

Resources," by Laure G. Wallace and Leslie C. Gordon, United States Geological Survey. The Colleges and Universities Workshops involved "Innovative Teaching Techniques For More Effective Geoscience Education – Ways to Actively Engage Students to Improve Learning," by Barbara Tewksbury (Clinton, NY); "Developing Technology Based Curricula in Earth System Science at the Undergraduate Level," by Sean Cash (University of Michigan), and John T. Snow (University of Oklahoma); and "Earth System Data Analysis and Visualization Tools for Classroom Use," by Daniel C. Edelson (Northwestern University) and Farzad Mahootian, Gonzaga College High School.

#### POST-CONFERENCE WORKSHOPS

Finally, two post-conference Instructional Design and Technology Workshops were conducted on Friday, 1 August. The first, hosted by Nir Orion, Weizmann Institute, Israel, and several of his graduate students, involved "Using the Computer as a Learning Tool in Studying the Solid Earth System," and the second by William Hoyt and Raymond Tschillard, University of Northern Colorado and Dr. Dan Jax, Bexley Middle School (Ohio) was on "Designing Earth Systems Education Curricula."

#### CONCLUSION

This intense spate of activity bodes well for the next Geoscience Education Conference that will be hosted by our Australian colleagues in Sydney in the third week of January in 2000. It also serves as a warning to the organizers of the Fourth Geoscience Education Conference (to be held somewhere in Canada in 2002) that much is expected at an international conference of this type.

GEOSCIED II was sponsored by The Coalition for Earth Science Education, the Commission on Geoscience Education and Training of the International Union of Geological Science, and the Association of Geoscientists for International Development. Financial support was provided by the National Science Foundation, the National Aeronautics and Space Administration, the United States Geological Survey, the American Geophysical Union, the American Geological Institute, National Association of Geoscience Teachers, National Earth Science Teachers Association, The Ohio State University, the University of South Carolina, the Weiz-

mann Institute (Israel), the University of Hawaii, and Hyogo University of Teacher Education (Japan).

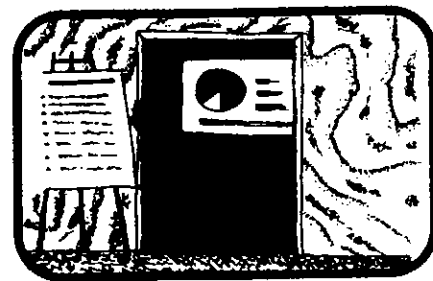
Additional support for editing and publishing the Conference Proceedings was provided by the Alphyl Memorial Endowment Fund of The Ohio State University. This is an endowment for support of earth systems education memorializing Victor C. and Phyllis C. Mayer.

Last but by no means least, all the conference participants owe a big vote of thanks to the respective committees involved with GEOSCIED II. The Conference co-conveners were John Carpenter (University of South Carolina), Victor Mayer (The Ohio State University), Nir Orion (Weizmann Institute), and Akira Tokuyama (Hyogo University of Teacher Education). The Program Committee consisted of Victor J. Mayer and Rosanne W. Fortner, Professor of Natural Resources (The Ohio State University), William Hoyt (The University of Northern Colorado), Dan Jax (Bexley City Schools, Ohio), and E. Barbara Klemm and Martha Sykes (The University of Hawaii - Manoa). The Arrangements Committee involved John Carpenter (University of South Carolina), Nir Orion (Israel), Laure Wallace (United States Geological Survey), and Frank Watt-Iretton (American Geophysical Union). Field trip leaders were Dr. Barbara Klemm and Dr. Martha Sykes (Hawai'i Institute of Geophysics and Planetology).

Many of the activities involving business were addressed during the meeting and are now in place. Some of these are mentioned above (locations of the next two conferences), and the first *Interconference Newsletter* has been distributed. Alan Morgan is acting as the Canadian contact for the next International Geoscience Meeting, and CGEN (the Canadian Geoscience Education Network) is looking at the arrangements for hosting the Canadian GEOSCIED IV Conference in 2002. If you wish to be kept informed of these developments contact the author at the email address above.

#### REFERENCE

- Morgan, A.V. and Ferguson, L. 1993, International Conference on Geoscience Education and Training (GEOED), University of Southampton, England, 20-24 April 1993: *Geoscience Canada*, v. 20, n. 4, p. 182-185.



## New Horizons in Mining: Seventh Annual Calgary Mining Forum

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#### INTRODUCTION

More than 300 people registered for this event, convened by the Calgary Mineral Exploration Group at the Telus Calgary Convention Centre, 8-9 April 1998: a first in attendance, and probably reflecting the high level of interest in diamond exploration in western Canada. Co-chaired by Hugh Abercrombie of Birch Mountain Resources Ltd., Calgary, and Mika Madunicky, Alberta Energy and Utilities Board, Calgary, the conference consisted of 18 talks, 16 posters, and 40 commercial exhibits. A novel feature was an afternoon session providing a corporate overview of Alberta diamond exploration (seven companies presenting). All sessions were well attended, particularly the papers on diamonds; there were also lots of discussions and possibly joint-venture deals (?) taking place in the hallways and exhibits area. For those of us working diligently over the past decade and more to persuade skeptics that there is more to explore for in Alberta than oil, natural gas, bitumen and coal, the talks, posters, commercial exhibits, interest level, and activity were gratifying. The 18 talks grouped as follows: ten on diamonds; three on metals; four were general; and one was on proposed University of Calgary minerals-related analytical equipment. A brief review of oral papers follows.

#### DIAMONDS

Interest level here is high. The front

cover of the March-April issue of *The Prospector*, an exploration and investment newspaper published in Vancouver and available before the conference, shouts "DIAMONDS" in large red letters, and announces that "Canada is ready to capture 15% of the world diamond market. Who will be the new billionaires?". More than 50 companies are exploring in Alberta, all over the province. A useful map of Alberta diamond and mineral exploration activities as of April 1998 has been compiled and produced by EnerSource of Calgary (email: [enersrce@cadvision.com](mailto:enersrce@cadvision.com)) and was available at the conference. During the conference, De Beers Ltd. announced through its Canadian subsidiary Monopros Ltd. of Toronto that it had signed a joint-venture agreement with Calgary-based junior exploration company Troymin Resources Ltd., thus taking up a position in the Troymin Buffalo Hills diamond prospect and giving enhanced credibility to Alberta diamond exploration. Meanwhile in the Northwest Territories the Ekati Mine of BHP/Dia Met Ltd., Lac de Gras area, is set to go into production in the fall of 1998, as Canada's first commercial diamond mine.

#### Alberta

Gerry Ross, of LITHOPROBE Alberta Base-

ment Transect fame, and colleagues considered the nature of the northern Alberta Buffalo Head area-terrane or craton (they favor craton), the location of the diamondiferous kimberlites discovered by the Ashton-Pure Gold-Alberta Energy joint venture. The Buffalo Head craton is composed mainly of magmatic rocks, probably not underlain by Archean mantle rocks; the fact that diamondiferous kimberlites occur here may indicate that Archean mantle may not be a prerequisite for diamond occurrence? Mike Dufresne and co-authors provided an update on the newly emerging diamondiferous kimberlite field in northern Alberta, with at least 23 kimberlites discovered. Microdiamond and macrodiamond counts and carat grades at this preliminary exploration stage compare favorably with the early phases of exploration in the Northwest Territories. The economics of access and possible future development of diamond mines in Alberta are very favorable when compared with developments in the Territories, a theme that would recur later in the conference. John Auston, CEO of Ashton Mining Inc., outlined the discovery and exploration of the Buffalo Head kimberlites. At the time of the talk, some 23 kimberlites had been discovered, almost all of them con-

taining at least some microdiamonds (less than 0.5 mm). The kimberlites are of crater facies, and were originally detected as sharp isolated magnetic anomalies on a survey flown for petroleum exploration. Two bodies, identified as K14 and K91, have gem-quality macrodiamonds, but Auston emphasized that much more work is necessary to reach any meaningful conclusions on the possible grade or quality of these and other pipes discovered by the Ashton-led venture. Mini-bulk sample testing is continuing. The Ashton-led group has the best record of identifying local-scale magnetic and structural anomalies that, on drilling, turn out to be kimberlite bodies. Golder Associates personnel discussed the environmental implications of diamond mining in Canada: because diamond recovery is largely accomplished using mechanical separation processes, the absence of hazardous chemicals is a plus. Environmental concerns tend to centre on the scale of projects, and may be best addressed by public consultation from beginning stages. Mark Fenton and John Pawlowicz reviewed the Quaternary geology of northern Alberta with respect to diamond exploration, noting the presence of extensive drift cover, highlands and multiple tills, all complicating the search for and interpretation of the meaning of diamond indicator minerals. Dale Leckie and Bruce Kjarsgaard suggested that there may be potential for the occurrence of diamonds as alluvial placer deposits in the Canadian prairies, possibly similar to the extensive alluvial diamond occurrences in South Africa and Zaire. Alluvial gravels, the common hosts of diamonds in the well-known African settings, may be worth more than a cursory look! John Pawlowicz and co-authors reviewed the geology of the Kakwa/Wapiti study area (NTS 83L) in the Alberta Foothills between Grande Cache and Grande Prairie, as pertinent to diamond exploration. Indicator mineral suites suggest three anomalous areas worthy of exploration.

In his introduction to a corporate overview of Alberta diamond exploration featuring presentations by seven junior exploration companies, Art Ettlinger of Yorkton Securities Ltd., Vancouver, noted that Canadian junior exploration companies have gained recognition and respect as successful diamond explorers. This has happened mainly since 1992, following the initial announcement



Figure 1 Susan Morrison and Derrick Strickland of Ashton Mining of Canada Inc., Vancouver, discuss prospects with an unidentified conference attendee (photo by Mika Madunicky).

of success at the BHP/Dia Met Lac de Gras property, which became the Ekati diamond mine. Ashton's exceptional success in the Buffalo Hills area (see above) was noted, along with the much-reduced costs of diamond exploration in Alberta, compared with exploration/production costs in the Northwest Territories. Alberta has a well-developed infrastructure, and the distances involved are much less. Of the more than 50 companies exploring in Alberta, at least two-thirds of them are planning active sampling and drilling programs on their properties in 1998. As more kimberlites are discovered, the odds of economic occurrences being discovered increase. Ettlinger's presentation was followed by company reviews by Birch Mountain Resources Ltd., Ellesmere Minerals Ltd., Lucerco Resources Corp. and partners, Marum Resources Inc. and partners, Pure Gold Minerals Inc., Troymin Resources Ltd., and Victory Ventures Inc. All of these companies have been able to raise venture capital and have active exploration programs, which is encouraging when one considers the scarcity of capital that ensued following the Bre-X fiasco of 1997. All diamond prospects in Alberta are at a preliminary stage. Drilling is underway on a number of properties, and mini-bulk sampling of a number of pipes is underway by the Ashton-led group. A common rule-of-thumb is that tonnage and grade of diamond properties cannot be defined with any certainty until 10,000 carats (typically 10-15 thousand tonnes of host rock) have been processed. This is suggested to be true of all diamond properties in the early stages of exploration.

#### Northwest Territories

Jennifer Burgess and co-authors reviewed Aber Resources Ltd./Diavik Diamond Mines Ltd. Diavik kimberlites, likely Canada's second commercial diamond project and expected to be in production in late 2001, providing that the necessary environmental and regulatory approval is obtained. Heavy mineral surveys and detailed aeromagnetic surveys were used to locate 49 pipes, 22 of which are diamond bearing. Four of these pipes make up the commercial diamond resource: grade in carats per tonne ranges from 1.9-4.6, with a total of 37.3 million tonnes to be mined. Glenn Laing described the discovery and evaluation of the six diamond-bearing

kimberlites of the Jericho property of Lytton Minerals, located on the Slave Craton, Northwest Territories, in the vicinity of the Lupin gold mine. Work continues, particularly the search for additional economic pipes.

#### General

In a paper entitled "Diamonds in Canada," Roger Clement of Monopros Ltd., Toronto, reviewed Canadian diamond exploration, noting that some 450 pipes are now known in Canada, with about 250 of these located in the Northwest Territories. Chuck Fipke's pioneering studies that led to Dia Met's initial discovery of the Lac de Gras pipe field were noted, along with its enormous stimulus to exploration. Clement reminded conference attendees that only about 50 pipes have ever been mined, worldwide.

Despite the high costs of exploration in remote areas, it is clear that the reported grades and tonnages of the Ekati and Diavik properties verify that these will be significant revenue generators, permitting Canada to produce 10% or more of the world's gem-quality diamonds in the near future. As exploration continues, more discoveries are likely: the diamond exploration story in Canada is far from over. Meanwhile, there is much scope for study and comparison of pipe distributions, textures, and morphologies, with global occurrences.

#### OTHER TOPICS

Reg Olson reviewed mineral exploration in Alberta on behalf of the Minerals Steering Committee of the Alberta Chamber of Resources. Although the most exciting exploration activity in Al-



**Figure 2** John Pukas of JMP Associates Ltd., Calgary, displays core from an active exploration project (photo by Mika Madunicky).

berta centres on the discovery of diamondiferous kimberlites, more than 40 minerals of possible commercial potential are known to occur. Although not unexplored, Olson suggested that Alberta has been under explored, at least until this latest interest in diamonds, which seems to be spurring exploration for other commodities. John Armstrong of Indian and Northern Affairs Canada provided an overview of exploration activities in the Northwest Territories. Despite low metal prices and production cutbacks, more than \$110 million were spent on exploration in 1997, including a number of gold projects and two poly metallic projects (gold, copper, silver). This also includes expenditures of \$54 million, nearly half of all Northwest Territories exploration expenditure in the Northwest Territories, on a number of diamond properties. Noteworthy was the discovery of the one hundredth kimberlite pipe on the BHP/Dia Met land holdings.

#### **Metal Prospects**

Three metal properties were reviewed in talks. Peter Gummer of Rhonda Mining Corporation (Calgary) discussed the Esker lead-zinc property in Nunavut, located 380 km north of Yellowknife. Mineralization is stratabound and occurs in stromatolite bioherms. Including probable and possible reserves, the property contains 80 million tonnes averaging 4.7% Pb + Zn. Lake sediment geochemistry has proved very useful in discovering this mineralization. The fact that the property is only 80 km south of the Arctic coast is a distinct advantage, permitting low-cost shipping. The current *in situ* value of Pb-Zn was given as more than \$3 billion! A second promising project reviewed was the NICO and Sue-Dianne polymetallic deposits of the Mazenod Lake district, southern Great Bear magmatic zone, Northwest Territories, 160 km northwest of Yellowknife. These are Proterozoic iron oxide-hosted polymetallic deposits (Co, Au, Bi, Cu, Ag) of Olympic Dam type, apparently the only known significant Canadian example. Tonnage and grades are impressive, as is a huge K-metasomatism anomaly associated with the mineralization, among the largest known in the world, and indicating the former presence of an enormous granite-driven hydrothermal system. In a fill-in talk (one was canceled), Paul Hawkins discussed the J.P. property of the TooDoggone

Gold Camp, of northern British Columbia. This deposit is hosted in andesite flows. One zone, the "Creek Zone," has promising values of gold, copper, lead and zinc: Hawkins wondered whether this deposit might be another Eskay Creek in the making?

#### **Gold Paleo-Placer Deposits**

Dale Leckie and co-authors presented a conceptual paper on potential paleo-placer gold exploration in Mannville Group gravels (Cretaceous) of north central Saskatchewan. The gravels outcrop locally, are only weakly cemented, and were derived from the Canadian Shield to the north, where at present there are considerable numbers of gold showings at the surface. The extremely coarse nature of some of the gravels indicates the potential for gold transport; one sample has anomalous values of gold.

#### **Analytical Equipment**

Dave Pattison of the University of Calgary outlined the university's application for a new state-of-the-art electron probe microanalyzer, which is expected to be of considerable use to the mineral exploration community. High-precision spot analysis along with the production of element maps at the micron scale can be completed; both of these applications are of interest in evaluating diamond indicator mineral compositions, studying Hemlo-type gold deposits, and other micro-applications. The university is looking for support from the exploration community to help acquire this equipment.

#### **POSTERS**

The 16 posters displayed during the meeting covered a variety of topics from the use of seismic data in mining to evaluation of gold deposits; four of the posters were directly linked to talks.

#### **FURTHER INFORMATION**

Both talks and posters had abstracts, with the 70-page program and abstract volume available at the meeting. Direct inquiries about viewing or obtaining the abstract volume to Co-chairman Mike Madunicky (email: madunmi@ eub. gov. ab. ca).

#### **CONCLUSIONS**

Although talks and posters centred on Western Canada, it is clear that mineral exploration in Alberta is thriving,

even though much of it is diamond driven at present. Kimberlite pipe finds are attracting attention in Alberta, some of which seems to be spilling over to other commodities. There is an enormous amount of oil industry drilling and seismic data, as well as good syntheses of regional geology, and this, along with the well-developed infrastructure, is a plus for mineral exploration in Alberta. What is needed now seems to be happening: that is, a focused approach toward mineral exploration.

According to the 1996 Canadian Minerals Yearbook (published in 1997), the value of Canadian mineral production in 1996 including mineral fuels was \$49.3 billion; of this, Alberta's production, almost all from mineral fuels, was 53% of the Canadian total. To outsiders, it may seem unfair that Alberta, with its rich deposits of oil, natural gas and coal, might now be closer to becoming a diamond producer as well. But what the heck, who said life was fair? (And besides, I live in Alberta).