



2006 Annual Report



Mineral Deposit Research Unit

2006 ANNUAL REPORT

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ABOUT MDRU

The Mineral Deposit Research Unit (MDRU) is a collaborative venture between the mining industry and The University of British Columbia (UBC). The unit, which was established in 1989 with support and financial assistance from the mining industry and the Natural Sciences and Engineering Research Council of Canada (NSERC), is administratively part of the Department of Earth and Ocean Sciences (EOS) and an internationally recognized research group dedicated to solving mineral exploration-related problems. Acting as the hub for integrated geological and geophysical research programs at UBC, MDRU seeks to solve research questions of interest to the community through the training of highly qualified geologists.

At the end of 2006, MDRU had 52 corporate, individual and government members, which include major and junior mining and exploration companies from Canada, United States, Perú, South Africa, Turkey and Australia. An additional 5 are planning to join in 2007. MDRU has collaborative research projects with economic geology research groups in the United States, Turkey and Australia, and has projects in North and South America, Asia, Australia, and Africa. All projects are designed in conjunction with corporate members, and address fundamental questions relevant to the mining and exploration industry.

MDRU assists members by increasing the understanding of mineral deposits and methods that are used for their discovery. This is accomplished through:

- Research projects,
- Resource Centre,
- Short courses and workshops,
- Training of qualified geologists.

MDRU and faculty in the Department of Earth & Ocean Sciences have established themselves as the most recognized economic geologic research centre in Canada. It has furthermore established a reputation for research excellence, and is attracting graduate students and researchers from around the world. Graduate students and senior researchers are active in Canada, United States, El Salvador, Perú, Argentina, Tanzania, Turkey, Mongolia, China (Tibet), New Zealand, and Australia, with expanding opportunities elsewhere. Regardless of their geographic focus, project results are applicable to understanding ore genesis processes and assisting exploration programs.

MDRU differs from other university-based applied research bodies and other economic geology research groups in that MDRU did not result from government-sponsored programs nor does it receive significant financial support for infrastructure from government programs or directly from university budgets. Instead, it grew from the combined interests of the mining industry headquartered in Vancouver and The University of British Columbia and is sustained by high levels of cooperation between the mineral exploration community and the Department.

Late in 2006, the MDRU Board of Advisors, which includes representatives from industry, UBC, and the provincial and federal geological surveys decided to change the governance structure, creating a formal Board of Directors charged with the long-term sustainability of the Unit and a separate Research Generative Group charged with developing the technical research program.

MESSAGE FROM THE DIRECTOR

Dr. Richard M. Tosdal



The Mineral Deposit Research Unit had another extremely successful year in 2006, and enters 2007 with new research initiatives, strengthened collaborations with economic geology research groups around the world, new research staff, and an expansion of the unit in new directions. MDRU continues to be active on five continents in six broad research themes ranging from traditional hydrothermal ore deposit investigations to kimberlite and diamond investigations to the development of exploration techniques, particularly the integration of geologic and geophysical data to build 3-D earth models.

In 2006, MDRU established the third in a succession of collaborative research projects focused at understanding the large-scale setting and formation of the Carlin-type gold deposits. A project mapping footprints of Archean orogenic gold systems was also established. The groundwork for future multi-company projects was also laid with efforts being developed in mapping far-field alteration around porphyry Cu systems; investigating indicator minerals associated with magmatic-hydrothermal deposits, and computer assisted geologic mapping and geophysical inversion. Some of these are extensions of earlier projects. Site-specific projects are also being developed in porphyry and epithermal deposits around the world.

The commodity markets remain very strong and our industry sponsors recognize the need to invest in the training of the next generation of geoscientists. Membership is up from last year, largely from within the junior sector, as we currently count 57 mining companies, individuals and government agencies as members of MDRU. We thank them for their continued support.

A new governance structure of MDRU became effective January 1, 2007. The Board of Advisors, which previously governed MDRU, is split into two parts. An industry-dominated Board of Directors composed principally of the Foundation members of MDRU assumes responsibility for the strategic direction of MDRU. Technical direction to research is the responsibility of the Research Generative Group, composing the membership of MDRU. Both of these are discussed in more detail in the Report.

Throughout 2006, MDRU continued to disseminate technical information to diamond and metal companies through the independently funded Sheahan – MDRU Literature Service. Some thirty-three companies and individuals subscribe to the service through which their geoscientists can maintain current knowledge and awareness of the newest scientific and technological advances.

MDRU enters 2007 on a positive note with the prospect of developing a wide-ranging variety of research topics on all the habitable continents of the world. We look forward to the coming year.

A handwritten signature in black ink, appearing to read "R. M. Tosdal". The signature is fluid and cursive, written in a professional style.

2006 REPORT OF ACTIVITIES

MEMBERSHIP

MDRU currently has four Foundation Members, forty-six Corporate Members and four Individual Members. Although the latter members only provide small financial contributions to the annual income of MDRU, all are regarded as important. The Geological Survey of Canada (GSC), the Geological Survey Branch of the B.C. Ministry of Employment and Investment (BCGSB), and the Department of Northern Affairs (Yukon) - Yukon Geoscience Office continue to be active participants in MDRU.

FOUNDATION MEMBERS

AngloAmerican Exploration Canada Ltd.
Barrick Gold Corp.
Kennecott Exploration Co.
Teck Cominco Ltd.

INDIVIDUAL MEMBERS

Peter Fischl
John L. Jambor
Daniel Rubiolo
Anne J.B. Thompson

GOVERNMENT ASSOCIATES

British Columbia Geological Survey
Geological Survey of Canada
Yukon Geology Program

CORPORATE MEMBERS

Almaden Resources Corp.
Amarc Resources Ltd.
AngloGold Ashanti Ltd.
Ashton Mining of Canada Inc.
BHP Billiton Ltd.
Canadian Zinc Corp.
Cardero Resource Corp.
Cash Minerals Ltd.
Cia. De Minas Buenaventura S.A.A.
Coeur d'Alene Mines Corp.
Corriente Resources Inc.
Diamondex Resources Ltd.
Entrée Gold Inc.
Equity Engineering Ltd.
First Point Minerals Corp.
Galore Resources Inc.
Geoinformatics Exploration Inc.
Geoscience BC
Goldcorp Inc.
Hecla Mining Co.
Imperial Metals Corp.
Ivanhoe Mines Ltd.
Jinshan Gold Mines Inc.
Kenrich - Eskay Mining Corp.
Klondike Star Mineral Corp.
Lysander Minerals Corp.
Miramar Mining Corp.
Newcrest Mining Ltd.
Newmont Mining Corp.

Northgate Exploration Ltd.
Novagold Resources Inc.
Pacific Rim Mining Corp.
Pacifica Resources Ltd.
Pan American Silver Corp.
Phelps Dodge Mining Co.
Resolute Mining Ltd.
Rimfire Minerals Corp.
Roca Mines Inc.
StrataGold Corp.
TLC Ventures Corp.
Tone Resources Ltd.
Triex Minerals Corp.
Tuprag Metal Madencilik
Tyhee Development Corp.
Western Copper Corp.
Xstrata Plc.

STAFF CHANGES

Dr. John Mair completed the Yukon Cretaceous Plutons project. He returned to Australia where he is employed by Geoinformatics Exploration Ltd.

Dr. Farhad Bouzari joined MDRU in mid-2006 to manage the Archean Footprints project at Red Lake. He received his Ph.D. from Queen's University where he worked on the Cerro Colorado porphyry Cu-Mo deposit in northern Chile. He comes to MDRU from Tehran University where he was a lecturer.

Christine Swanson joined MDRU in April 2006 becoming the Manager of the Sheahan-MDRU Literature Service. She has many years of experience with exploration companies, and we welcome her perspective on the information needs to the subscribers.

SHORT COURSES

Two short courses attended by as many as 170 registrants were offered in 2006:

Great Metallogenic Provinces of the World, by Camus, F., Law, J., Maier W. and Oliver, N., in conjunction with the Association for Mineral Exploration British Columbia (AME BC) Mineral Exploration Roundup 2006, January 21 and 22, 2006.

Field mapping of ore deposits: Anatomy of a tilted porphyry Cu batholith and its hydrothermal alteration features, Yerington, Nevada (USA) by Dilles, J. and Tosdal, R.M., Joint Mineral Deposit Research Unit (MDRU) - Oregon State University, April 8-15, 2006.

GRADUATE THESES COMPLETED IN 2006

Jurado Carrasco, J., Distal alteration in the carbonate-hosted replacement and skarn systems at Yauricocha, central Peru: M.Sc.

Mackie, R., Crustal contamination, sulphide mineralization, and compaction during formation of the marginal zone of the Muskox Intrusion, Nunavut, and implications for the evolution of the 1.27 Ga Mackenzie magmatic event: M.Sc.

Richer, M., Volcanic framework, geochronology and geochemical evolution of the El Dorado Gold District, El Salvador, Central America: M.Sc.

Sterritt, V.A., Understanding physical property-mineralogy relationships in the context of geologic processes in the ultramafic rock-hosted mineral deposit environment: Aiding interpretation of geophysical data: M.Sc.

Nakano, K., Geologic framework of the Thunderstruck massive sulphide prospect, Goalnet property, Finlayson Lake district, YT: B.Sc. Hons.

Woodhouse, J.N., The characterization of hydrotalcite-group minerals and their anion exchange capabilities at Mount Keith Nickel Mine, Western Australia: B.Sc. Hons.

RESEARCH ACTIVITIES

MDRU initiates and funds research projects on a wide variety of topics and scales. Where possible, research is undertaken in large project environments supported by an industry consortium as these scales of projects generate significant results because of the critical mass of intellectual talent and resources to address the questions posed. In addition to the larger projects, small site-specific or topic-specific projects are established with single company support. Overall, research within MDRU & EOS revolves around six themes in which we have established expertise (see the following sections for descriptions).

Support for current and past projects has come from industry sponsors, NSERC, Yukon Geology Program, Geological Survey of Canada, British Columbia Geological Survey Branch, Geoscience BC, the Rocks to Riches Program and the Science Council of British Columbia.

Research funded through MDRU involves EOS faculty as well as geologists in various government, industry, and university institutions in Canada, the United States, and Australia. EOS faculty members also coordinate several of the research themes, and their involvement within the activities of MDRU is vital. Faculty managed research groups such as the Diamond Laboratory (Maya Kopylova) and the Geophysical Inversion Facility (UBC-GIF, Doug Oldenburg) are important compliments to MDRU and to the success of the research programs. The state-of-the-art analytical facility of the Pacific Centre for Isotopic and Geochemical Research (PCIGR, Dominique Weis, James Scoates, James Mortensen, Greg Dipple) is a critical partner in many research projects. Their collaboration with MDRU contributes greatly to the success of projects, and their continued involvement is critical to the future of MDRU.

Research Associates and Post-Doctoral Fellows comprise the bulk of the senior research staff, and at the end of 2006, there were six combined. Post-graduate thesis projects are essential to MDRU, and to date MDRU has supported 50 theses. At the end of 2006, MDRU supported 10 Ph.D. and 17 M.Sc. projects. Six theses were completed in 2006.

Research was active in all six themes during the year. Five projects were supported by multi-company consortium. The *Combining Geology, Physical Properties, and Geophysical Inversion for 3-D Integrated Earth Models* (joint with UBC-GIF) entered the third and final year. The *Mapping Thermal Anomalies* project was extended by the sponsoring companies and through a grant from the U.S. Geological Survey. The *Shallow and Deep-Level Alkalic Mineral Deposits, Tethyan Metallogensis – Turkey, and Carbon Sequestration* projects enter year 2. The *Footprints in Archean Lode-Gold Deposits* project was established. Groundwork was laid for projects to begin in 2007 with efforts focused on expanding the Magmatic-Hydrothermal research theme. New projects will involve faculty, research associates, post-doctoral fellows, graduate students, and research assistants. Fifty-one faculty, researchers, graduate students, and administrative staff participated in projects associated with MDRU during 2006.

THEME 1

MAGMATIC-HYDROTHERMAL DEPOSITS

DR. RICHARD TOSDAL - RESEARCH COORDINATOR

Shallow and deep-level alkalic mineral deposits: An integrated exploration model. **Dr. Claire Chamberlain, Project Coordinator**

Alkalic deposits have features atypical of 'classic' porphyry and epithermal systems that both allow them to be put into these classes as well as distinguish them from the sub-alkalic systems. Although known around the world, the quality of individual deposit descriptions in the public domain varies markedly. In contrast to their more common calc-alkalic cousins, there has been little effort made towards developing a coherent model that integrates the characteristics of various alteration styles that can develop in either a shallow- or deep-level alkalic igneous setting. Instead, the calc-alkalic model has driven the community's view of alkalic deposits historically. This 3-year, multidisciplinary project will advance understanding of the characteristics of individual alkalic systems and integrate that information into a holistic model for the porphyry and epithermal environment. The project is a joint effort with the Centre for Ore Deposit Research (CODES) at the University of Tasmania. *Dr. David Cooke* heads to collaborating research group at CODES. Nine companies support the project, including Amarc Resources, AngloGold Ashanti, Barrick Gold, Lysander Minerals, Newmont Mining, Newcrest Mining, Imperial Metals, Novagold, and Teck Cominco. Additional financial support derives from GeoScience B.C. and from the Collaborative Research and Development program of the Natural Sciences and Engineering Research Council of Canada.

Nine graduate students are working on the project from MDRU and CODES. Study sites include Mount Polley, Mt. Milligan, Galore Creek

and Lorraine in B.C., and Cowal and Cadia, N.S.W. (Australia), and Porgera and Ladolam, P.N.G.



Janina Micko logging core at Galore Creek.

Porphyry and epithermal deposits **Dr. Richard Tosdal, Project Coordinator**

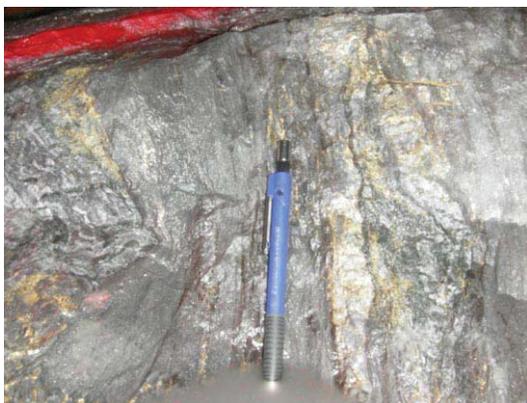
At the El Dorado property in El Salvador (*Mathieu Richer*) and at the Manantial Espejo property in Argentina (*Stefan Wallier*), detailed mapping of these low-sulfidation style epithermal deposits are defining the paragenesis, zoning, and volcanologic setting of these vein deposits. Pacific Rim and Pan American Silver, respectively, are supporting these projects. In contrast, continental margin tectonics strongly influences the formation and preservation of porphyry Cu deposits. A framework study on the Oyu Tolgoi porphyry Cu-Au deposits in Mongolia (*Alan Wainwright*) is linking igneous petrology, stratigraphy, and geochronology to define the setting of these Devonian deposits. Ivanhoe Mines is supporting this project. A new project at the giant Quellaveco porphyry Cu-Mo deposit in southern Perú was established, with fieldwork scheduled to begin in 2007. Anglo American Exploration Peru is sponsoring this site-specific

project. All projects are supported in addition to the industry sponsors by a Discovery Grant from NSERC to *Richard Tosdal* in addition to NSERC Industrial Graduate Scholarships to the graduate students.

Footprints of Archean lode-gold deposits

Dr. Farhad Bouzari, Project Coordinator

Archean lode-gold deposits are of significant economic importance and attractive exploration target especially in the vast terrains of the Superior and Slave cratons of central and northern Canada. They include some of the world's highest grade and largest gold deposits (e.g., Red Lake, Ontario: 31 million ounces of gold at average grade of 21 g/t). Moreover, their vertical extension, as much as 3 km, provides a unique opportunity to view the anatomy of the Earth's oldest hydrothermal systems and in particular the evolution of hydrothermal systems at depth.



High-grade gold, Red Lake.

Whereas the structural setting of these gold-only deposits is well understood, fundamental aspects of the hydrothermal system and their architecture remain elusive despite many years of excellent research, largely in Canada and Australia. Thus, although broad conceptual models are known, predictive models of

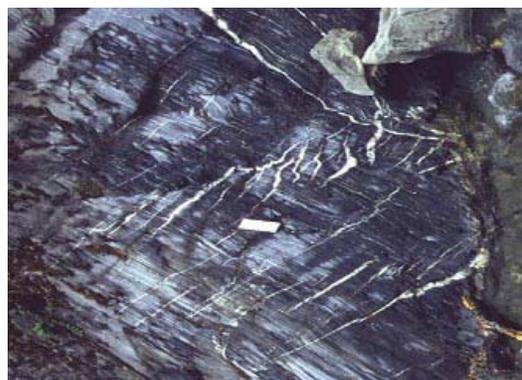
hydrothermal systems showing mineralogical and geochemical relationships in detail are not widely available to guide exploration or are subject to conflicting interpretation. Nonetheless, Archean gold deposits clearly have unique and complex characteristics as they appear to commonly have evolved from a volumetrically large, but barren, early-stage to a more localized and mineralized stage, thus in this aspect similar to many other ore deposit types. Therefore, the challenge is to characterize and distinguish footprints of each stage of a hydrothermal system, or of superposed systems. Once established, these footprints provide guidelines to pinpoint each stage within a broader zone of alteration visible in surface outcrops, potentially leading to the identification of the fluid pathways where gold will be located. Such a study also benefits current research on hydrothermal ore deposits as it demonstrates how and why these systems evolve from a large barren system to an ore deposition stage and why in most cases their life ends at the early barren stage.

This project is the first step in a collaborative program with Goldcorp Canada and NSERC at the Campbell - Red Lake mines in western Ontario to examine the hydrothermal alteration on the camp and deposit scale. Field mapping and core logging supported by modern mineralogic and geochemical techniques are the principal tools to be utilized. A practical outcome of the project is a series of predictive tools to vector toward gold in the Red Lake area, and elsewhere in Canada. The goal will be attained through study of both ore-related features and far field alteration along several cross sections and on surface outcrops to build a 3-D image of these systems. The results will have immediate benefit to ongoing gold exploration in the district and elsewhere in Canada, as well as examine the size and nature of these enigmatic metalliferous hydrothermal systems.

Nature, origin and structural controls on Phanerozoic orogenic gold deposits

Dr. Jim Mortensen, Project Coordinator

Phanerozoic orogenic gold deposits (OGDs) are commonly associated with rich and extensive placer deposits, and therefore represent attractive exploration targets. However OGDs are one of the least understood styles of gold mineralization, and uncertainties concerning specific controls on their formation hamper exploration. Detailed studies of OGDs are underway in the Klondike Gold District in western Yukon and in the Otago Schist Belt in South Island, New Zealand. A total of 5.5 months of geological mapping and structural investigations were carried out in the Klondike in 2006, in collaboration with *Doug Mackenzie* and *Dave Crow* from the University of Otago. A structural model for the controls on gold-bearing vein systems in the Klondike was developed and will be applied and further refined during exploration work in the area in 2007. A new geological map of the Klondike District and adjoining Indian River area is currently being prepared for publication in 2007 by the Yukon Geological Survey. Isotopic dating and lead isotopic investigations in the Klondike are also continuing. A detailed investigation of the age and lead isotopic characteristics of gold bearing vein systems and shear zones in the Otago Schist Belt was begun in 2006. This new work builds on over twenty years of structural and metamorphic studies in the region by *Dave Crow*, *Doug Mackenzie* and other colleagues at the University of Otago. Work thus far has confirmed that at least three distinct mineralizing events affected this region, and we are now attempting to better understand the structural controls and regional



Gold-bearing extensional veins at Glenorchy, New Zealand.

scale tectonic setting of the mineralization. A new collaborative project has recently been initiated with *Dave Rhys* of Panterra Geoservices, Inc., focusing on the various styles of OGD mineralization in the Cariboo Gold District in east-central British Columbia. This work will include detailed investigations of gold-bearing vein and replacement deposits in the historic Wells-Barkerville gold camp, which are hosted by metamorphic rocks of the Barkerville terrane and closely resemble OGD mineralization in the Klondike District. We will also study gold-bearing vein systems and shear zones hosted within structurally higher and much less metamorphosed sedimentary units at the Spanish Mountain and Frasergold deposits, and determine whether these deposits represent a higher-level manifestation of the same hydrothermal systems that operated in the Wells-Barkerville camp or result from completely unrelated systems. Work in the Cariboo Gold District builds on ten years of structural work by *Dave Rhys* in this area. *Dr. Tim Baker* from James Cook University is joining the project in 2007 as an additional collaborator, focusing on the fluid chemistry of these three major Phanerozoic OGD districts.

Global volcanogenic massive sulfide deposits

Dr. Jim Mortensen, Project Coordinator

A study of the volcanological and paleotectonic settings in which precious metal enriched VMS mineralization occurs within the Stikinia terrane in western and northwestern British Columbia was completed in 2007 and results are being prepared for publication. A separate project focusing on the volcanological and paleotectonic setting of VMS deposits in the mid-Paleozoic Sicker Group on Vancouver Island (including the Myra Falls deposits) and regional potential for undiscovered VMS deposits is also underway with *Tyler Ruks* (Ph.D. candidate with Mortensen). This project is currently funded through Geoscience BC. A new project aimed at developing a detailed chronostratigraphic framework (using U-Pb zircon dating methods) for the Mt. Read Volcanic Belt (MRVB) in Tasmania will begin in mid-2007. This work is being done in collaboration with CODES at the University of Tasmania. The MRVB is one of the most productive VMS districts in the world; however additional research into the nature and genesis of deposits in the belt is currently hampered by very limited age constraints on magmatism. Approximately 25 new U-Pb zircon ages will be generated for intrusive and extrusive rock units associated with VMS deposits and occurrences within the MRVB within the first year of this study.



Jim Mortensen, Sarah Gordee, Brian Mahoney, Jay Hodgeson and David Gale in the snow at Eskay Creek, BC.



Lawrence Winter underground in the Coeur d'Alene District, Idaho.

THEME 2 METALLOGENIC FRAMEWORK

DR. KENNETH HICKEY - RESEARCH COORDINATOR

Framework of Archean orogenic gold deposits

Dr. Claire Chamberlain, Project Coordinator

Orogenic deposits are a major global source of gold and varying deposits grouped within this broad class form at different times during the evolution of granite-greenstone belts and their amalgamation as part of an Archean cratonic core. Critical to understanding their genesis is a proper geologic framework, including precise timing of the events. The project provides these constraints in one of the world's poorest known Archean terranes, the Lake Victoria Gold Fields of east Africa. The granite-greenstone belt composing the goldfield is the site of 2 world-class gold deposits, the Bulyanhulu and Geita systems, with several smaller mines (Tulawaka, North Mara, and Golden Pride) and numerous prospects (e.g. Buzwagi, Nyanzega). Together with evidence from cross-cutting relations in the field, constraining the timing of volcanic and intrusive units and sedimentary basins will allow a better understanding of the timing of major structures and mineralization. In doing so, this will assist in generating a holistic model for terrane evolution and provide a framework for testing and developing exploration strategies in Tanzania and equivalent terranes throughout the world. Barrick, AngloGold Ashanti, Placer Dome and Resolute Mining support the project. Final analyses was completed in 2006 and presented to the supporting companies.

Metallogenesis of the Tethyan collage: Magmatic association and age of ore deposition in Turkey

Dr. Ilkay Kuscu, Project Coordinator

The Mesozoic and Cenozoic Tethyan collage stretching from Europe across southern Eurasia is an extremely complex geologic terrane caught between colliding continents. Although complicated, the geodynamic setting of the Tethyan collage is reasonably well known as a result of decades of geologic investigation. However, a similar understanding of the metallogenic evolution of the region is not available or only sparsely known. With the opening or potential opening of much of this region to mineral exploration as a result of political events of the last decade and hopefully continuing into the future coupled with the presence of world class deposits within the Tethyan collage, developing a metallogenic framework for the region will aid future exploration. The project focuses initially on transects across the belt in western and central Turkey. Barrick Gold and Teck Cominco supported the initial stages of the project. Tüprag Metal Madencilik Sanayi ve Ticaret Limited, a subsidiary of El Dorado Gold, will join the project as a sponsor in 2007.

Structural evolution of Ormsby Zone

Dr. Richard Tosdal, Project Coordinator

The Yellowknife belt of the N.W.T. has been the site of extensive gold mining. On the northern end of the belt, new exploration has defined gold resources near the abandoned Discovery Mine. The new prospect, the Ormsby Zone, is the site of research on the structural and metamorphic

framework of gold (*William Whitty*). The critical question is the paragenetic timing of gold deposition within the deformation and metamorphic sequence.

Geology of the Hope Bay greenstone belt, Nunavut

Dr. Richard Tosdal, Project Coordinator

The Hope Belt greenstone belt is the site of active exploration for shear zone hosted gold deposits. As part of a regional exploration program supported by Miramar Hope Bay Mining, *Andrew Shannon* is undertaking a volcanology and petrochemistry study of the regional stratigraphy to better define the distribution of favourable host rock units.



Andrew Shannon and Ross Sherlock having lunch on the Hope Bay greenstone belt, Nunavut.

Mapping the Resource Potential Beneath the Chilcotin Flood Basalts

Dr. J. Kelly Russell & Dr. Graham Andrews, Project Coordinators

The Neogene (25– 3 Ma) Chilcotin flood basalt (CFB) province of south-central British Columbia overlies an area of nearly 36,500 km². It covers and obscures Paleozoic-Mesozoic basement

rocks with high mineral potential (e.g., Quesnel Trough) and petroleum-prospective Cretaceous-Eocene sedimentary rocks of the Nechako Basin, except for rare basement “windows”. The CFB is composed of plateau lavas and associated volcanoclastic breccias that reach thicknesses of ≤ 200 m and are typically overlain by thick Pleistocene glacial deposits. This project is the first to examine the CFB from a volcanological perspective.

Our goal is to better constrain the present thickness distribution of the CFB through fieldwork, geochronology, and geochemistry, in the context of better-understood flood basalt provinces elsewhere. By establishing a three dimensional volcanic architecture, we are delivering “hard-data-points” for geophysical surveys (e.g., locally exact thickness measurements) and to provide 3-D geo-referenced physical property data from collected samples. In addition to aiding larger-scale geophysical exploration, our fieldwork will locate and identify basement “windows” where the basalt is thin, and identify ancient drainages below and within the CFB, with the potential to host placer deposits.

Our preliminary results from the 2006 field season suggest that the distribution of the CGB is highly variable and thickness variations are strongly influenced by paleo-topography. It is probable that the thickest (> 50 m) sequences of CGB reflect the locations of pre-Miocene paleo-drainage systems; these paleo-valleys are sub-parallel to present-day valleys and may be fault-controlled. If true, areas between the thick, basinal accumulations of CGB represent basement highlands and may be covered by a relatively thin (<20 m?) and “exploration-friendly” basalt cover. These hypotheses are being tested in the summer 2007 by further mapping and focussed geophysical surveys.

THEME 3 EXPLORATION METHODOLOGY

MR. NIGEL PHILLIPS - RESEARCH COORDINATOR

Mapping thermal anomalies

Dr. Ken Hickey, Project Coordinator

Previous MDRU research has reconstructed the Eocene paleogeography around the northern Carlin trend (Nevada) and outlined a zone of apatite fission track age resetting around those gold deposits. This zone of resetting reflects a large zone of convective heat transport that is the footprint of a "Carlin-related" geothermal system. This project is applying the lessons learned in the previous project to other clusters of Carlin type deposits to evaluate whether similar zones of resetting characterize Carlin-type deposits, and if there is some correlation between the size of the reset zone and the gold endowment. As part of the project, *Iskra Zamarron* is reconstructing the eruptive history of the Caetano tuff, which is a critical volcanic unit adjacent to the emerging world-class gold camp in the Pipeline – Cortez Hills area. Industry sponsors Barrick Gold, Newmont Mining Corporation, and Placer Dome, prior to the merger with Barrick, extended the project. Additional funds secured through the US Geological Survey Mineral Resources External Research Program allow the project to continue into 2007.

Combining Geology, Physical Properties, and Geophysical Inversion for 3-D Integrated Earth Models

Dr. Ken Hickey and Mr. Nigel Phillips, Project Coordinators

Geophysicists now produce 3-D images of subsurface physical properties by inverting a wide range of geophysical survey data. There is still much to be learned about how to extract specific geologic information from geophysical

inversion results and how best to integrate geologic constraints and information into the geophysical inversion process in order to further refine resulting models of ore deposits and associated geology. This project seeks to delineate more explicitly how inversion tools and geologic information can be used together to help answer geologic questions in a range of mineralized environments. The project combines the expertise in MDRU, the Department, and the Geophysical Inversion Facility headed by Doug Oldenberg. Study areas include the northern Carlin trend Nevada (*Ken Hickey*), Kabanga, Tanzania (*Claire Chamberlain* and *Victoria Sterritt*), Timmins area of Ontario (*Dianne Mitchinson*), Flin Flon and Rio Blanco (*Nicolas Pizarro*), and the Lenora-Wiluna Greenstone belt of Western Australia (*Nick Williams*). AngloGold North America, Anglo American, Barrick Gold, Geoinformatics Exploration, Inco Technical Services, Noranda Falconbridge, Placer Dome Exploration (now part of Barrick Gold), Teck Cominco, WMC International (now part of BHP Billiton) are financially and logistically supporting the project.

Geochemistry, mineralogy and morphology of gold: Applications to exploration and understanding placer/lode relationships

Dr. Jim Mortensen, Project Coordinator

The relationship between placer and lode gold deposits is generally not well understood, and in many parts of the world placer gold deposits of substantial size exist for which no lode source has been convincingly identified. From an exploration standpoint, placer gold clearly indicates the potential for significant lode sources, but because the linkage is poor, there

is little constraint on what type of deposit might be providing the placer gold. Understanding this linkage is thus an unsolved question that has practical implications. *Evan Crawford* is utilizing the geochemistry, mineralogy and crystallinity of gold grains to investigate the linkages between lode gold occurrences and placer deposits derived from them. *Dr. Rob Chapman* (University of Leeds) is on this study. The basic premise is that major, minor and trace element compositions of placer gold, together with the nature of the contained micro-inclusion suite, should provide a unique signature that can be used to constrain the specific type of lode source(s) from which the gold was derived. Conversely, the information may constrain how placer gold might be modified or augmented by in situ growth within the surficial environment. A separate component of this study focuses on the evolution of the shape(s) of placer gold grains during alluvial/fluvial transport. We are attempting to quantify the evolution of grain shape with distance travelled; clearly if successful this would provide a valuable tool for better delimiting possible source areas for placer gold.



Evan Crawford and Rob Chapman sampling in the Klondike, Yukon.

Vectors toward Carlin type gold deposits

Dr. Kenneth Hickey, Project Coordinator

One of the main challenges faced by companies exploring for Carlin-type deposits is to be able to search under the sequences of Paleozoic to Quaternary rocks overlying the Lower Paleozoic, carbonate dominated, miogeoclinal rocks that form the main host for mineralization. The current project builds upon the existing MDRU research with the aim of developing an integrated model for the exploration of Carlin-type deposits that maximizes the potential for success under cover. The project will combine a well-constrained geological understanding of the paleogeographical, tectonic and magmatic environment of gold deposition, with a range of thermometers, thermochronometers and geochemical tracers to delineate the location and scale of Eocene hydrothermal fluid circulation and where it may manifest under cover. These tracers will also provide a means to define direction and scale of fluid flow and help delineate feeder structures within areas of Eocene hydrothermal activity. *Jeremy Vaughan* will be undertaking the geochemical tracer study as part of his Ph.D. The study area will encompass all the major Carlin-type deposits in the Great Basin west of the Ruby Mountains. The results of the project should have implications beyond the Great Basin, and have the potential to assist in the evaluation and exploration of other terranes favorable for Carlin-type gold deposits, or other sedimentary rock-hosted deposits. This project is sponsored by Barrick Gold, Newmont Mining Company, and Teck Cominco Ltd. A grant to the Natural Sciences and Engineering Research Council for matching funds will be submitted in 2007.

THEME 4 MAGMATIC SULFIDE DEPOSITS

DR. JAMES SCOATES - RESEARCH COORDINATOR

Layered mafic-ultramafic intrusions and flood basalts from Large Igneous Provinces worldwide are major sources of economic Ni-Cu-PGE deposits. *Rob Mackie* (M.Sc. April 2006) completed his study of the petrology, geochemistry, geochronology and metallogeny of the marginal rocks of the Muskox intrusion, Nunavut. The project was supported by Anglo American Exploration Canada (AAEC) and NSERC CRD, and Rob is now a Project Geologist with AAEC. *Andrew Greene* (Ph.D.) continues to make advances in his large-scale volcanological, geochemical and geochronological study of flood basalts from the giant Wrangellia terrane that is exposed over 2000 km along the west coast of North America from Vancouver Island to Alaska. A major component of the Wrangellia project is to assess the magmatic sulfide potential of the basalts and underlying sills using whole rock PGE chemistry as a monitor of sulfide saturation state. This project has been supported by the B.C.-Yukon Chamber of Mines Rock to Riches Program, NSERC, and research grants from the Yukon and B.C. Geological Surveys. *Erik Scheel* (M.Sc.) is finishing his detailed study

of the origin of nickel sulfide mineralization in the Turnagain Alaskan-type intrusion in north-central B.C. (supported by Hard Creek Nickel Corporation). *Katrin Breitsprecher* (Ph.D.) has initiated a major isotopic and geochronologic study of Mesozoic porphyry intrusions across southern B.C. from the Quesnel terrane to the Coast Plutonic Complex with the aim of linking subduction cycles to magma genesis and mineralization style (funding from GSC TGI-3 and Geoscience BC). Elsewhere in Canada, *Caroline-Emmanuelle Morisset* (Ph.D.) is nearing the completion of her evaluation of the mechanisms of segregation of Fe-Ti oxides (hemo-ilmenite and rutile) in Proterozoic anorthosite complexes in Quebec based on a comprehensive petrologic, geochemical, isotopic and geochronologic study of massive ilmenite deposits and their associated host rocks (supported by Rio Tinto Iron and Titanium and NSERC CRD). Finally, an on-going project involves determining the precise age of crystallization, mineralization and cooling history of the platiniferous Merensky Reef in the Bushveld Complex, South Africa (funding from NSERC).



Andrew Greene at base of the Karmutsen basalts, Schoen Lake region, Vancouver Island.

THEME 5 KIMBERLITE

DRS. MAYA KOPYLOVA AND KELLY RUSSELL - RESEARCH COORDINATORS

Mapping and interpretation of volcanic facies is now recognized as a critical tool in the prediction of diamond distribution and in the evaluation of kimberlite during exploration. The active MDRU research program is addressing fundamental issues concerning the eruption of kimberlite volcanoes and the practical issues of how volcanic facies relate to diamond grade distributions.

MDRU's research program in kimberlite volcanology began with *Liane Boyer's* (2004) M.Sc. research on kimberlites in the Buffalo Head Hills (Alberta). Her research showed these deposits to be largely pyroclastic (fall, surge) in created a composite model for kimberlite volcanoes. Her work demonstrated the pronounced similarities between the eruptive products of kimberlites and those defining "maar" eruption craters.

Another project is the M.Sc. research project of *Emma Gofton* on the Renard kimberlite cluster (Quebec). Her research examined the nature and origins of coherent and fragmental deposits in the deep root zones of diamondiferous kimberlite. The sequence of textures found in these rocks suggests that the Renard bodies preserve the transition from root to diatreme zone of the kimberlite pipes.

Maya Kopylova, Kelly Russell and Barbara Scott-Smith (Adjunct Professor) are funded by DeBeers Canada and NSERC to establish a volcanological framework for the two (Main and Northwest) nested kimberlite craters that form the Victor Pipe (Ontario). The PhD project of *Bram van Stratten* has the ultimate goals of establishing a petrological or volcanological explanation for the

heterogeneous distribution of diamond in Victor Main and Northwest bodies.

The most recent project on kimberlites is funded by Diavik Diamond Mines (Rio Tinto-Aber joint venture) to create understanding of the deposits within the four Diavik kimberlite pipes (A154N, A154S, A418, and A21). *Stephen Moss's* PhD research is aimed at testing the hypothesis that the diamond distributions may reflect the volcanic facies (including re-sedimentation) of the deposits superposed on original compositional differences between kimberlites. The first year of research consisted of elucidating the volcanological properties of the kimberlite deposits at in the A154N kimberlite body.



Stephen Moss at Diavik.

Highlights of the study (Moss et al. 2007) include: a) the first granulometric datasets (e.g., size distributions) for pyroclastic kimberlite which supports comparisons against other conventional deposits, and b) facies re-constructions of the upper 120 m of A154N pipe, and c) a model for the geometry of the kimberlite volcano including a deep, partly-filled, steep-walled crater preserved at the end of the eruption. Recently, Moss et al. (2007) used these results to show

that the upper 60 m of kimberlite deposits in pipe A154N actually derive from another source. These “orphaned deposits” are diamond-rich and appear to be pyroclastic kimberlite deposits produced by another kimberlite volcano but captured by the this kimberlite volcano’s empty crater. We suggest that this may be a much more common phenomena than expected because:

- a) kimberlites occur in clusters, and kimberlite eruption produce broad shallow volcanic craters underpinned by deep (> 400 m) steep-walled, 100-200 m diameter conduits that are largely empty (forming lakes) and volcanism in kimberlite clusters overlaps in time. The implication is that these open holes resulting from kimberlite eruptions act as receptacles for “orphaned” deposits from adjacent kimberlite volcanoes. Infill of a single kimberlite pipe can be the result of multiple eruptions from different locations. We consider this a first order result fro volcanological sciences and for the diamond exploration industry.



We have recently added a M.Sc. student (*Curtis Brett*) to the Diavik kimberlite project. His goal is to research project to characterize the mineralogy and geochemistry of individual phases of kimberlite. A practical application of this work would be to develop chemical and or mineralogical “fingerprints” for distinguishing between diamondiferous and non-diamondiferous phases of kimberlite in the Diavik cluster. This year Brett and Moss collected and prepared

104 samples representing a maximum of 25 different phases of kimberlite from 4 kimberlite bodies (A154N, A154S, A21 and A418). The sample suite includes coherent facies (hypabyssal) and volcanoclastic (pyroclastic and resedimented) facies. Preliminary results suggest that there are substantial differences between melts that derive from pyroclastic vs. coherent facies kimberlite.

Future work will integrate stable isotopic analysis (C and O) of carbonate from the same sample suite.

THEME 6 SUSTAINABILITY

DR. GREG DIPPLE - RESEARCH COORDINATOR

Carbon Sequestration in Mine Tailings

**Dr. Greg Dipple and Dr. Gordon Southam
(University of Western Ontario), Project
Coordinators**

The carbon sequestration project examines greenhouse gas fixation in the tailings of operating mines. It is sponsored by BHP-Billiton, Diavik Diamond Mine, and NSERC. We are evaluating the rate of carbon uptake in tailings of the Mount Keith Nickel Mine (Western Australia) and the Diavik Diamond Mine (NWT), and using isotopic analysis to fingerprint which carbon reservoirs are being mineralized. Mineral precipitates that fix carbon dioxide (CO₂) are predominantly the Mg-carbonate minerals hydromagnesite and nesquehonite. Other Mg, Ca and Na carbonate minerals are present, but generally in limited abundance. Mineralized carbon is derived from the atmosphere, from bedrock, and from industrial sources including waste streams. More than 1,000 tailings samples were collected in 2006 to allow a statistically valid analysis of carbon uptake rates. Examination and processing of those samples will continue in the coming months. Carbon uptake rates appear to be limited by cation abundance in process waters. Sulphate mineral precipitation competes for these same cations and may be suppressing carbon fixation rates. One route for accelerating carbon uptake may therefore be by suppression of sulfate mineral precipitation. Microbial studies indicate that photosynthetic activity may seasonally increase the carbonate content of process waters at Diavik. Microbial acceleration of carbon fixation may also be possible. Ph.D. students *Sasha Wilson* (UBC) and *Ian Power* (UWO) lead the field-based mineralogical and microbial studies.

Silicate mineral dissolution controls the rate of cation release needed for carbon fixation. Laboratory experiments have determined a far-from-equilibrium dissolution rate law for serpentine and identified microbially-accelerated dissolution strategies. The laboratory studies are conducted by Ph.D. students *James Thom* (UBC) and *Ian Power* (UWO). *Joanne Woodhouse* examined CO₃-SO₄ exchange in hydrotalcite-group minerals from the Mount Keith Mine (B.Sc. Hons thesis 2006, UBC). Anion exchange within hydrotalcite-group minerals adds to the carbon sequestration potential at Mount Keith. *Sasha Wilson* continues to improve and expand the verification protocol that uses powder X-ray diffraction data and the Rietveld method to accurately assess the amount of bound carbonate in tailings.



*Mg-Carbonate
efflorescences...*

*...cements
and other
subsurface
precipitates...*



*...coatings
and
ephemeral
drainages.*

SHEAHAN-MDRU LITERATURE SERVICE

The Sheahan-MDRU Literature Service and economic geology library continued to thrive and grow in 2006 as a non-profit service, wholly sustained by subscribing mineral exploration companies. Diamond and base/precious metals newsletters were distributed each month and population of the online database continued. The database contained over 100,000 highly relevant references at the end of 2006. The number of subscribers continues to hold steady with thirty-three major and junior companies combined receiving the service. The Sheahan-MDRU Literature Service finished 2006 with a deficit budget.

RESOURCE CENTRE

The Resource Centre, located mainly in Room 202 of the Geology building, contains the following equipment:

- GIS computer - dedicated to map preparation and spatial data manipulation
- Various computers - windows applications - presentation and database
- Digitizer and Plotter - map and diagram production
- B.C. Minfile/Yukon Minfile - online/compact disk
- BC Assessment Reports - microfiche
- Island Copper Archive - BHP archive files, data, and core from Island Copper
- Work areas - reading, meeting, map preparation

Databases include GEOREF, B.C. Minfile, and Yukon Minfile. Arne Toma supervises the Resource Centre and his office also provides space for visiting researchers and Individual Members. Improvements to the computer facilities and software upgrades are an ongoing minor part of the MDRU budget.

The other part of the Resource Centre is located in Room 313Q and 323. These rooms contain fluid inclusion equipment, a petrographic microscope, a binocular microscope, and a section storage area. MDRU personnel and Individual Members continue to provide various petrographic and analytical services to the industry, often involving contractual arrangements with analytical laboratories in the Department (XRD, Microprobe and SEM). This work helps foster interaction between MDRU, the industry and EOS.

INTERNATIONAL ACTIVITY

MDRU continues to gain international recognition through research projects, publications, international members, lectures, visitors and overseas visits. International activities in 2006 included fieldwork on 5 continents (Africa, North America, South America, Australia and Asia), lectures to international geological societies, and participation at international meetings in Canada, Perú, US, and Australia. Fieldwork in Mongolia, USA, Australia, Argentina, El Salvador, and Perú as part of graduate student projects is providing important exploration information, international experience for the students and exposure for MDRU.

SOCIETY OF ECONOMIC GEOLOGISTS STUDENT CHAPTER (UBC)

The UBC Society of Economic Geologists Student Chapter is open to UBC undergraduate and graduate students interested in the study of economic geology and its essential role in our society. The goal is to maintain the chapter as a research resource and discussion forum.

The major activity of the Student Chapter each year is an annual student-organised international trip to a region of the world with notable geology and mineral wealth. Each two week trip, usually in May, aims to visit several world class mines, including type examples of particular deposit styles, as well as a range of different deposit types to broaden participants' understanding of mineralizing process. In addition the tours aim to expose students to different landscapes and cultures.

New Zealand was the destination for the 2006 trip. See www.mdru.ubc.ca/home/resources/seg/seg_ft/2006nz.php for details. The 2007 trip will be to Sweden (www.mdru.ubc.ca/home/resources/2006nz.php).

As a non-profit society with no membership fees required, the Student Chapter must gather funds through fund-raising activities. We gratefully acknowledge the companies, organizations and individuals who supported us in 2006: Equity Engineering Ltd., Kaminak Gold Corp., Barrick Gold Corp., the Society of Economic Geologists, the Geological Association of Canada, Ed Balon and MDRU.

SUMMARY

The past year was excellent for MDRU. In 2006, MDRU established one multi-company project, several one-company projects, laid the groundwork for future multi-company project, reorganized the governance structure of the Unit, and continued to graduate highly-trained young geoscientists who are now working for the minerals industry. It ended the year with an increase in membership largely from within the junior sector. MDRU continues to produce high-quality research and organize short courses that are well attended by the geologic community. MDRU advanced further on the international scene through overseas visits and visitors combined with the publication of a number of papers in major journals during the year.

EXPENDITURE AND BUDGET

MDRU ACCOUNTS

MDRU has three UBC accounts. The Industry Funds account contains membership fees and other income related to charge-outs of technical support. The Short Course and Endowment accounts are retained separately to simplify accounting and reporting requirements. During 2006, funds in the Short Course and Endowment accounts supplemented the operating expenditures. Additional funds were derived from the salary charge-outs for technical support to the projects.

2006 INCOME AND EXPENDITURE

Income and expenditure for 2006 are shown in Table 1. Membership fees received were slightly higher than projected, as was the income from the endowment and salary charged to other sources. Income from short course was also higher due to the attendance level at the course offered during the Mineral Exploration Roundup. Income derived from salary charge-out to projects and to other faculty accounts was higher than projected.

Expenses for 2006 were slightly higher than projected due to salary adjustments for the core administrative staff. No new equipment was purchased for the MDRU infrastructure, resulting in a lower than projected operating expense. Financial short falls in the management of the Sheahan-MDRU literature service impacted the expenditures in 2006.

Overall, the MDRU infrastructure accounts ended the year with a surplus in the three accounts.



Moonrise over the Wasatch Mountains, Utah. Courtesy Jamie Wilkinson, Imperial College.

TABLE 1. INCOME AND EXPENDITURES FOR 2006 (X \$1000)

INCOME:	Budget	Actual
MDRU Fees (Received & Promised)	138.4	145.7
Charge Outs	11.0	30.5
Salary chargeout for Resource Centre	49.9	56.3
Endowment projection	93.5	97.2
Short Courses (net income)	12.0	16.7
Publication (net income)	0.4	0.9
Life Long Learning Plan (net income)	0.0	2.3
Total Income	305.2	349.8
EXPENSES:		
Salaries & Benefits	196.5	196.7
Salary charge for Resource Centre	49.9	56.5
Operating Expense	15.0	19.0
Travel & Conferences	10.0	1.1
Equipment	4.0	2.8
Publications	0.0	-
Sheahan Library	16.3	19.9
Total Expenses	291.7	296.0
CARRY FORWARD:		
Carry Forward from 2005	75.7	77.7
Total 2006 Income	305.2	349.8
Total 2006 Expenses	291.7	296.0
Profit/(Loss) for 2006	13.5	53.8
Estimated Carry-forward to 2007	89.2	131.5

CASH IN LIEU

MDRU continues to receive additional support, particularly in the form of space, and assistance from Financial Services and other UBC departments. The Geological Survey Branch of the BC Ministry of Investment and Employment (BCGSB) continues to provide publications, although the BCGSB has moved to the electronic distribution of many publications. MDRU member companies also donated a considerable amount of personnel time to MDRU including attendance at meetings of the Board of Advisors and research discussion for project planning. Board members have also been involved in the fund raising initiative as have been other members of the mining and exploration community.

2007 BUDGET

The 2007 budget is outlined in Table 2. The anticipated membership income is higher due to an increase in membership fees for the four Foundation member companies in addition to new membership expected in early 2007. Short Course income is expected to increase slightly. Publication costs from previous years are being recouped over time, and a modest income is projected. Additional income will accrue from salary charge-outs to the projects and other faculty in the Department. In 2007, the library is projected to continue to run a deficit for the fiscal year, and funds are budgeted to off set those expenses. Project activity, a full administrative staff, and travel associated lead to projected expenses for 2007 approximately the same as in 2006.



Panorama of the Bingham Canyon Copper Mine, Utah.

TABLE 2. PROPOSED MDRU 2007 BUDGET (X 1000)

INCOME:	
Foundation Members Fees (Received & Promised)	80.0
MDRU Fees (Received & Promised)	101.4
Charge Outs	6.3
Salary chargeout for Resource Centre	55.5
Endowment projection	97.2
Short Courses (net income)	25.0
Publication (net income)	0.9
Total Income	366.3

EXPENSES:	
Salaries & Benefits	208.8
Salary & Benefits - Resource Centre	55.5
Operating Expense	20.0
Travel & Conferences	10.0
Equipment	4.0
Publications	0.0
Sheahan Library	27.8
Total Expenses	326.1

CARRY FORWARD:	
Carry Forward from 2006	131.5
Total 2007 Budgeted Income	366.3
Total 2007 Budgeted Expenses	326.1
Profit/(Loss) Budgeted for 2007	40.3
Estimated Carry-forward to 2008	171.7

LOOKING AHEAD TO 2007

ADMINISTRATION AND MEMBERSHIP

MDRU continues to develop large-scale regional or thematic research projects around global issues, and to establish highly visible projects on a smaller scale that are supported by one or two companies interested in a particular problem, region, or deposit. These opportunities are reflected in the research projects currently established and opportunities expected to arise in 2007. As new projects become funded, it is envisioned that sufficient resources will become available to employ new post-doctoral fellows or research associates who will be responsible for managing and on-going project development. New project will also maintain membership and where attract new members.

Access to these research projects and the results both technical and human resources are the most important reason for companies to belong to MDRU. New projects that have sufficient relevance and appeal to attract funding under the present circumstances are critical for survival. In addition to research, the continued delivery of high-quality short courses is important, particularly for attracting junior companies and non-Canadian companies as members. Maintaining the facilities in the Resource Centre is critical for Individual members.

NEW MDRU GOVERNANCE

A new governance structure of MDRU becomes effective January 1, 2007. The MDRU Board of Advisors, which previously governed MDRU, is being split into two parts. A new Board of Directors assumes responsibility for the strategic direction of MDRU, including the managing and leading the efforts to place the unit on a sustained financial basis into the future. The major task is what MDRU should look like 5 years into the future, and how shall MDRU reach this goal. The Board Directors consists of individuals representing the Foundation member companies of MDRU. Each of these companies has decided to increase their financial sponsorship of MDRU to a level significantly larger than the general membership. Foundation Board seats are open to any MDRU sponsor companies. Board members at the beginning of 2007 are Bob Holroyd (Teck Cominco), Francois Robert (Barrick Gold), Ian Graham (Kennecott Canada), and Owen Bavinton (Anglo American). Annual membership fees for Foundation member companies are higher than the normal membership. In addition, there will be 3 independent board members who will come from outside of UBC and member companies. Currently, only one independent director, Jim Franklin, has been appointed. Lastly, the Vice President Academic from UBC and the Head of Department at UBC will occupy seats, as will the MDRU Chair of the Research Generative Group. Currently this is Ron Britten (First Point Minerals).

Second, a Research Generative Group is established to provide input on the technical direction and potential research projects to be undertaken by future graduate students and research staff of MDRU. The mandate for the Group is research. Corporate members of MDRU along with university faculty and government survey

geologists constitute the Group. This group meets annually after an open research review to discuss directions and topics for small to large research projects. Smaller meetings with a subset of the MDRU membership will be organized around specific projects. The chair of the group acts as a representative of the MDRU membership toward the strategic direction of MDRU.

MDRU RESEARCH PROJECTS

Research expenditures for all MDRU projects are projected to be approximately \$2.12 million for 2007. Of this figure, about 48% is directly from industry contributions and 52% derives from non-industry sources such as NSERC and provincial or territorial governments. Active economic geology projects in 2007 will be:

- Structure and tectonic controls on porphyry Cu and epithermal deposits – NSERC discovery grant with NSERC industrial graduate scholarship
- Building 3-D Earth Models (MDRU-GIF): Anglo Gold North America, Anglo American Canada, Barrick Gold, Geoinformatics Exploration, Kennecott Canada, Inco Exploration, Noranda Falconbridge, Teck Cominco, Placer Dome Exploration, WMC International; NSERC CRD grant
- Mapping thermal haloes – USGS Extension
- Vectors toward Carlin-type Au deposits: Barrick Gold, Newmont Mining, TeckCominco, NSERC – CRD Grant pending
- Footprints in Archean lode gold system: Goldcorp Canada, NSERC – CRD grant pending
- Peru porphyry Cu-Mo – Anglo American Exploration
- Reconstructing the Oyu Tolgoi porphyry Cu-Au deposit – Ivanhoe Mines
- Renard kimberlite – Ashton Mining of Canada; NSERC CRD grant
- CO2 sequestration – WMC, Kennecott, Yukon government, NSERC CRD grant
- Cretaceous magmatic database – Yukon government
- Alkalic systems – AngloGold Ashanti, Barrick Gold, Newmont USA, Teck Cominco, Amarc Resources, Imperial Metals, Newcrest Mining, NovaGold Resources Canada, Lysander Minerals, Geoscience BC, NSERC – CRD grant
- Diavik volcanology – Diavik Mining, NSERC CRD
- Chilcotin Plateau – Geoscience BC
- Taseko Lake porphyry systems – Galore Lakes, Geoscience BC
- Hope Bay greenstone belt – Miramar Mining
- Tethyan metallogeny – Barrick Gold, Teck Cominco, Tuprag Metalinik
- Victor Kimberlite: DeBeers, NSERC CRD grant
- Kimberlites of Slave: NSERC Discovery
- Sulphide Mineralization Potential of the Muskox Intrusion, Nunavut - Anglo American Exploration (Canada) Ltd, NSERC
- Fe-Ti Oxide Mineralization in Proterozoic Anorthosites Québec - Rio Tinto Iron and Titanium Inc., NSERC
- Turnagain Ni-Cu-PGE Project, B.C. - Hard Creek Nickel Corporation (\$55,950)
- Wrangellia Flood Basalts - Rocks to Riches Program, Yukon Geological Survey, B.C. Geological Survey

NEW RESEARCH PROJECTS FOR 2007

Three new research projects were in development at the end of 2006:

- Mineral mapping and lithogeochemistry of far-field alteration around porphyry Cu systems
- Indicator minerals associated with magmatic-hydrothermal deposits
- Computer assisted geologic mapping and geophysical inversion

RESOURCE CENTRE

Further minor upgrades to facilities in the Resource Centre will be considered in 2007. Upgrading GIS capabilities, developing 3-D modelling capabilities, and purchasing of desktop and CD publication equipment are proposed for developing projects. Hardware and software will be purchased depending on the available budget. This equipment will be a major improvement to the facilities of use to researchers and Individual members of MDRU. Upgraded computational facilities could be made available at cost for or shared with other members of the Department.

SHORT COURSES

Two short courses are planned for the first half of 2007. Other potential courses are under discussion.

VIEW FROM THE FRINGE: FAR-FIELD ALTERATION AROUND ORE DEPOSITS

By Nick Oliver (JCU), Ross Large (CODES – University of Tasmania), Greg Dipple (MDRU), Scott Halley (Mineral Mapping Service), and Richard Tosdal (MDRU). Held at the Mineral Exploration Roundup in Vancouver, January 2006.

FIELD MAPPING OF ORE DEPOSITS

By John Dilles (Oregon State University) and Richard Tosdal (MDRU), March, 2007.

INTERNATIONAL NETWORKS

MDRU continues to work domestically and internationally to increase exposure through research projects, collaboration with other research groups, interaction with companies, and presentation of short courses and presentations. Efforts are continuing to seek international members and to consolidate the reputation of MDRU within the industry. MDRU has established collaborative working relations with the University of Tasmania (CODES), Oregon State University, and the Royal School of Mines at Imperial College in London, England. MDRU is continuing to investigate collaborative research efforts with universities in the US, Australia, Europe, and in Perú.

MDRU TEAM IN 2006 - 2007

Administrative Staff

Tosdal, Richard	Director
Smith, Karie	Assistant to the Director
Swanson, Christine	Manager, Sheahan-MDRU Literature Service
Toma, Arne	Resource Centre Coordinator
Wong, Sue	Finance Clerk

Project Coordinators

Andrews, Graham	Kimberlite Volcanology
Bouzari, Farhad	Campbell - Red Lake Archean lode-gold deposits
Chamberlain, Claire	Alkaline Systems, Lake Victoria Geochron
Hickey, Ken	Carlin Paleothermal Mapping, MDRU-GIF
Kuscu, Ilkay	Tethyan Metallogeny, Turkey
Mair, John	Yukon Geology
Mackenzie, Doug	Klondike District
Phillips, Nigel	MDRU-GIF

Professors and Associates

Baker, Tim	Lecturer	JCU	Hydrothermal Deposits
Cooke, David	Lecturer	CODES	Alkaline Systems
Dipple, Greg	Associate Professor	UBC	Metamorphic Petrology
Groat, Lee	Professor	UBC	Pegmatites and Gems
Kennedy, Lori	Associate Professor	UBC	Structural Geology
Kopylova, Maya	Assistant Professor	UBC	Kimberlite
Mortensen, Jim	Professor	UBC	Geochronology, Cordilleran Tectonics
Oldenburg, Doug	Professor	UBC	Inverse theory / Electromagnetic Geophysics
Piercey, Steve	Associate Professor	MERC	Massive Sulphide Deposits
Russell, Kelly	Professor	UBC	Geochemistry and Volcanology
Scoates, James	Associate Professor	UBC	Magmatic Ore Deposits
Weis, Dominique	Professor	UBC	Isotope Geochemistry

Graduate Students

Barnes, Elspeth	Ph.D.	Yukon Pegmatites	Lee Groat
Beranek, Luke	Ph.D.	Cordilleran Tectonics	Jim Mortensen
Blevings, Scott	M.Sc.	Taseko Lakes: Structural control	Lori Kennedy
Breitsprecher, Katrin	Ph.D.	Isotope geochemistry of Mesozoic arc-related intrusions, southwestern BC	James Scoates & Dominique Weis
Brett, Curtis	M.Sc.	Kimberlite Volcanology: Diavik	Kelly Russell
Byrne, Kevin	M.Sc.	Intrusion related Cu-Au	Richard Tosdal
Cade, Andrea	Ph.D.	Geology of gemstone deposits	Lee Groat

Crawford, Evan	M.Sc.	Gold Geochemistry	Jim Mortensen
DeStefano, Andrea	Ph.D.	Jericho kimberlite (N. Slave craton, Canada)	Maya Kopylova
Escalante, Abraham	Ph.D.	Central Peru	Greg Dipple
Gofton, Emma	M.Sc.	Kimberlite Volcanology: Renard	Kelly Russell & Richard Tosdal
Greene, Andrew	Ph.D.	Triassic Wrangellia oceanic plateau	James Scoates
Henriques, Frederico	Ph.D.	Alkaline Systems: Cu Isotopes	James Scoates
Henry, Amber	M.Sc.	Alkaline Systems: Lake Cowal	Richard Tosdal
Hollis, Lucy	M.Sc.	Taseko Lakes: Porphyry-epithermal mineralization	Lori Kennedy
Jackson, Meghan	M.Sc.	Alkaline Systems: Mt. Polley	Richard Tosdal
Jago, Paul	M.Sc.	Alkaline Systems: Mt. Milligan	Richard Tosdal
Jurado, Julio	M.Sc.	Central Peru	Richard Tosdal
Mackie, Rob	M.Sc.	Muskox Intrusion	James Scoates & Dominique Weis
MacNeil, Dan	M.Sc.	Donlin Creek	Richard Tosdal
Micko, Janina	Ph.D.	Alkaline Systems: Galore Creek	Richard Tosdal
Mitchinson, Dianne	Ph.D.	MDRU-GIF: Timmins	Richard Tosdal
Morisset, Caroline-Emmanuelle	Ph.D.	Proterozoic anorthosites	James Scoates & Dominique Weis
Moss, Stephen	M.Sc.	Kimberlite Volcanology: Diavik	Kelly Russell & Richard Tosdal
Peterson, Nils	M.Sc.	BC mantle lithosphere	Kelly Russell
Pizarro, Nicolas	M.Sc.	MDRU-GIF: Flin Flon	Richard Tosdal
Rasmussen, Kirsten	M.Sc.	Mid-Cretaceous Intrusions - Selwyn Mountains	Jim Mortensen
Richer, Mathieu	M.Sc.	El Dorado	Richard Tosdal
Ruks, Tyler	Ph.D.	VMS deposits in the Sicker Group	Jim Mortensen
Scheel, Eric	M.Sc.	Turnagain Alaska-type ultramafic-mafic complex in northern BC	James Scoates
Shannon, Andrew	M.Sc.	Hope Bay Greenstone Belt	Richard Tosdal
Simmons, Adam	Ph.D.		Richard Tosdal
Sterritt, Victoria	M.Sc.	MDRU-GIF: Physical Properties	Richard Tosdal
Tafti, Reza	Ph.D.	Gangdese Arc, Tibet, China	Jim Mortensen
Thom, James	Ph.D.	CO2 Sequestration	Greg Dipple
van Straaten, Bram	Ph.D.	Kimberlite Volcanology: Victor	Maya Kopylova
Vaughan, Jeremy	Ph.D.	Carlin	Richard Tosdal
Wainwright, Alan	Ph.D.	Oyu Tolgoi	Richard Tosdal
Wallier, Stefan	Ph.D.	Manantial Espejo, Argentina	Richard Tosdal
Washburn, Malissa	M.Sc.	Cadia, NSW	Richard Tosdal
Whitty, Will	M.Sc.	Ormsby Zone, Discovery Mine, N.W.T.	Richard Tosdal
Williams, Nick	Ph.D.	MDRU-GIF: Leonora-Wiluna	Richard Tosdal & Doug Oldenburg
Wilson, Sasha	Ph.D.	CO2 Sequestration	Greg Dipple
Winter, Lawrence	Ph.D.	Tambogrande	Richard Tosdal
Zamarron, Iskra	M.Sc.	Carlin Reconstruction	Richard Tosdal

BOARD OF ADVISORS

Jan.1, 2005 - Dec.31, 2006 (2-Year Term)

Mr. Mark Baknes	VP Exploration, Rimfire Minerals Corp., Elected Industry Rep.
Dr. Ron M. Britten	VP Exploration, First Point Minerals Corp., Elected Industry Rep.
Dr. Sandy Colvine	Director, Earth Sciences Sector, Geological Survey of Canada, Government Rep.
Mr. Ian Graham	Diamond Exploration Manager, Kennecott Canada Inc., Kennecott (Foundation) Rep.
Mr. Dave Heberlein	Chief Geochemist, Barrick Gold Corp., Barrick (Foundation) Rep.
Dr. John Hepburn	Dean, Faculty of Science, UBC, Faculty of Science Rep.
Mr. Bob Holroyd	Manager Geophysics, Teck Cominco Ltd., Teck Cominco (Foundation) Rep.
Mr. Peter Kowalczyk	Chief Geophysicist, Barrick Gold Corp., Elected Industry Rep.
Dr. Dave Lefebure	Director and Chief Geologist, BC Geological Survey, Government Rep.
Dr. Tom McCandless	Chief Mineralogist, Ashton Mining of Canada Inc., Elected Industry Rep.
Mr. Jack McClintock	President and COO, Canarc Resource Corp., Elected Industry Rep. (Ex-Officio)
Dr. William Mercer	Director, Geology and Geochemistry, Falconbridge Ltd., Elected Industry Rep.
Dr. Doug Oldenburg	Professor, EOS, UBC, Faculty Rep.
Dr. James Scoates	Associate Professor, EOS, UBC, Faculty Rep.
Dr. J. Kelly Russell	Acting Head, EOS, UBC, Faculty Rep.
Dr. Moira Smith	Exploration Manager, Teck Cominco Ltd., Elected Industry Rep.
Dr. Richard Tosdal	Director, MDRU

BOARD OF DIRECTORS

Newly appointed, as of January 1, 2007

Owen Bavinton	AngloAmerican plc.
Ron Britten	First Point Minerals Corp., Chair, MDRU Research Generative Group
David Farrar	Vice-President, Academic, UBC.
Jim Franklin	Independent Director
Ian Graham	Kennecott Exploration Co.
Bob Holroyd	Teck Cominco Ltd.
Francois Robert	Barrick Gold Corp.
Paul Smith	Head, Department of Earth and Ocean Sciences, UBC

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