MERC
Mineral Exploration Research Centre
AT THE HARQUAIL SCHOOL OF EARTH SCIENCES

METAL EARTH

March 2017 - Newsletter

Message from the MERC and Metal Earth Director, Dr. Harold Gibson

Since announcement of $49.26M in funding for Metal Earth from the Canada First Research Excellence fund on Sept 06 2016, plus an additional $55 M in cash and in-kind funding from Laurentian University, the Northern Ontario Heritage Fund Corporation and our academic, government and industry partners, MERC's focus has been on implementing Metal Earth, Canada's largest mineral exploration research program. We have built an organizational and reporting structure to govern, guide and to implement Metal Earth, hired administrative staff, and acquired the space necessary to house the MERC and Metal Earth research team and our new instrumentation. We are interviewing for four Metal Earth funded, tenure-track faculty positions, including a Chair in Exploration Targeting, and Professors of Exploration Geophysics (seismology), Precambrian Geology and Earth System Modeling/Data Analytics; the former two are to start in July 2017, and the latter two in January 2018. Other significant benchmarks include:

- Established strong industry, government and First Nation participation on the MERC Advisory Board and Metal Earth science and technical committees
- Interviewing for an Indigenous Liaison and Outreach position and for 4 Metal Earth funded technical positions (Database Management, GIS, IT and LA-ICP-MS instrumentation)
- Hired two Research Associates for the geophysical and geochronological-isotopic-compilation of the Superior province, the first phase of the Metal Earth Craton-scale research activity, as described below.
- Assembling a team of 4 Research Associates, 3 PhD, 13 MSc and 15 BSc students to initiate the Metal Earth Transect research activity this summer. This research is aimed at collecting geophysical, geochemical, and isotopic data that will be integrated to produce 3- and 4-D crust-mantle images of metal endowed and less endowed volcanic centres and crustal structures as described below.
- Selected a contractor to undertake a 1000 line km, 2-D seismic reflection survey, the framework for the Transect research activity, and an RFP for a coincident MT survey is in preparation. Both surveys will commence in September, 2017.

Meanwhile, we have not lost sight of MERC's research and professional objectives. The Abitibi Thematic gold research project, led by Dan Kontak and John Ayer which involves 4 faculty, 1 PDF, 1 PhD and 6 MSc students is progressing, and interim results have been presented at a number of research seminars and will be presented at short courses at PDAC on March 5th and in Timmins on April 20th. Through the Univ. of Limpopo-Ivanplats Mines and Goodman School of Mines research agreement we have 1 PDF, 2 PhD and 9 MSc students now working on the Bushveld Igneous Complex, SA and the Kamoa and Kipushi deposits, Congo.

In January 2017 we held a MERC-Metal Earth Luncheon at the Royal York Hotel in Toronto that attracted 68 invitees from the mining and exploration sector to learn about Laurentian University's mining initiatives, the research and educational programs at the Harquail School of Earth Science, and research and partnership opportunities available through MERC and Metal Earth. As a result of that luncheon, MERC has 6 new Advisory Board members, and I would like to thank David Harquail and family for their ongoing advocacy and support, and for the leadership role they played in organizing this successful event. In that regard I would like to welcome Barrick Gold and Kirkland Lake Gold as Foundation members, GoldCorp and IAMGOLD as Tier I members, and Taseko and Vale as Tier II members.

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In addition, we have invited industry to participate in our Transect Research Activity through additional seismic transects, to be funded by industry partners, but with Metal Earth line km rates, in areas of mutual interest where Metal Earth would provide additional geoscience information. Our professional, educational and outreach initiatives include 3 workshops and field trips as outlined below. All in all, 2016 was a year to remember, and 2017 is rapidly shaping up to be the same.

Lastly, you may have noticed the Metal Earth logo, which appears for the first time on this newsletter. The symbol is a depiction of Earth's northern hemisphere with the stylized letters "M" and "E" above and below the surface respectively. This positioning puts a global perspective on Canada's north, identifying its potential metal endowment and focusing on far north growth and sustainability.

MERC Professional Development and Educational Opportunities

- **March 5, 2017; 1 Day MERC Short Course at PDAC**. **New exploration methods for base and precious metal deposits: How to increase success in Greenstone Terranes.** Contact jayer@laurentian.ca
- **April 20, 2017; 1 Day Abitibi Exploration Research Symposium** associated with the Northeastern Ontario Mines and Minerals symposium in Timmins. Presentations by MERC faculty & students. Contact jayer@laurentian.ca
- **May 2017 ; 7 day Greenstone Gold and Base Metal Mapping Course:** Exploration Models and Methods. To be held in the Timmins area led by Drs. Bruno Lafrance, John Ayer and Harold Gibson. Contact jayer@laurentian.ca

Upcoming Modular Courses

- **Apr. 2017; Exploration for Hydrothermal Ore Deposits**. Contact mleybourne@laurentian.ca
- **Aug. 2017; Structure, Tectonics and Mineral Exploration** (field-based). Contact blafrance@laurentian.ca
- **Oct. 2017: Hydrothermal Ore Deposits** (U Ottawa). Contact mark.hannington@uottawa.ca
- **Dec 2017; Exploration Geophysics.** Contact rssmith@laurentian.ca

HES/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
- 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
- Jeremy Richards, Professor: Economic Geology, Tier 1 Canada Research Chair in Metallogeny starting July 2017
- Michael Schindler, Associate Professor: Environmental Mineralogy, Hydrology
- Graeme A. Spiers, Associate Professor: Environmental Geochemistry
- Richard S. Smith, Professor, 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
- Currently interviewing for 4 new faculty (see http://hes.laurentian.ca/faculty-recruitment).

Metal Earth Luncheon

On January 12th 2017, on the day of the Annual Canadian Mining Hall of Fame Dinner, a luncheon was held at the Fairmount Royal York Hotel for industry and the media to introduce them to Laurentian University's new $104M Metal Earth research program, the Harquail School of Earth Sciences and its Mineral Exploration Research Centre (MERC).

Pesentations were made by David Harquail, President and CEO of Franco-Nevada Corporation; Dominic Giroux, President and Vice-Chancellor of Laurentian University; Doug Tinkam, Director of the Harquail School of Earth Sciences; and Harold Gibson, Director of Metal Earth and MERC. Information was providedon Metal Earth, the largest exploration-focused R&D program in Canada's history, to encourge industry participation and solict new memberships in MERC.

David Harquail and Earth Sciences networking with industry leaders.

David Harquail, affirming his support of Laurentian University and the vital importance of its research activity.

Dominic Giroux discussed Laurentian University's expertise in mineral exploration and mining education and its growing number of industry partnerships.

Doug Tinkham explained the vision of the Harquail School of Earth Sciences.

Harold Gibson spoke about Metal Earth and encouraged industry to become involved with this exciting and innovative exploration research program.

The luncheon was extreemly well attended and resulted in 6 new industry members joining the MERC Advisory Board.

METAL EARTH

Metal Earth is a Seven-year $104M applied Research and Development initiative led by MERC. The funding consists of a $49.3M grant from the Canada First Research Excellence Fund (CFREF) and $55M cash and in-kind from Laurentian University, Federal, Provincial, Academic, and Industry Partners. Outlined below is a summary of Metal Earth, how it was developed, its' goals, scientific capacity building and partnerships, and research activities,

Metal Earth is a comprehensive collaborative research program involving a strategic consortium of outstanding Canadian researchers from academia and allied Canadian and international research centres, government, and industry led by Laurentian University.

The CFREF Proposal was developed by:

- Establishing working groups within the Harquail School of Earth Sciences to identify knowledge gaps in our understanding of Precambrian gold and base metal deposits
- Consulting recognized industry experts
- Discussions with government and academic colleagues
- Industry and academic workshops
- What we learned is a major impediment to exploration success is how to identify metal endowed areas from the vast areas that are geologically similar, but have less or no metal endowment

Notification of the success of the Metal Earth proposal was received in September 2016. The CFREF Scientific Review panel indicated that "the Metal Earth proposal presented the strongest scientific merit among the proposals considered by the Panel and that it was the most clearly presented, being driven by clear scientific hypotheses that demonstrated strong internal scientific leadership."

Metal Earth will:

- Build on existing knowledge of ore deposits/districts to **resolve ore system-scale controls on metal endowment** on an unprecedented scale: craton through greenstone belt and district to deposit
- Image **entire ore and non-ore .systems at full crust-mantle scale** to identify key geological-geochemical-geophysical attributes that explain the processes responsible for the extraction of metals from sources, transport pathways, and economic concentration.
- Relate **deep earth features to specific distribution of ores**
- Place **equal emphasis on less endowed areas** to identifying/fingerprint measurable differences that resulted in contrasting metal endowment
- Research, develop, and use **new 3D-4D data integration, analysis, and visualization** tools to address the significant challenges of deposit-to-craton scale data integration to aid in the discovery of new deposits

Building Scientific Capacity

Metal Earth's Principal Investigators:

Prof. Harold Gibson, Laurentian U, Director, VMS deposits, Volcanology, Geochemistry
Prof. Bruno Lafrance, Laurentian U, Associate Director, Structural Geology and Tectonics
Dr. John Ayer, Laurentian U, Adjunct Prof and MERC Associate Director – Precambrian Geology
Prof. Georges Beaudoin, U Laval, Stable Isotopes and Alteration
Prof. Réal Diagnault, U Québec - Chicoutimi, Precambrian tectonics and structure
Prof. Michael Hamilton, U Toronto, Geochronology and Precambrian Geology
Prof. Mark Hannington, Ottawa U, Seafloor Tectonics and Metallogeny
Prof. Daniel Kontak, Laurentian U, Gold and Ore Fluids
Prof. Michael Lesher, Laurentian U, Magmatic Ore Deposits and Geochemistry
Prof Jeremy Richards, U Alberta / Laurentian U, Metallogeny and Tectonics
Dr. Steven Shirey, Carnegie Institute of Science, Precambrian Geology and Mantle Processes
Prof. Richard Smith, Laurentian U, Exploration Geophysics – Electromagnetics
Dr. David Snyder, Geological Survey of Canada, Geophysics – Seismology
Dr. Philips Thurston, Laurentian U, Adjunct Prof, Precambrian Geology

New Faculty and Highly Qualified Persons (HQP):

5 *new* full-time Faculty Positions

- Chair in Exploration Targeting (LU)
- Exploration Seismology (LU)
- Precambrian Geology (LU)
- Earth Systems Modeling and Data Analytics (LU)
- Economic Geology (UQAC)

Over 100 HQP Positions

- 35 Research Associates/PDF
- 9 technical support positions
- 30 PhD
- 40 MSc
- 105 BSc

This is in addition to the existing Harquail School of Earth Sciences faculty including:

- Incoming **Canada Research Chair in Metallogeny** (Jeremy Richards)
- Existing **Research Chair in Exploration Geophysics** (Richard Smith)
- Existing **Research Chair in Mineral Exploration** (Michael Lesher)
- Two **Professors of Economic Geology** (Harold Gibson, Dan Kontak)
- **10 additional faculty** also conducting research on ore deposits (Alesandro Ielpi, Bruce Jago, Pedro Jugo, Bruno Lafrance, Matthew Leybourne, Andrew McDonald, Michael Schindler, Phil Thurston, Doug Tinkham, and Elizabeth Turner)

Metal Earth's Research Strategy is to:

- Initially focus on **Archean greenstone belts**, which represent 80% of Earth history, 30% of Canada's Far North rock exposure, and almost 50% of Canada's metal wealth
- Determine the **processes responsible for differential metal endowment** in the Archean and require a new understanding of secular changes in the evolution of Earth's atmosphere, hydrosphere, lithosphere, mantle, and geodynamic processes and environments
- Conduct **Craton-belt-district-deposit scale** research and integration
- Study **endowed and less endowed** geological "equivalents"
- Undertake integration, analysis, and visualization of **multiparameter** geoscience data

In Four integrated activities:

1. **Craton-scale research** to understand greenstone belt architecture and the interaction of greenstone belts with their surrounding granitoids during terrane assembly and ore district formation
2. **Transect research** where more detailed studies will resolve the lithospheric-crustal architecture and fluid (magma/heat) pathways, providing a geological framework to resolve the differential endowment of terranes and structures – Mantle-crust slices
3. **Thematic research** from craton to deposit scales will address specific processes or questions on metal endowment
4. **Data Analytics research** to develop new data integration, analysis and interpretive tools to predict metal endowment

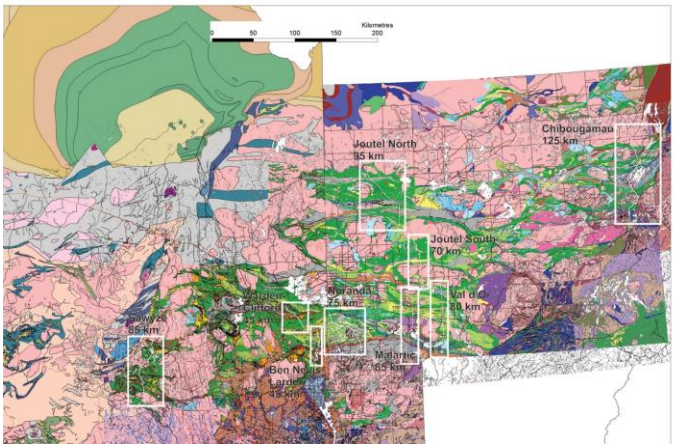
Craton Research: Years 1-6

- New understanding of the 3D and 4-D architecture of the Superior and Slave cratons
- Compilation of regional geoscience data
- New zircon Lu-Hf, Sm-Nd, and O isotopic data to map time slices of the secular variations in assembly of cratons and identify mantle-crustal pathways
- Live and extinct radionuclide isotopic tracer systems and PGEs on mantle rocks and mantle-probing crustal rocks to map mantle metal reservoirs

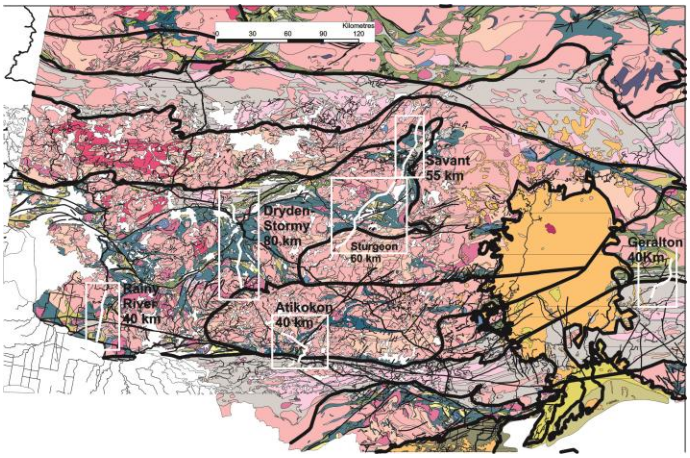
Metal Earth's areas of Focus within the Canadian Shield.

Transect Research: Years 1-5

- Transects across endowed gold-rich ancestral fault systems and volcanic centres that host gold and or base metal deposits and less endowed ancestral fault and volcanic centres with similar geology
- Collection, integration, interrogation, and visualization of complex multiparameter geoscience data (seismic, MT, gravity, and surface geological, geochemical, geophysical data)
- 4D Slices from mantle to crust



Proposed transects for seismic, magnetotelluric, and gravity surveys along with geological mapping and data collection in the Abitibi greenstone belt.



Proposed transects for seismic, magnetotelluric, and gravity surveys along with geological mapping and data collection in the Wabigoon Subprovince.

Other Proposed Transects Areas

Sudbury (active seismic)
Bird River Sill (active seismic)
Ring of Fire (passive seismic)
YellowKnife (passive seismic)
Hope Bay Belt (passive seismic)

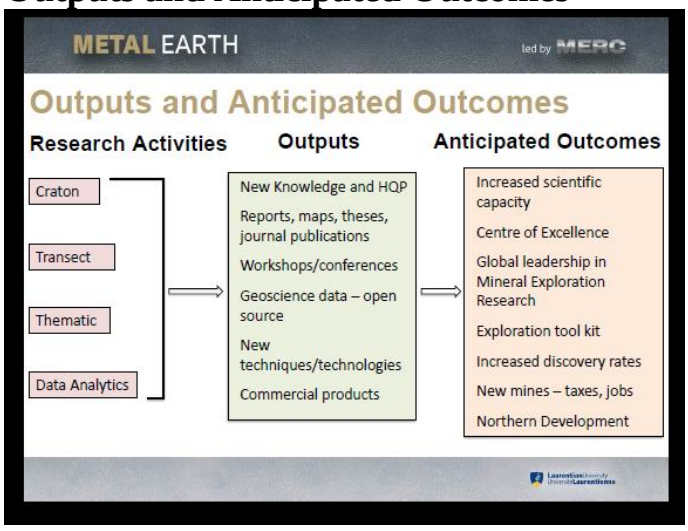
Thematic Research: Years 3-7

- Research at the craton- district- deposit scale directed at answering fundamental questions pertaining to features/processes associated with metal endowment
- General Themes
  - Fluid/magma/heat pathways
  - Subcontinental Lithospheric Mantle variations/differences in endowed and less endowed areas
  - Fluid and metal sources in mantle and crust
  - Archean tectonics and metallogeny

Data Analytics: Years 1-7

- Geoscience data from Craton, Transect, and Thematic studies will be integrated, analyzed, interrogated and visualized using a goCAD Common Earth Model
- Partnership with MIRA Geosciences
- Explore other software - Geoscience ANALYST/INTEGRATOR, Geon IDV (time stamp data sets), Machine learning
- Build on established best practices from LU-led "Exploration Footprint" project
- Visualization using LU and UNSW Virtual Realty Labs
- Develop new technologies, modeling algorithms, software tools, and techniques to integrate, interpret and visualize data and to aid exploration
- Commercialization

Outputs and Anticipated Outcomes



Metal Earth Partners

CANADA-NUNAVUT
GEOSCIENCE OFFICE

BUREAU GÉOSCIENTIFIQUE
CANADA-NUNAVUT

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KANATAMI-NUNAVUMI
GEOSCIENCE TITIGAKVIIT

MERC Foundation Members

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125 ANNIVERSARY Est. 1891 ONTARIO GEOLOGICAL SURVEY

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