarctic Data Management (JCADM), groups representing close to 40 countries and international organizations involved in polar research.

The objective of the meetings was to stimulate joint discussion of issues and approaches to the management of polar data and information; to better co-ordinate science education and training initiatives; to develop policies and strategies that acknowledge the natural linkage between the Arctic and Antarctic research communities; and to establish a common set of standards, protocols, and procedures for the maintenance of high-quality polar knowledge resources at the global level.

The meetings were extremely productive and resulted in the approval of several initiatives, including: development of a framework for future co-operation; publication of a report on bipolar data management; and the organization of regional training workshops. For further information, contact Alan Saunders, Canadian Polar Commission. Tel.: (613) 943-8605; Fax: (613) 943-8607; E-mail: [saunders@polarcom.gc.ca](mailto:saunders@polarcom.gc.ca).

**Alan Saunders is Chair of the International Arctic Data Directory Council and Canadian representative to the Joint Committee on Antarctic Data Management.**

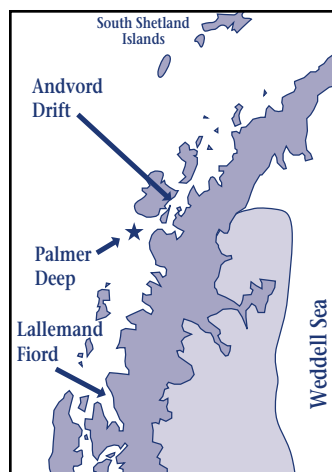
## Glacimarine Studies on the Antarctic Peninsula

Robert Gilbert and Åsa Chong

Between February 21 and March 23, 1998, Robert Gilbert and graduate student Åsa Chong took part in a cruise to the Antarctic Peninsula on the newly commissioned vessel *L.M. Gould*, as part of a project supported by the National Science Foundation under the direction of E. Domack (Hamilton College) and A. Leventer (Colgate University). The study was directed to assessing Holocene paleoenvironmental change along the Antarctic Peninsula, with emphasis on fiords and the Palmer Deep, a closed depression on the continental shelf near Anvers Island. Work at the latter site was linked to the recovery of long cores as part of the Ocean Drilling Project. The Antarctic work extends paleoenvironmental and process studies in lakes and fiords of the Canadian Arctic and Greenland (e.g., Gilbert et al. 1998). Further information is available at <http://qsilver.queensu.ca/~gilbert/>.

During the cruise, we installed sediment traps in Lallemand Fiord near the face of the Muller Ice Shelf. Three sets, each consisting of four traps from near the sea floor to about 150 m below the water surface, were placed in 600 to 800 m of water. Each was equipped with an anchored catch line to permit recovery by grappling. A brief 3.5 kHz sub-bottom acoustic survey was also conducted in the vicinity of the traps and the ice front. Glacimarine sediment 0 to 20 m thick overlies an irregular bedrock surface. The thin sediment cover is a function of the retreat of the ice shelf and the recent exposure of the sea floor, and the low input of terrestrial sediment from the ice shelf and tributary glaciers.

A study was also conducted of glacimarine sedimentation in the outer regions of Andvord Bay and nearby shelf, and a novel depositional regime, referred to as "the Andvord drift" was documented (Harris et al. in press). The drift covers 44.5 km<sup>2</sup> and exhibits continuous and discontinuous parallel reflections that conform to peaks and valleys in the acoustic basement as observed in deep-tow boomer/sparker seismic records. This style of drift deposit is a common feature of deep oceanic sediments but is not normally found in continental shelf environments. Measured sedimentation rates of 1 to 3 mm/a on the Andvord drift indicate that the total 40 m drift thickness observed in the seismic records is probably postglacial. The drift contrasts with the basin-fill style of sedimentation normally associated with the Antarctic continental



Site of glacimarine studies, Antarctic Peninsula.

shelf and may play an important role in the carbon cycle. On the basis of an isopach map of drift sediments and previously published core information, the rate of carbon accumulation in the Andvord drift is estimated to be about 1.7 g/cm<sup>2</sup>/ka, which is

comparable to the highest rates reported for the southwestern Ross Sea.

Between March 28 and April 12, 1999, Åsa Chong returned to the Peninsula as part of a cruise on the *N.B. Palmer* under the direction of E. Domack and A. Leventer. The work continued the study begun in 1998 with the recovery of the sediment traps deployed in Lallemand Fiord. Although ice conditions in the fiord were more severe due to calving from the front of the shelf, all trap sets were recovered, and eight undisturbed samples with up to 28 cm of fine-grained sediment were preserved. The sediment consists mainly of faintly laminated black mud, although several traps contained prominent layers of white silt or clay. All samples have been returned to laboratories at Queen's University for detailed sedimentologic study to begin in spring 1999. We anticipate that the results will provide important information about the sedimentary environment of the fiord during the year the traps were deployed; this may be related to long-term data from core records.

Future plans include participation in 2000 by R. Gilbert in study under the direction of E. Domack of the glacimarine sedimentary environment in the vicinity of the Larsen Ice Shelf. A large section of the northern part of the shelf disintegrated during the 1990s, and it is anticipated that the newly exposed sea floor will contain in its sediments a wealth of environmental and paleoenvironmental information.

### Reference:

- Gilbert, R., Nielsen, N., Desloges, J.R., and Rasch, M. 1998: "Contrasting glacimarine sedimentary environments of two arctic fiords on Disko, West Greenland." *Marine Geology*, 147: 63-83.
- Harris, P. T., Domack, E., Manley, R. L., Gilbert, R., and Leventer, A. (in press): "Andvord Drift: a new type of inner shelf, glacial-marine deposystem from the Antarctic Peninsula." *Geology*.

**Prof. Robert Gilbert and Åsa Chong are with the Department of Geography, Queen's University, Kingston, Ont.**



## Influence of Contaminants from McMurdo Station on Antarctic Marine Benthos

Kathleen Conlan

Macerated raw sewage from the 150 to 1000 residents of the U. S. McMurdo Station is released into the Antarctic marine environment year-round at 20 m depth. In 1997–98, wastewater release varied from 52,517 litres/day in the winter low season to 271,547 litres/day in the summer high season. After dilution with water from the station's aquarium and reverse osmosis plant, flow varied from 0.6 to 2 million litres/day. Large particles, which include food and feces, deposit at the mouth of the sewage outfall, accumulating in a large pile roughly 1200 cubic metres in volume. Prevailing currents carry small particles and liquids along the shore. Previous studies have shown the presence of the human bacterium *Escherichia coli* in the water as far as 300 metres offshore of the sewage outfall. Sewage has also affected the benthic fauna near the outfall, with altered community structure, dramatically lower diversity and biomass, and the dominance of disturbance-associated animals.

In 1991, I began working with a team from Moss Landing Marine Laboratories of California to study the biological effects of McMurdo's sewage. In 1996, I returned with a team from Montana State University and California State University, Monterey Bay. We had been awarded a grant by the National Science Foundation to apply new methods to determine if McMurdo's sewage influence was more widespread than previously thought. Our intent was to

determine whether a sewage signature could be distinguished using carbon and nitrogen stable isotopes, and whether this corresponded to the distribution of human bacteria. Every organism contains natural isotopes of carbon and nitrogen, but the proportion varies according to what is eaten. A shift in food source, as from a carnivorous to a vegetarian diet, has been found to result in a shift

in body composition of these isotopes. This principle enables biologists to determine food-web relations and, for pollution studies, the distribution and assimilation of anthropogenic enrichment.

We also intended to follow a different human bacterium, *Clostridium perfringens*, because it survives virtually indefinitely in cold water, while *E. coli* is soon killed. Once dead, the presence of bacteria is not recognizable by lab plating methods. An additional purpose was to determine whether benthic fauna outside the immediate sewage halo assimilated the sewage and showed enrichment effects.

In 1997 and 1998 I joined a team from the University of North Carolina to work on a related project. We predicted that organic enrichment and heavy metals had different effects on benthic communities, and these effects were evident at high taxonomic levels. Organics favoured annelid and nematode worms, while heavy metals preferentially depressed crustacean and echinoderm populations. Our strategy was to lay out dishes full of clean, definite sediment which had been spiked with organics and copper in various combinations and concentrations. In 1997 we set out more than 250 dishes at three sites, leaving them to be colonized for a year. In 1998 we retrieved the sediments, sieved the organisms out, measured the sediments for various chemical parameters, and shipped the animals home for identification and enumeration.

Understanding of contamination effects on the coastal fauna of Antarctica is essential for effective waste management and policy decisions. We hope that our findings will result in better sewage treatment, both at McMurdo Station and at other Antarctic



Photos: Wayne Pollard

stations. Furthermore, we hope that our study will influence the design and interpretation of polar benthic research conducted in the vicinity of human habitation or other sources of organic enrichment.

In our 1996 study, we found a distinct sewage signature contaminating the McMurdo coastline from the sewage outfall to as far as we could sample, which was 824 metres downstream. We also found that the guts of sea urchins and tunicates were contaminated with human bacteria from the station. Starfish, sea urchins, and ribbon worms recorded a shift in nitrogen isotopes in their tissues that corresponded with the sewage signature on the seabed. This indicated that these bottom feeders had assimilated nitrogen from the sewage outfall. Sea urchins registered a similar shift in carbon, indicating that they had assimilated sewage-derived carbon as well. Suspension-feeding clams, soft corals, and tunicates showed no indication of assimilation. The difference between bottom and suspension feeders may be due to a difference in concentration of the sewage. Organic particles trapped on the sediment may concentrate before they are consumed by passing animals, while particles suspended in the water column are more dispersed. We also found that starfish and sea urchins showed a diet shift at the sewage outfall and significantly heavier and lipid-rich food storage organs.

Results of our settling experiments in 1997–98 are incomplete, but indicate that sewage selects for annelid and nematode worms, while crustaceans and echinoderms are able to colonize sediments contaminated with copper. Where both of these types of contaminants co-occur, neither group may be found. Selective responses of certain animal groups to different types of pollution should enable us to predict human effects more precisely in the future.

We conclude that the McMurdo Station sewage outfall influences the coastal fauna to at least 824 metres downstream. Bottom-feeding animals are assimilating the waste and are contaminated by human bacteria. The sewage ranges sufficiently to infect invertebrates that formed the basis for seminal ecological studies in seemingly pristine environments. The widespread presence of human bacteria in the water column and on the seabed near McMurdo Station may be of concern. Infection of other invertebrates in

the area may lead to transfer of human bacteria to other marine life as well. We have some evidence that seals pick up human bacteria during the summer high season. This and previous studies collectively indicate that a wastewater treatment facility should be installed at McMurdo Station. Our understanding is that the National Science Foundation is currently evaluating ways to improve sewage treatment at McMurdo Station.

**Kathleen Conlan is a polar scientist with the Canadian Museum of Nature, Ottawa.**

### Some Recent Canadian Contributions to Antarctic Science

(♣ denotes Canadian co-authors, except where all are Canadians.)

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## NEWS IN BRIEF

**Stewart J. Moorhead**, a University of Waterloo graduate now in a Ph.D program at Carnegie Mellon University in Pittsburgh, PA, works on the NASA-funded Robotic Antarctic Meteorite Search project. The project uses a robot, NOMAD, to search for meteorites on blue ice fields in Antarctica. Fieldtests were done at the Patriot Hills base of the Chilean Air Force, and scientists from Canada, Chile, France, and the United States participated. Stewart was responsible for the autonomous navigation and obstacle avoidance capability of the robot. As this was the first autonomous robot to operate in Antarctica, researchers were particularly interested in how the system, especially the robot's perception sensors (stereo cameras and a laser scanner), would perform in a polar setting. For more details, see the project website at [www.frc.ri.cmu.edu/projects/meteorobot](http://www.frc.ri.cmu.edu/projects/meteorobot).

The Department of Fisheries and Oceans convened an **Arctic Science Climate Workshop**, February 21–23, 1999, in Sidney, BC to discuss the science effort required to address climate change issues in polar regions. As a result of Fisheries and Oceans Minister David Anderson's visit to New Zealand (see p.1), a New Zealand scientist, **Dr. Murray Poulter**, was invited to present a bipolar perspective on the topic. CCAR was invited to present a complimentary Canadian perspective, and this was given by **Dr. Olav Loken**.

As mentioned in Issue # 7, SCAR has formed a new Group of Specialists in Antarctic Neo Tectonics, and we are happy to report that **Dr. Tom James, Geological Survey of Canada (Pacific)**, has been selected by the SCAR Executive as one of eight Group members from six different countries. Tom was selected in view of his contributions to studies of glacial rebound in Antarctica and in Canada. CCAR congratulates Tom on his prestigious appointment and wishes him all possible success.

A Gordon Research Conference on "Controls and Significance of Carbon Fluxes in Polar Seas" was held in Ventura, California, March 7–12, 1999, and was chaired by **Professor Louis Legendre**, Dépt. de biologie, Université Laval, Quebec. Vice-chair was **Professor Barbara Prézelin** of the University of California at Santa Barbara. The

workshop consisted of invited lectures, alternating between presentations on the Arctic Ocean and Antarctic Ocean, and posters and discussions. About 120 polar oceanographers attended the event.

**Stephen de Mora**, CCAR member and Canadian representative on the SCAR Working Group on Physics and Chemistry of the Atmosphere, has left Université du Québec, Rimouski, to take up a position as Head, Marine Environment Studies Laboratory, in Monaco. The lab, part of the International Atomic Energy Agency, is involved in a wide range of non-nuclear marine pollution investigations, and has an important mandate in marine analytical chemistry. The facility specializes in technique development, runs an international QC/QA program, and produces certified standard reference materials. As well, it undertakes training and capacity-building in developing nations, and operates a number of international monitoring and research programs in the Mediterranean Sea, Black Sea, Persian Gulf, and South Pacific. More information can be found at the web site [www.iaea.org/monaco](http://www.iaea.org/monaco). We congratulate Steve on his appointment, wish him all possible success, and thank him for his valuable contributions to CCAR during its initial year.

The Canadian Polar Commission has appointed **Dr. Ed Carmack**, a research scientist with the Institute of Marine and Ocean Sciences, Fisheries and Oceans Canada, as a new member of the Canadian Committee for Antarctic Research (CCAR). Dr. Carmack brings to the Committee extensive international experience in oceanographic research, including studies of bottom water in the Southern Ocean.

A new field guide to the coastal marine life of McMurdo Sound can be viewed on <http://scilib.ucsd.edu/sio/nsf/fguide/index.html>. The number of species will be augmented shortly with photographs taken by **Kathy Conlan, Canadian Museum of Nature**, who has been diving there over seven field seasons. Kathy has also recorded the underwater life on video, and footage has been televised on Rogers Cablevision and the Discovery Channel. Photographs and journal excerpts can be viewed on the Canadian Museum of Nature's web site at [www.nature.ca](http://www.nature.ca).

## First International Conference on Mars Polar Science and Exploration

### David Fisher

The Geological Survey of Canada (GSC) co-sponsored and co-convened the First International Conference on Mars Polar Science and Exploration, held at Camp Allen, TX, Oct 18–22 1998. More than 100 attendees from the terrestrial glaciology, planetary science, and space exploration communities saw for the first time several key new data sets. We now know for certain that the North Cap is more than 3 km thick and that, surprisingly, the South Cap is 2.5 km thick, and apparently also made mostly of water ice.

The prospects of finding 100 million years of exposed surface stratigraphy of volatiles on the flanks of the North Cap inspired the attendees to make plans for orbital and surface explorations of this huge ice deposit. The history of the atmosphere and intrained impurity fallout are compelling prizes for such a study. If liquid water is present over this interval then the North Cap could also be a candidate for life habitats. Whether the Cap is presently flowing is an unanswered question.

Papers from the conference will come out in a special issue of ICARUS, and the summary will appear in EOS. The Geological Survey supported the conference with a financial contribution, and the GSC's

David Fisher served as co-convener along with NASA's Lunar and Planetary Institute and the International Glaciological Society. Two Canadian university students and one Canadian firm received support to attend the event.

A workshop is planned for 1999 and a second conference for 2000. The North Cap is the second largest ice cap in the inner solar system and represents a huge resource of water ice both for scientific study and future practical use.

**David Fisher is a research scientist with the Geological Survey of Canada.**

## Biology Workshop

The SCAR Workshop on Evolutionary Biology was held May 12–15 at the Federal University of Paraná in Curitiba, Brazil. Providing a view of current research in the field of evolutionary biology, workshop discussions focused on paleorecords, molecular approaches, biodiversity, adaptation, gene flow, life cycles, methodology and environmental concerns. A research program is now being developed for presentation to the next meeting of the working group, during the SCAR meeting in Japan in 2000.

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