Vol 16, May 2003

NEWSLETTER FOR THE

Canadian Antarctic Research Network

Inside

Canada to Ratify Protocol on Environmental Protection

Environment Canada issued the following press release as legislation was introduced in Parliament to ratify the Protocol on Environmental Protection.

Ottawa, June 6, 2003 – The Honourable David Anderson, Minister of the Environment and the Honourable Bill Graham, Minister of Foreign Affairs, today introduced legislation that would allow Canada to ratify the Protocol on Environmental Protection to the Antarctic Treaty (the Madrid Protocol) to protect the Antarctic environment.

"I am pleased to introduce Bill C-42 today which will allow Canada to ratify the Madrid Protocol and officially join its global partners to further prevent pollution and environmental degradation in the Antarctic," said Minister Anderson. "And I am proud that since signing the Protocol in 1991, Canada and Canadians have been meeting or exceeding the obligations of the Protocol."

"By ratifying the Madrid Protocol, Canada will contribute to the protection of one of the most fragile ecosystems in the world," said Minister Graham. "Canada is pleased to join other countries around the world in ensuring that the Antarctic environment is preserved for future generations."

The Madrid Protocol is part of the Antarctic Treaty System, which includes the Antarctic Treaty (1961) to which Canada is a Party. The Treaty designates the Antarctic as an area to be used for peaceful purposes only. The main

features of the Treaty are: prohibition of military activity; freedom and international cooperation in scientific research and exchange of information; suspension of claims of territorial sovereignty; and prohibitions of nuclear activities or disposal of radioactive waste.

With a goal of further preventing pollution and environmental degradation in the Antarctic, the Madrid Protocol came into force in 1998. The Protocol designates the Antarctic as a natural reserve dedicated to science and peace. Under the Madrid Protocol environmental principles are set out for all activities to take place in the region. For example, any activity relating to mineral resources, other than scientific research, is banned; the taking of, or harmful interference with flora and fauna is banned; and all planned activities are required to undergo an environmental assessment according to the procedures prescribed in the Protocol. Under the Madrid Protocol, the Government of Canada will be responsible for the activities of Canadians and Canadian companies, vessels and aircraft, by requiring them to have a permit to be in the Antarctic.

The Antarctic is a region of great environmental importance. It plays a significant role in global climate and ocean systems. The Antarctic region is a sensitive indicator of global change. Small changes in temperature resulting from climate change can have large consequences in terms of ice melt there by contributing to global sea level change – one of the main threats generated by climate change. The Antarctic supports unique and vulnerable wildlife species and provides valuable scientific opportunities, as a result of its relatively untouched natural ecosystems. The fragile ecosystems of the Antarctic face a number of threats, including human disturbance of flora and fauna, marine pollution, climate change, invasive alien species, and contamination from poor waste management locally, as well as the long range transport of pollutants.

Roughly 400 Canadians visit the Antarctic each year. Two Canadian tour companies operate in the Antarctic, and approximately 40 Canadian scientists are involved in Antarctic research.

The Madrid Protocol is part of the Antarctic Treaty System, which also includes the Antarctic Treaty, the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR), and the Convention for the Conservation of Antarctic Seals (CCAS). Canada is a Party to the Antarctic Treaty, the CCAMLR and the CCAS.

For further information, please contact: Kelly Morgan, Director of Communications, Office of the Minister of the Environment, Tel: (819) 997-1441.

Update

Bill C-42 was passed by the House of Commons on June 13, 2003, tabled in the Senate the same day and is now going through the legislative process in the Senate. OL.

Canada and CCAMLR

Olav H. Loken

Canada ratified the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR) in 1988, and Canada's role within CCAMLR has been reviewed recently. The Canadian Polar Commission and CCAR report *Antarctic Science and Bipolar Linkages: A Strategy for Canada* (September 2002), sent to the Minister of Fisheries and Oceans (DFO) and to five other federal ministers, recommended that Canada should join and become an active member of the CCAMLR Commission. Also, at the October-November 2002 meeting of CCAMLR parties, members agreed to a diplomatic *démarche* to engage Canada more actively in CCAMLR issues. They especially wanted Canada to implement the Catch Documentation Scheme (CDS) established by CCAMLR to curb the trade, and hence the catches of the endangered Patagonian tooth fish. Canada is regarded as a significant importer and exporter of tooth fish.

Australia spearheaded a campaign on behalf of more than 20 member countries. It was launched in March-April 2003, when the Ottawa-based missions of some CCAMLR countries made independent representations to the Government of Canada. Related contacts occurred between the Canadian missions in some CCAMLR capitals and the respective host governments. CARN has not succeeded in obtaining written information about the Canadian response; but individuals close to the file indicate that as of late June 2003 DFO is leading an effort to implement the CDS. This requires modifications to regulations and will take some time, but interim measures are being considered for the short term. It is expected that the Canadian Food Inspection Agency will play a key role in implementing the CDS. This is very good news.

Regarding Commission membership, the Government of Canada does not see any reason "at this time" for becoming a member, but will continue as an Observer – *i.e.,* the status quo. The key argument is that Canada has no harvesting interest in the Southern Ocean and no other interest that warrants the expenditure (membership fee and related travel costs were estimated to be $ 100K/year, but it is not clear how the benefits of Commission membership were assessed). In short, the response seems to be based on short-term national economic interests and therefore overlooks Canada's responsibility to implement global initiatives aimed at preserving and managing the planet's natural resources.

On June 6, 2003, the Government introduced legislation in Parliament to ratify the Protocol on Environmental Protection to the Antarctic Treaty (see front page). The Protocol designates Antarctica as "as a natural reserve, devoted to peace and science" and the question of Commission membership must now be examined in a much broader context. The recommendation in the CPC/CCAR report was based on an analysis within this broader context. We hope the Government of Canada will re-examine the question of Commission membership by considering a wider range of factors and by involving a more diverse group of stakeholders.

Discontinuous Volcanic Eruptions in a Phreatomagmatic Vent Complex: Coombs Hills, South Victoria Land

Pierre-Simon Ross and James D.L. White

Over 500 million people are directly at risk from volcanic activity. Before we can successfully predict eruption behaviour we need to understand the internal workings of volcanoes. Discontinuous eruptions – those involving discrete explosions and intermittent ejection of material – are less well understood than continuous eruptions. In the case of discontinuous eruptions (Strombolian, Vulcanian, and phreatomagmatic eruptions), various debris may fill the vent between explosions, and therefore eruptive styles and even fragmentation mechanisms may be different from those operating in "open-vent" (debris-free) conditions.

At Coombs Hills, South Victoria Land, the Mawson Formation (Jurassic) has been interpreted as an unusually large phreatomagmatic vent complex (White and McClintock, 2001). Several hundred vertical metres of volcaniclastic rocks are exposed, making Coombs Hills a superb place to study how volcanic vent structures shaped by discrete explosions form. The Mawson Formation underlies the Jurassic Kirkpatrick Basalt (Ferrar province) and is stratigraphically younger than the Devonian-Triassic Beacon Supergroup (Fig. 1).

Much of the Mawson Formation consists of structureless, poorly sorted lapilli-tuff and minor tuff-breccia. Blocky juvenile fragments are dominant, but accidental Beacon clasts are also abundant. This association of components suggests phreatomagmatic explosions (Elliot and Hanson, 2001). Rafts (megaclasts) of Beacon rocks and layered pyroclastic rocks – presumably slumped down into the vent from beds of surface ejecta – "float" in the Mawson Formation, and clastic dikes cross-cut other volcaniclastic facies.

We revisited the area from November 25, 2002 to January 7, 2003 with the aim of mapping in detail the facies variations within the unbedded part of the formation. The new study reveals three principal types of structureless basaltic pyroclastic rocks: (1) the dominant heterolithologic lapilli-tuff (described above), which forms the host for cross-cutting zones of other types; (2) vertical pipes of accidental-rich lapilli-tuff, tens of centimetres to tens of metres across; (3) irregular-shaped, steeply dipping zones of juvenile-rich tuff-breccia, metres to hundreds of metres wide, including domains of blocky to fluidal peperite and glassy basalt (Fig. 2).

Vertical, cross-cutting zones of tuff-breccia or lapilli-tuff are interpreted as individual volcanic conduits bored in wet, unconsolidated debris. Subterranean tephra jets propelled by phreatomagmatic explosions excavated and travelled through these conduits. Explosions would generate variable proportions of accidental versus juvenile material depending on their location. Accidental-rich pipes, for instance, would represent the last explosions within "intact" (unmixed) Beacon country rocks. The heterolithologic lapilli-tuff, in contrast, would be formed by progressive mixing of material from multiple sources. Finally, irregular juvenile-rich zones accompanied by peperite and basalt pods would indicate less energetic interaction of magma and

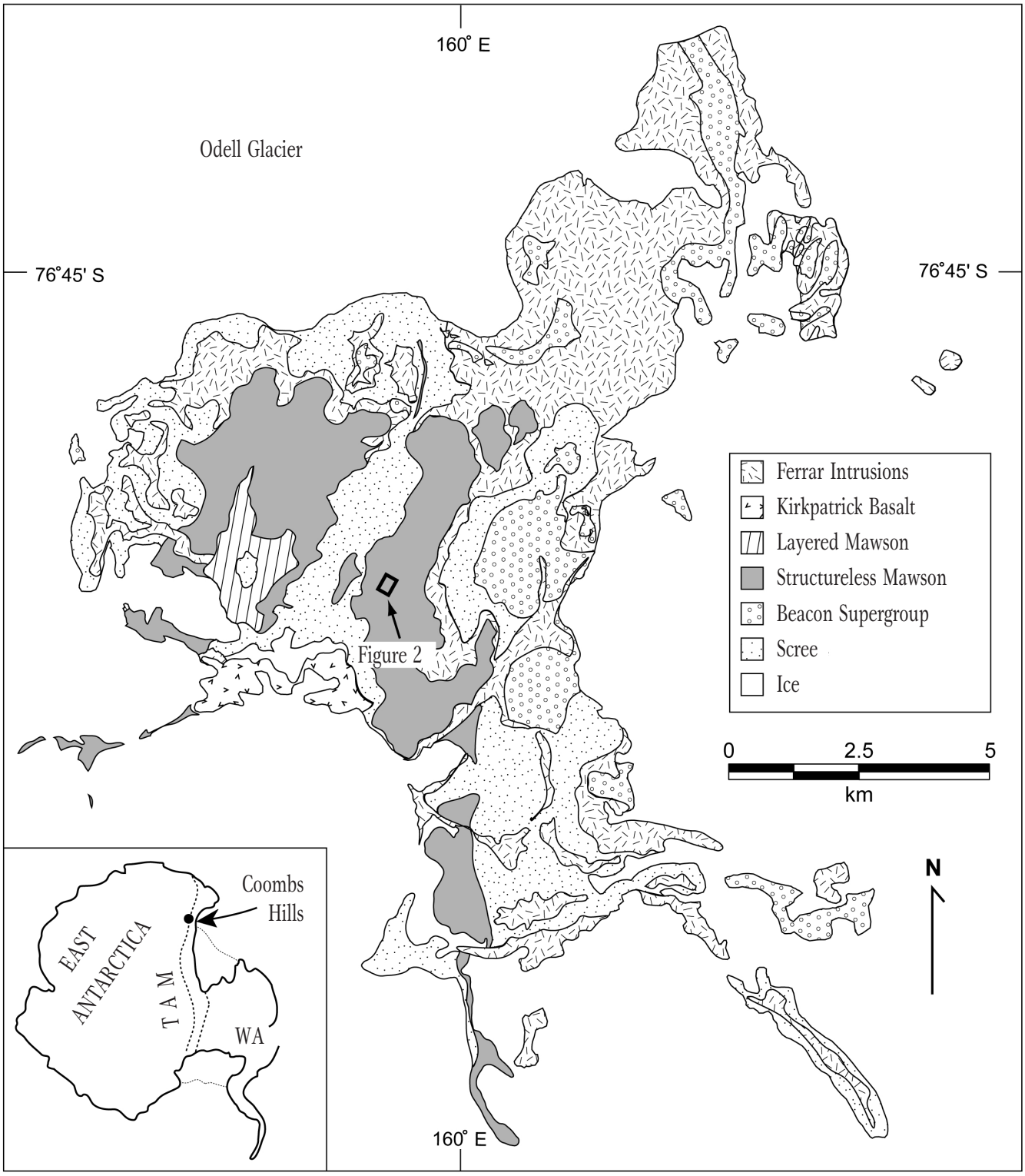

Figure 1
Generalized geology of Coombs Hills, modified from McClintock (2001).

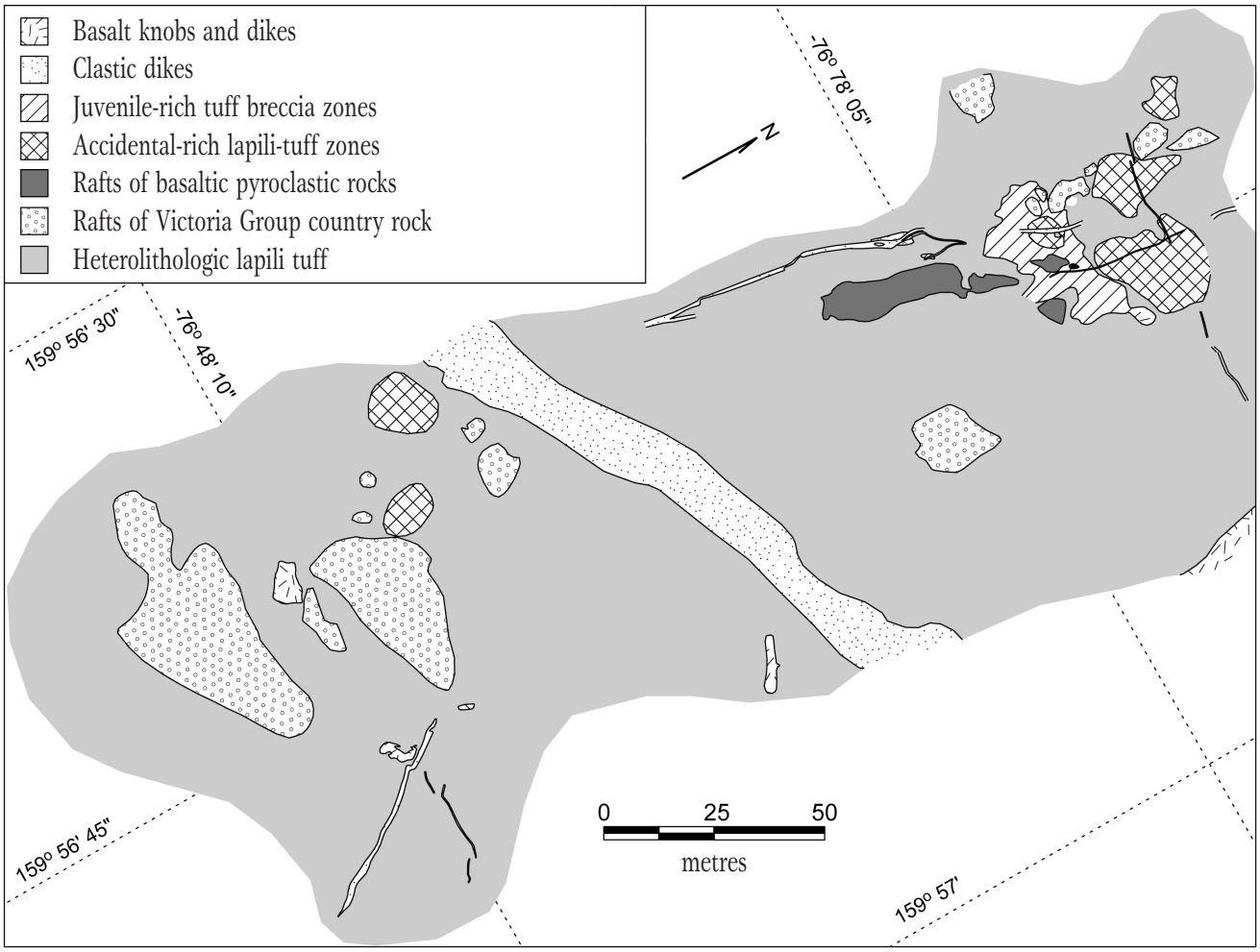

Figure 2
Map of a complex area in the Mawson Formation at Coombs Hills, showing the outcrop pattern of different types of structureless pyroclastic rocks (see Fig. 1 for location).

water-saturated material. Coombs Hills illustrates the evolution of a large debris-filled vent complex shaped by discontinuous phreatomagmatic eruptions.

For further information contact Pierre-Simon Ross, e-mail: p_s_ross@hotmail.com.

Pierre-Simon Ross has a M.Sc. in Earth Sciences from Université du Québec à Montréal and is working on his Ph.D in Geology at the University of Otago, New Zealand. Dr. James D.L. White is the senior lecturer in volcanology and sedimentology at the University of Otago and supervises P.-S. Ross.

Acknowledgements

We thank Antarctica New Zealand, the Otago University Research Committee and the Fonds de recherche sur la nature et les technologies (Quebec) for support.

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Biogeochemical Transformations of Organic Carbon in Cold-based Glacier Systems

Joel Barker

The search for primordial life on Earth and on other planets has focussed research on ice-covered environments. Not only do these environments provide essential water to basic life forms but also filter potentially harmful UV radiation and insulate against atmospheric temperature fluctuations. Recent investigations have identified the existence of microbial communities in glacier ice and subglacial meltwater (*e.g.:* Sharp *et al.,* 1999; Skidmore *et al.,* 2000). Active microbial metabolism affects the geochemical cycling of both organic and inorganic compounds in glacier systems. The circulation of liquid water beneath warm based glaciers exerts a control over the distribution of elements, such as oxygen and carbon, that may be crucial for microbial respiration. In cold based glaciers, the distribution of liquid water is limited to vein networks at ice crystal boundaries. Consequently the distribution of these elements may be highly heterogeneous within the ice mass. Availability may also be limited because elements are not replenished by

Victoria Upper Glacier terminus showing dark basal ice overlain by white meteorically derived glacier ice.

larger scale water circulation. During January, 2003, Joel Barker collected samples from two glaciers in Victoria Valley, Antarctica, to investigate whether glacier ice in cold based glaciers contains enough organic carbon to support microbial metabolism, to determine whether this organic carbon was being biogeochemically transformed within the ice mass, and to identify the micro-organisms that mediated these transformations.

Two glaciers in the Dry Valleys were sampled: Victoria Upper Glacier, a cold based valley glacier, and an adjacent unnamed cold-based cirque glacier. A three meter vertical trench extending from meteorically derived glacier ice into basal ice was excavated from the terminus of Victoria Upper Glacier. The basal ice of the unnamed cirque glacier was sampled opportunistically. Ice samples were collected aseptically using ethanol-washed and flame-sterilized chisels and collection reservoirs. Once collected, the ice samples were transferred into sterile Whirlpack bags, melted in the field, and bottled in sterile amber glass bottles. These water samples were stored in the dark at ~4°C and transported to the University of Alberta for analysis.

Preliminary results indicate that viable microbial populations can be cultured from both glacier and basal ice samples, but that the morphology of cultured microbes differs between glaciers. This may be a consequence of glacier-proglacial lake interactions during the early Holocene when Victoria Upper Glacier may have been in contact with the proposed Glacial Lake Victoria (Hall *et al.*, 2002). The unnamed cirque glacier would have remained above lake level, as indicated by perched deltas in the upper Victoria Valley. As such, the microbial populations observed in meltwater samples from Victoria Upper Glacier may reflect an entombment of microbial populations from Glacial Lake Victoria while those in the cirque glacier samples may reflect a more autochthonous (locally derived) microbial population. Both glacier and basal ice samples contain ~1.5 mg/L dissolved organic carbon, which exceeds carbon concentrations reported as being sufficient to support microbial metabolism in glacier systems in Arctic Canada by Skidmore and others (2000). The distribution of this organic carbon within glacier ice seems to by highly heterogeneous with the highest concentrations (15 mg/L) occurring in ice at the basal ice/meteoric ice interface.

Future molecular analysis of the dissolved organic carbon in the meltwater samples, as well as the taxonomic identification of the microbial cultures will help to resolve the origin of the microbial biomass as well as the biogeochemical transformations of the organic carbon that may be occurring in these cold based glacier systems.

Joel Barker, a Ph.D candidate at University of Alberta, can provide additional information. e-mail: jdbarker@ualberta.ca.

Acknowledgements

I thank my supervisor, Dr. Martin Sharp (University of Alberta) for providing support for this project. Thanks also to the New Zealand Antarctic Program and to Dr. Sean Fitzsimons (University of Otago) for logistical support and guidance in Antarctica and New Zealand. The Natural Sciences and Engineering Research Council of Canada and the Canadian Arctic-Antarctic Exchange program funded this work.

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Contaminants in Polar Ecosystems

Don Mackay

The Northern Contaminants Program (NCP) of the Canadian Department of Indian Affairs and Northern Development (DIAND) has concluded the second phase (1998–2003) of a study of contaminants in the Canadian North that started in 1991. Progress was reviewed at a meeting of some 300 participants in Ottawa in March 2003. The reports are available in paper or CD format from DIAND or the NCP website www.ainc-inac/ncp/index.

There is now a much clearer picture of levels of a variety of contaminants in media such as air, marine and fresh water, ice, wildlife, in humans and in their foodstuffs. The processes by which chemicals reach the Arctic, migrate between media and bioaccumulate are now better understood. A capability of describing these processes quantitatively in the form of mass balance models is emerging. An important aspect of this capability is that models now have the potential to predict which "new" chemicals are likely to become problematic.

Of specific results, the study shows that most POP levels in the Arctic atmosphere and wildlife are decreasing in recent years. However, up to 70% of Inuit women still have POP levels in their blood which exceed, by up to 20 times, the guidelines established by Health Canada. The levels of some new POPs are increasing in the Canadian Arctic, notably polybrominated diphenyl ethers, used as flame retardents. The rising level of mercury contamination is also an emerging issue, as mercury levels have increased 2–3 times in some marine mammal populations over the last 25 years. Recent results show that a unique combination of photo-chemical reactions in the Arctic atmosphere leads to enhanced mercury deposition following the polar sun rise in the spring (W.H. Schroeder *et al.*, 1998).

There is an obvious and compelling incentive to switch to a preventative mode rather than a reactive mode. We now know enough to act to prevent contamination, rather than relying on the old strategy of waiting for monitoring programs to identify new problems. Accordingly, there has been increasing attention on brominated and fluorinated substances, which display many of the same persistent and bioaccumulative characteristics as their chlorinated cousins.

The NCP study focus on the Canadian North, but some of the results and methodologies would be applicable to Antarctica as both regions are high latitude environments and receive influx of contaminants from lower latitudes. Contamination levels in Antarctica are much lower (UNEP, 2002) due mainly to the longer distances to major concentrations of populations and industrial activities, and the more predominant zonal circulation patterns in the Southern as compared to the Northern Hemisphere.

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News in Brief

The Canadian Meteorological and Oceanographic Society (CMOS) held its 37th congress in Ottawa, June 2–5 with a record attendance of more than 600. Among some 330 papers and more than 100 posters, **three were of special interest to Antarctic science:**

Dr. Jennifer Lukovich presented "Observational Analysis of the Containment of Antarctic Vortex Air following the Split Ozone Hole of 2002" on behalf of a group of four scientists from York University and the University of Toronto. The paper was based on data from the Canadian Optical Spectrograph and InfraRed Imaging System (OSIRIS) instrument on the ODIN satellite developed by a Swedish-led group and launched in February 2001.

Dr. V.J. Hipkin presented "Decoupling of the Strongly Stable Atmospheric Boundary Layer over an Antarctic Ice Shelf" in collaboration with a scientist from the British Antarctic Survey and University of Leeds. The paper was based on data from an experiment at the UK Halley Station on the Brunt Ice Shelf.

Dr. W.J.R. French of the Australian Antarctic Division (currently at University of Western Ontario), professor **R.P. Lowe,** UWO and a colleague from AAD presented a poster on "Temperatures in the Mesopause: Detecting Long Term Trends in Hydroxyl Airglow Rotational Temperatures from Davis Station, Antarctica". The poster reported on analyses of data collected by a Canadian instrument operated by the AAD at Davis Station.■

In December 2002, **Students on Ice** completed its third successful educational expedition taking high school students, teachers and scientists from across Canada and around the world to Antarctica. The pioneering Canadian initiative is becoming internationally recognized, and this last expedition had participants from eleven different countries. The theme of the expedition was climate change and during the expedition several of the Canadian students called **Environment Minister David Anderson** via satellite phone while standing on top of an Antarctic glacier. **During the call they congratulated the Minister of having ratified Kyoto, and encouraged him to set his sights on ratifying the Madrid Protocol.** The Minister said he thought that was a good idea and that he hoped Canada would ratify within the year. The entire transcript of this conversation can be found at www.ec.gc.ca/minister/speeches/2002/021223_t_e.htm.

Future developments with the program include plans to launch a university-college level expedition in 2004–05, and the next high-school level expedition is set for December 16–30, 2003. Students on ice has also formed an exciting working partnership with Carleton University's Cybercartographic Atlas of Antarctica project.

For more information feel free to call Students on Ice at (866) 336-6423 or see their website at www.studentsonice.com.■

Peter Pulsifer, Carleton University will represent Canada at the 7th meeting of the Joint Committee on Antarctic Data Management (JCADM) in Brussels June 30 – July 4, 2003. JCADM is a joint committee of SCAR and COMNAP that encourages Antarctic scientists and operators to ensure that important data are properly stored and readily accessible to other colleagues that may be interested in the

information. Canada hosted a meeting of Arctic and Antarctic data specialists in 1999, but has not played an active role regarding Antarctic data since we do not have an Antarctic research program *per se.* The start of the Antarctic cyberatlas project led to a renewed interest in JCADM activities and following the meeting Peter, who coordinates the Antarctic cyberatlas, will advise on the future role of Canada in JCADM. For additional information contact: Peter Pulsifer, e-mail: pulsifer@magma.ca.■

Northern Lights against POPs: Combatting Toxic threats in the Arctic edited by David Leonard Downie and Terry Fenge was released during the Canadian Arctic Contaminants Assessment Symposium (see article by Don Mackay) in March 2003. With a foreword by The Honourable David Anderson, Chair, UNEP Governing Council and Klaus Töpfer, Executive Director of the United Nations Environment Programme, the book follows the events leading up to the May 2001 signing of the Stockholm Convention on Persistent Organic Pollution in twelve essays by a variety of authors. Some of the authors were deeply involved in the various stages of the negotiations, and provides fascinating insider perspectives. What started off in the late 1980s as mainly a **regional** concern for the health of northerners, notably the indigenous peoples in Northern Canada eventually led to the signing of the **global** Stockholm convention in 2001. Northern indigenous peoples played key roles in this process and McGill-Queen's University Press published the 347-page book for the Inuit Circumpolar Conference Canada (ISBN 0-7735-2448-7).■

Workshop to plan a Canadian Antarctic Research Program

"Polar Connections" is the title of a CCAR workshop to be held at the University of Edmonton on September 26–27, 2003. The purpose is to develop a framework for the scientific content of a Canadian Antarctic Research Program. To set the stage for the discussions, a group of prominent foreign Antarctic scientists will be invited to give overviews of the state of the art, major challenges and future plans within their areas of expertise. Future development of international collaboration in Antarctic research will be a key consideration. We hope to attract a number of Canadians interested in Antarctic and polar science and we will provide assistance for graduate students wishing to attend the workshop. In the planning stage for some time, the workshop will now be even more relevant in view of the expected early ratification of the Protocol on Environmental Protection to the Antarctic Treaty and the required follow-up. The report from the workshop will form the basis for a proposal to the Government of Canada to establish and fund a Canadian Antarctic Research Program. The Canadian Polar Commission, the Going Global S&T Program of DFAIT and NSERC are providing financial support for the workshop.

For further details contact workshop coordinator: Olav H. Loken, e-mail: oloken@sympatico.ca.

Update:
Contaminants in Polar Ecosystems

Since the symposium, the Minister of DIAND has announced that the Northern Contaminants Program will continue, with increased emphasis on human health issues.

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