



# Mineral Exploration Research Centre

October 2015 - Newsletter

## Message from the Director Dr. Harold Gibson

Despite the difficult times facing the exploration and mining sectors, MERC and the Department of Earth Sciences (DES) have successfully initiated two new research programs, an Abitibi Thematic Gold Study and a study of Sudbury Low-Sulfide PM-rich Footwall Mineralization. As well, we have initiated a research and educational partnership with Ivanhoe Mines Ltd and the University of Limpopo directed at the Platt reef, South Africa and the Kipushi and Kamoia deposits, in the Democratic Republic of Congo, as described in more detail within the newsletter. These initiatives build on MERC's Precambrian ore systems and exploration expertise, and expand our research to yet another Precambrian craton.

One of MERC and DES's most exciting research initiatives is Metal Earth. Over the past 6 months John Ayer, MERC Associate Director, Bruno Lafrance, DES Chair, myself and DES faculty and scientific consultants have focused on preparing Metal Earth's Notice of Intent and application for submission to the Canada First Research Excellence Fund (CFREF) due on Nov., 9<sup>th</sup>, 2015. Metal Earth will be a \$55M research program led by Laurentian University and MERC. It will be a strategic consortium of outstanding Canadian researchers from academia, and allied Canadian and international research centres, government and industry. It will address fundamental science question regarding metal endowment during Earth's evolution starting with the Precambrian. Metal Earth promises to transform our understanding of the genesis and differential endowment of base and precious metal deposits through time. Metal Earth will, for the first time, undertake integrated 4-D, geological, geochemical and geophysical research to produce MRI-like images of slices through the near surface, crust and the subcontinental lithospheric mantle to determine key measurable differences between endowed, less endowed and barren areas that else wise appear to be geologically equivalent. This novel holistic approach using a common

earth model will result in a new understanding of the processes and controls on metal endowment during Earth's early evolution. The new knowledge and technology generated will be delivered via open source. It will be used by Industry to focus exploration to the most prospective areas and by governments to aid in resource assessment and to develop strategies for growth and sustainability of Canada's north.

To date we have discussed research collaborations with 4 Canadian Universities, and have established support and collaborations with the Ontario, Quebec, Manitoba, and NWT geological surveys, Canadian research centres, DIVEX (Diversification de l'Exploration Minérale au Québec) and internationally with the Carnegie Institute, Washington, the Centre for Exploration Targeting (CET), University of Western Australia and Curtin University, the Centre for Ore Deposits and Exploration Studies (CODES), University of Tasmania, and GEOMAR, Kiel University, Germany. Laurentian has allocated a new Tier I Canada research Chair in Metallogeny to DES (see advertisement below) in support of our CFREF application. An information circular on Metal Earth is displayed on page 7 of the newsletter.

## Educational Initiatives

- **Nov. 5th, MERC Exploration Symposium: Presentations in Sudbury highlighting MERC research projects and overviews by faculty focused on gold, Ni-Cu-PGE-Cr & VMS.**  
Contact [cduval@laurentian.ca](mailto:cduval@laurentian.ca) for registration.
- **Goodman School of Mines/MERC collaborative workshops (fall & winter 2015).**  
Contact [ntardif@laurentian.ca](mailto:ntardif@laurentian.ca) for details.
  - Aboriginal Communities and Resource Development
  - Technical Writing; Resume Interview skills
  - Portable XRF
  - Leapfrog

## Upcoming Modular Courses

- **Oct. 24-31, Hydrothermal Ore Deposits** (GEOL 5607), Ottawa University. For details contact [mark.hannington@uottawa.ca](mailto:mark.hannington@uottawa.ca)
- **Dec. 9-18, Exploration Geophysics** (GEOL 5956), Laurentian University. For details contact: [rsmith@laurentian.ca](mailto:rsmith@laurentian.ca)

## DES/MERC Faculty

- Harold L. Gibson, Professor and MERC Director: Economic Geology, Volcanology
- Bruce Jago, Professor and Executive Director, Goodman School of Mines, Economic Geology
- Pedro J. Jugo, Associate Professor: Igneous Petrology, Economic Geology
- Alesandro Ielpi, Assistant Professor: Clastic Sedimentology to begin in January 2016
- Daniel J. Kontak, Professor: Economic Geology
- Bruno Lafrance, Professor and DES Chair: Structural Geology, Economic Geology
- Matthew Leybourne, Associate Professor: Geochemistry
- C. Michael Lesher, Professor: Economic Geology, Igneous Geochemistry
- Andrew M. McDonald, Professor: Mineralogy
- Michael Schindler, Associate Professor: Environmental Mineralogy, Hydrology
- Graeme A. Spiers, Associate Professor: Environmental Geochemistry
- Richard S. Smith, Professor: NSERC IRC in Exploration Geophysics
- Phillips C. Thurston, Adjunct Professor: Precambrian Geology
- Douglas K. Tinkham, Associate Professor: Metamorphic Petrology
- Elizabeth C. Turner, Associate Professor: Carbonate Sedimentology, Invert. Paleontology
- Search underway for a Tier I Canada Research Chair in Metallogeny

## Tier I Canada Research Chair

The *Department of Earth Sciences* (DES) and *Mineral Exploration Research Centre* (MERC) at Laurentian University invite applications for a *Tier I Canada Research Chair in Metallogeny* that integrates ore system research with broad scale tectonic processes. The Chair will enhance research and teaching in the field of ore deposit geology and tectonics, and advance the position of Laurentian University as a centre of excellence in Mineral Deposits and Precambrian Geology. The Chair

will be a scientific leader of METAL EARTH, a proposed Canadian \$55 million R&D program led by Laurentian University. With funding from the Canada First Research Excellence Fund, METAL EARTH will transform our understanding of metal endowment and the genesis of base and precious metal deposits during Earth's Evolution ([merc.laurentian.ca](http://merc.laurentian.ca)).

Tier I CRC Chairs are funded by the Canadian government on a renewable 7-year term and the position will be filled at the tenure-track or tenured, Associate to Full Professor level (see [www.chairs-chaieres.gc.ca](http://www.chairs-chaieres.gc.ca)). The successful applicant must submit a full proposal for funding to the CRC program, with the support of Laurentian. We seek an innovative individual with an outstanding record of research and publication, who will provide leadership for national and international collaborative research and become a focus for integration of research initiatives involving DES/MERC, the Ontario Geological Survey/Ontario Geoscience Laboratories (located in the same building), and the mining industry. Additional information about DES and Laurentian University can be found at [des.laurentian.ca](http://des.laurentian.ca) and [www.laurentian.ca](http://www.laurentian.ca).

Laurentian University is a bilingual institution with a policy of passive bilingualism (English/French) as a condition of tenure. It is committed to equity in employment and encourages applications from women, Aboriginal peoples, members of visible minorities, and persons with disabilities. All qualified candidates are encouraged to apply, but priority will be given to Canadian citizens and permanent residents. Applications, including curriculum vitae, statements of research and teaching interests, and contact information for four academic references, should be sent as PDF files to [vpap@laurentian.ca](mailto:vpap@laurentian.ca). Review of applications will begin on 16 November 2015, but applications will be accepted until the position is filled.

## MERC Exploration Research Highlights in 2015

### 1) Abitibi Gold Research

The Abitibi Thematic Gold Program added five new MSc students and a post-doctoral fellow in 2015. This program is a research collaboration between MERC, mining exploration companies and the Ontario Geological Survey with the goal of helping to improve the understanding, and key exploration criteria for gold in the Abitibi-Wawa Subprovince. A listing of the eleven ongoing projects within this program is provided in Table 1.

**Table 1: Abitibi Thematic Gold Projects**

Supporting Organization	Student Year started	Faculty Supervisors	Project Title
Iamgold Corp.	PhD, Laura Katz, 2012	Kontak, Lafrance	Origin of the Archean Cote Gold Au-(Cu) intrusion-related gold deposit, northern Ontario
Iamgold Corp.	MSc, Jocelyn Smith, 2013	Lafrance, Kontak	Role of structure in the formation of the Cote Gold Au-(Cu) Deposit, Northern Ontario
OGS	PhD, Evan Hastie, 2014	Kontak, Lafrance	Metallogeny of Au mineralization in the southern Swayze greenstone belt, Abitibi Subprovince, Canada
OGS	MSc, Jordan McDivitt, 2014	Kontak, Lafrance	The Renabie gold deposit, Wawa Greenstone Belt, Ontario
Detour Gold Corp.	MSc, Kelly Malcolm, 2014	Kontak, Tinkham, Ayer, Dubé	Geology of the South Au zone of the Detour Au deposit, Northern Ontario
Primero Mining Corp.	MSc, Ian Chappell, 2015	Kontak, Leybourne Lafrance, Ayer	Structural controls on the Northeastern Hislop Deposits, Matheson, Ontario
St Andrews Goldfields Ltd.	MSc, Chris Kelly, 2015	Kontak, Leybourne Lafrance, Ayer	Alteration and fluid geochemistry of the Northeastern Hislop Deposits, Matheson, Ontario
Balmoral Resources Ltd.	MSc, Marie Létourneau, 2015	Kontak, Leybourne Lafrance, Ayer, Dubé	Geological Setting and Mineralization of the Martinère and Bug Lake Gold Zones, Northern Québec
Iamgold Corp.	Kimberly Martin	Kontak, Leybourne	Fluid Chemical Study of the Hydrothermal Evolution of the Cote Gold Deposit, Northern Ontario
Oban Mining Corp	MSc, Luis Arteaga, 2015	Gibson, Kontak, Jugo	Temporal and spatial relationship between gold mineralization and intrusive rocks in the Boston Creek area, Ontario
Goodman School of Mines	Post-doctoral fellow, Györgyi Tuba, 2015	Kontak, Leybourne Lafrance, Ayer	Post Doctoral Project. This newly initiated study will provide independent geochemical research and a synthesis of the significant results of the thesis projects

The following is a research project highlight provided by MSc candidate Kelly Malcolm:

*"The South Detour Project is focused on a new (2014) discovery that is located about 5 km south of the active Detour Lake mine (459Mt of 1.01g/t Au reserves). The new discovery, known as the 58N zone, is different from the Detour mine in that it is much higher grade, hosted within feldspar-porphyry dikes (Figure 1) rather than volcanic rocks, and appears to be a magmatic-hydrothermal system rather than a structurally controlled lode gold deposit. The research is focused on understanding the timing and controls of gold, as well as determining the characteristics of mineralizing fluids through studies of alteration, stable isotopes, fluid inclusions, and litho-geochemistry. Geochronology by LA-ICP-MS on zircons and titanites from the host porphyry indicate a magmatic age of  $2680 \pm 10$  Ma indicating the age of this gold event is significantly younger than the event at the Detour Mine (Oliver et. al, 2012) and could be similar to the age of the major gold events in the southern Abitibi (ca. 2670-2665 Ma). Higher precision geochronology is currently underway at the Geological Survey of Canada to help better constrain ages using the ID-TIMS. This research will contribute to a heightened understanding of metallogeny in the Detour-Burntbrush area, which will provide new exploration ideas in the Northern portion of the Abitibi."*



**Figure 1.** High-grade intersection of the 58N zone, with brittle stockwork-type quartz ± carbonate ± tourmaline veins in a porphyry intrusion with silica, sericite, and biotite alteration.

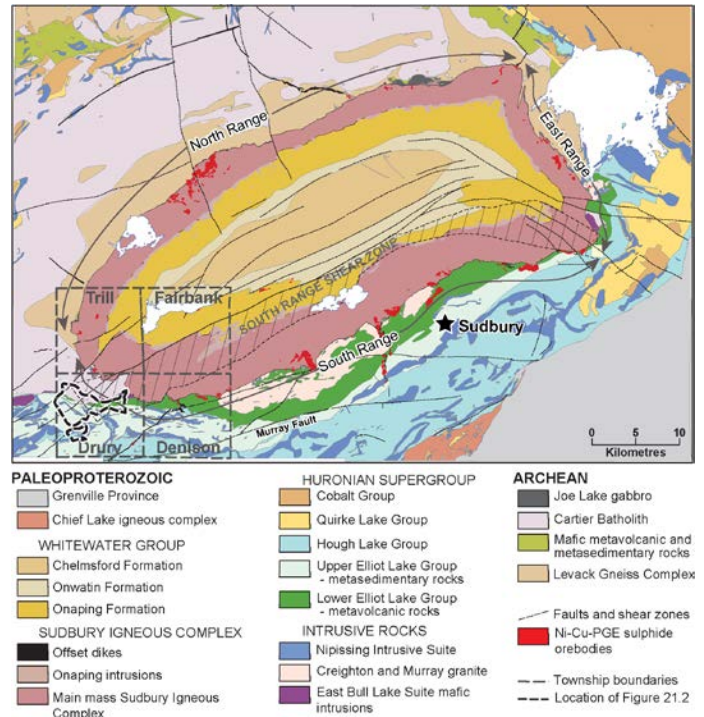
Future plans also include expanding research on Abitibi gold deposits through a NSERC CRD grant matching the funding provided by mining companies for ongoing Abitibi projects. Additional funding will be used on studies of more Abitibi gold deposits to help improve our understanding of important regional criteria for gold exploration (e.g., geochemical, structural, etc.). The new study sites will be chosen in collaboration with the sponsoring companies.



## 2) Low Sulfide, PGE-rich Footwall Mineralization at Sudbury

The Sudbury Structure, which is a remnant of a deformed impact crater, is host to numerous nickel-copper-platinum group element (Ni-Cu-PGE) deposits and is one of the greatest Ni-producing districts in the world. The Southwest Sudbury Structure bedrock mapping project, focussing on 1:20 000 scale mapping of Drury, Denison, Trill and Fairbank townships (Figure 2), was initiated by the Ontario Geological Survey (OGS) in 2015 as part of a 5-year, multi-disciplinary research program on Low Sulfide PM-rich Sudbury Footwall Mineralization being conducted by MERC in collaboration with the OGS and the private sector. The goal of this research collaboration is to develop an integrated geological, geochemical and geophysical exploration model for low sulfide, PM-rich mineralization in the Sudbury footwall. In addition, a graduate thesis focussing on determining structural controls on low-sulphide mineralization in the Sudbury Footwall was initiated in 2015 by Carole-Anne Genereux (supervised by Drs. B. Lafrance and D. Tinkham) as part of the bedrock mapping project through the Ontario Geological Survey – Laurentian University Graduate Mapping School Agreement. Mapping in 2015 was conducted by Caroline Gordon and Rene-Luce Simard of the Earth Resources and Geoscience Mapping section of the OGS and focussed on Drury Township. Preliminary results will be publicly released in December in the annual OGS Summary of Field Work volume.

The Low Sulfide PM project will have an initial five year life span; the objectives for the first five years are to: 1) characterize the mineralization, including metallurgy; 2) characterize the sulfide and oxide mineralogy, mineral chemistry, and texture/grain-size; 3) understand the cryptic alteration style and mineralogy and structural and textural relationships; 4) characterize the structural controls; 5) determine if there are genetic and temporal relationships between this style of mineralization and sharp-walled Ni-Cu-PGE “vein” mineralization; and, 6) determine the extent to which this style of mineralization is expressed in the surficial (till) environment. The ultimate aim is to develop a true Exploration Model for low sulfide PGE mineralization. The project is funded by KGHM, Lonmin, Glencore and Wallbridge, with an application to NSERC’s CRD program in preparation for matching funds. In addition, significant support is being provided by the OGS through the funding of two PhD projects on the structural and surficial geochemical aspects of the project.



**Figure 2.** General geology of the Sudbury basin after Ames and Farrow (2007) showing the location of townships that will be mapped in detail between 2015 and 2017. Black lines within Drury Township indicates areas mapped in detail in 2015.

## 3) African Research Initiatives

Ivanhoe Mines Limited (TSX: IVN), the University of Limpopo, South Africa and Laurentian University signed an agreement officially launching an educational collaboration between the two universities. The collaboration, initiated and sponsored by Ivanhoe’s South African subsidiary, Ivanplats, was celebrated at a signing ceremony on the University of Limpopo campus attended by officials from Laurentian University, the University of Limpopo, Ivanhoe and the South African and Canadian governments.

A principal goal of the five-year partnership, which is renewable for a further five years, is to develop and equip the University of Limpopo’s geology department to become a centre of excellence in geosciences. This will be achieved through measures that include:

- improved training and curriculum choices in economic geology and mineral exploration at the University of Limpopo;
- increased teaching and research capacities at the graduate student level;
- equipping laboratories;
- purchasing an outdoor vehicle and trailer for field excursions; and
- collaborating with Laurentian University to improve the University of Limpopo’s learning programmes.

Ivanplats will also provide in-service training opportunities for students from both universities and assist them in conducting research on the Northern Limb of the Bushveld Complex. The funds also will support a number of Laurentian's graduate students to travel to Limpopo for three-to-four-month internships over the course of the first five years of the funding agreement with Ivanhoe. These advanced graduate students will teach and assist junior faculty at the University of Limpopo. A portion of the funding will be used to hire a full-time academic tutor/program administrator to provide educational and administrative support for the successful completion of designated educational programs for Limpopo students, along with other support typically offered to all Laurentian international students.

Ivanhoe Mines, through Ivanplats, has allocated a total of US\$2.5 million to the Limpopo and Laurentian universities to fund their partnership during its initial five years. In addition to Ivanhoe's investment, Laurentian University, of Sudbury, Ontario, has been awarded C\$500,000 in scholarship funds for the project through the Queen Elizabeth II Graduate Scholarship in Science and Technology (QEII-GSST) Program with an additional C\$570,000 scholarship awarded to Laurentian by the International Development Research Corporation.

Two of the three Ivanhoe-owned properties where research will be fostered under the Ivanhoe-LU-UL Memorandum of Understanding are in the central African copper belt in Democratic Republic of Congo. Dr. Elizabeth Turner and post-doctoral fellow Masoumeh Alimohammadi spent two weeks in DRC in August-September laying the foundation for future research projects.

The Kipushi mine, which operated from 1924 to 1993 before going on care-and-maintenance, produced copper from two zones in Neoproterozoic carbonate host rocks (~60 MT @ 11% Zn and 7% Cu). Prior to the mine's closure in 1993, deep drilling had identified a new body of massive sphalerite ("Big Zinc") below the established copper zones, but it was not mined. Ivanhoe acquired an interest in the property in 2011 and initiated a new subsurface drill program in 2014 to explore the open zone below the "Big Zinc". Although much work has been done over the decades on the mineralogy of the deposit, a basic understanding of the host rocks and spatial controls on the three ore zones has remained elusive, and a coherent and spatially well constrained understanding of mineralizing fluids remains to be undertaken. Preliminary LU work at Kipushi has identified that carbonate lithofacies is an important control on the spatial distribution of base-metal sulphides; this could be a focus of student research.

The mineralising fluid system will be the main thrust of post-doctoral research undertaken by M. Alimohammadi, whose recent Phd research was on Cu porphyries in Iran.

The Kamaoa deposit, discovered in 2011 by Ivanhoe geologists, is the world's largest undeveloped high-grade Cu deposit. Hosted by mid-Neoproterozoic 'snowball Earth' diamictite, the stratiform deposit is several metres thick and spans tens of square kilometres in the subsurface. Numerous potential student projects were identified in the course of the visit.



**Figure 3.** Images from the Kipushi mine and Kamaoa deposit.

#### 4) Geophysical Research

Michal Kolaj has recently completed his PhD research, which investigated how to estimate the near-surface conductance using an electromagnetic system that measures the vertical gradient of the magnetic field. The method was able to estimate the conductance using a simple ratio of measured quantities; a more sophisticated inversion gave better results in areas where the conductance was changing laterally. The method was extended to borehole electromagnetic methods so that the conductance can be estimated from a simple combination of measured three component data. Michal also worked on a simple method to invert ground electromagnetic data. The method was tried on data from Joe Lake, in the north range of the Sudbury igneous complex, and it was possible to estimate the dip and depth of the conductor that is consistent with drill information.



There are two students working on research projects funded through Richard Smith's Industrial Research Chair, both will be completed by the end of next year. Omid Mahmoodi, who has just completed his research, has published two scientific papers. His first paper investigates the ability of physical properties logs to identify lithological information, the second paper uses two downhole logs to identify boundaries between different rock types. The second student, Yongxing Li, is using the COMSOL modelling package to generate synthetic radio imaging data. In one study he has showed that the COMSOL package gives results consistent with other techniques, and that the synthetic data can be interpreted using the ImageWin package.

In addition, there are three other graduate students working on geophysical projects. Frédéric Gaucher is investigating how electromagnetic methods can help detect low grade ore at the Opemiska exploration property near Chapais, Quebec. Frédéric has compiled the historical data for the property and is planning an electromagnetic survey for next summer. Tomas Naprstek is working on ways to grid magnetic data so that narrow features like dykes do not have "beading" or "string of pearls" artifacts associated with them. A new student Nikolas Gazo has started an investigation on whether it is feasible to deploy a Nuclear Magnetic Resonance (NMR) technique on an aircraft to detect shallow groundwater.

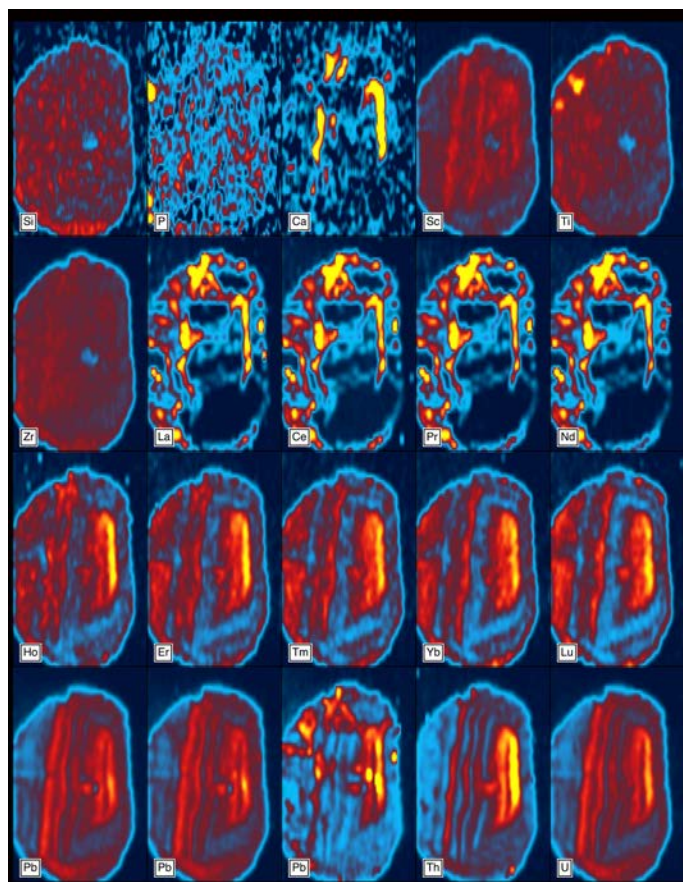
## 5) MERC Laboratory Services

The Chemical Fingerprinting Laboratory was established in 2006 and is a state-of-the art analytical facility in the Department of Earth Sciences and Mineral Exploration Research Centre at Laurentian University. The primary objective of the laboratory is to support research and graduate and undergraduate education in geochemistry and analytical methods. The laboratory works with students, researchers and clients from other universities, government agencies and industry, and although focused on geology, also provides services for projects in the environmental, anthropological, archeological and biological fields. The laboratory hosts a Thermo Scientific ICP-MS, which is coupled to a Resonetics 193 nm ArF excimer laser. For further information contact [mleybourne@laurentian.ca](mailto:mleybourne@laurentian.ca)

### Typical costs for industry partners are as follows:

1. Age dating of zircon, apatite or titanite/rutile from igneous rocks – includes sample preparation, mineral separation, mounting, LA-ICP-MS analysis and data reduction and interpretation. **\$1600 CAD**

2. Age dating of detrital zircon, apatite or titanite/rutile from (meta)sedimentary rocks – includes sample preparation, mineral separation, mounting, LA-ICP-MS analysis and data reduction and interpretation. **\$1750 CAD**
3. Cathodoluminescence imaging of minerals for dating. **\$250 CAD**
4. Sample preparation and separation of minerals for dating without analysis – includes crushing, milling, wilfley table, heavy liquid separation, magnetic separation and hand picking. **\$800** for igneous rocks/sample and **\$1000** for sedimentary rocks/sample (typically results in up to 50 zircons and 150 zircons, respectively).
5. LA-ICP-MS analyses (spots, lines and mineral maps) on sulfide, oxide and other minerals, including all data reduction. **\$1200/day CA**



**Figure 4.** Laser ablation elemental maps of a zircon crystal in the heavy mineral fraction of till. The zircon shows evidence of zonation (Pb, Th, U) and alteration to gittinsite (a zirconosilicate) with elevated Ca, La, Ce, Pr and Nd.

## A new Canadian research initiative seeking support from the CANADA FIRST RESEARCH EXCELLENCE FUND

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### WHAT IS METAL EARTH?

**Metal Earth is a Canadian \$55 million applied R&D program led by Laurentian University.** With funding from the Canada First Research Excellence Fund, this initiative will be a strategic consortium of outstanding Canadian researchers from academia and allied Canadian and international research centres, government and industry. Metal Earth will transform our understanding of the genesis of base and precious metal deposits during Earth's evolution. It will make Canada a world leader in metal endowment research and world-class innovator through open source delivery of new knowledge and the implementation of new technology.

*Metal Earth will contribute to the economic growth of Canada and the sustainability of Canada's Far North while firmly placing Canada as a global leader in mineral exploration research.*

### Keys to Understanding Our Planet

Metal Earth will initially focus on the Precambrian era to answer fundamental questions related to how secular changes in Earth's evolution have resulted in differential metal endowment in space and in time. Research will seek to determine the geological, geochemical and geophysical differences between metal endowed, less endowed and the more common barren areas that appear geologically equivalent.

Defining the key characteristics that differentiate endowed versus less endowed crust will transform our understanding of the processes responsible for Earth's differential base and precious metal endowment.

Research will seek to answer fundamental questions including:

1. Current metal endowment models emphasize modern geodynamic environments and processes. Precambrian geodynamic environments and processes are controversial. If they differed from those operating today, what are the processes that resulted in early Earth's metal endowment and how can they be recognized?
2. Can we recognize subtle differences in the mantle, the subcontinental lithospheric mantle, the crust and in the deep crustal structures between endowed and less endowed areas, which may explain metal endowment localization?

**MERC Foundation Members**

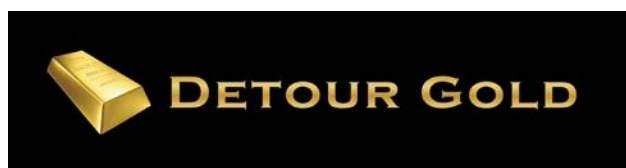


**Ontario Geological Survey,  
Ontario Ministry of Northern  
Development and Mines**



**Teck  
Teck Resources Ltd.**

**MERC Tier 1 Members**



**Detour Gold Corp.**



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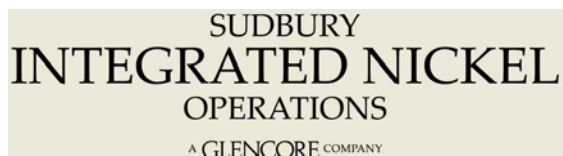
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