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

METAL EARTH

October 2017 - Newsletter

Message from the MERC Director, Dr. Ross Sherlock

Since the last newsletter MERC has had a busy and successful 6 months. The Metal Earth project has been all encompassing with the launch of the project field work including, seismic and gravity surveys and targeted mapping. An update on Metal Earth is given below. Outside of Metal Earth, MERC has the Abitibi thematic gold project led by Dan Kontak and John Ayer which involves 4 faculty, 1 PDF, 1 PhD and 6 MSc students. The project is progressing well, and results have been presented at a number of research seminars and journal articles and will be presented at short courses in Sudbury and the PDAC in 2018. Through the University of Limpopo-Ivanplats Mines and Goodman School of Mines research agreement we have two faculty members 1 PDF, 2 PhD and 9 MSc students now working on the Bushveld Igneous Complex, SA and the Kamoa and Kipushi deposits, Congo.

With the increase in MERC membership and the start-up of Metal Earth we are redoing, from scratch, our websites so that HES, MERC and Metal Earth sites have common and consistent content. We are targeting having these new websites on line before the end of November.
To facilitate communications and digital content we are hiring a new communications specialist splitting the cost with HES and Laurentian. With this initiative we will be revising how frequently, and the format with which, we communicate to our members.

Collaborative Seismic Research Project:

To date, six corporate partners have opted to collaborate with MERC by funding high resolution R2 and R3 surveys (explained below) in their specific areas of interest associated with a number of the Metal Earth transects. The companies have provided funds outside of Metal Earth for seismic data acquisition that will now be used in an application to the National Science and Engineering Council for a Collaborative Research and Development Grant (CRD) to match these funds. The CRD will be used to help process and integrate the seismic data with other datasets such as new gravity, magnetics and magnetotelluric (MT) data. We anticipate that the CRD will also be used to partner with IBM to develop full wave form inversion techniques on seismic data which will allow more accurate imaging of sub-vertical structures, critical to our interpretation of transect geology. In addition, funds from the CRD will be utilized to complete additional geological and geochemical research on the controls of mineralization in these areas. This CRD is a great opportunity for MERC. If successful, MERC can leverage our industry partners contribution to complete additional research that will complement the work being done at Metal Earth.

MERC has been invited, along with MIRACO, by Northeastern University in China to investigate potential avenues of collaboration. Between Dec. 8 and 18th, Vic Pakalnis President MIRACO and Ross Sherlock, Director of MERC will travel to Northeastern University and present current research activities and investigate potential avenues for partnership. The trip is fully funded by Northeastern University.

Lastly with the new membership and increased project activity we are looking at revising how our advisory board is structured and to integrate Metal Earth boards. At the AGM in January 2018, we will present a proposal on the board/membership structure.

In the upcoming months I will be reaching out to our membership to discuss how MERC operates and what your expectations are of MERC.

I am pleased to welcome First Cobalt, McEwen Mining and Pelangio as new members and to thank the existing membership for continued support.

FIRST COBALT

McEWEN MINING
NYSE MUX TSX

PELANGIO

MERC Professional Development and Educational Opportunities

March 2018; 1 Day MERC Short Course at PDAC. An assessment of Precambrian gold deposit models from deep to shallow crustal levels. Contact jayer@laurentian.ca

- **October, 2018; 1 Day Abitibi Exploration Research Symposium** associated with the Northeastern Ontario Mines and Minerals symposium in Kirkland Lake. Contact jayer@laurentian.ca

Upcoming Modular Courses

- **Dec. 6-15, 2017; Exploration Geophysics.** Contact rssmith@laurentian.ca
- **April 2018; Exploration for Magmatic Ore Deposits. Contact** mlesher@laurentian.ca
- **August 2018; Mineral Exploration in Volcanic Terrains. Contact hgibson@laurentian.ca**

RECENT MERC/HARQUAIL SCHOOL OF EARTH SCIENCES FACULTY HIRES

Dr. Ross Sherlock, Research Chair in Exploration Targeting

Ross obtained his PhD from the University of Waterloo in 1993 and MSc from Lakehead University, both in the field of economic geology. He did post-doctoral research at MDRU, UBC, worked as a Research Scientist in Economic Geology at the Geological Survey of Canada, and has over 25 years of experience working in the mineral exploration industry at all levels. Ross arrived at Laurentian on August 01, 2017, as incoming Director of the MERC to help oversee and lead the *Metal Earth* research project; he will assume the additional role of Metal Earth Director on July 01, 2018.

Dr. Leonardo Feltrin, Earth Systems Modelling/Data Analytics

Leonardo obtained his PhD in Economic Geology from James Cook University in 2007 with an emphasis on Geoinformatics. He obtained his BSc and MSc in Earth and Environmental Science from the University of Padova. He has 15 years of experience in the field of mineral exploration and has extensive experience working with large multi-parameter datasets. He has worked on the *NSERC-CMIC Exploration Footprints* project as a Research Scientist at the University of Western Ontario since 2013. He will arrive and start working on the *Metal Earth* project in January 2018.

Dr. Mostafa Naghizadeh, Exploration Geophysics Seismic Methods

Mostafa obtained his PhD in Geophysics from the University of Alberta in 2009. He obtained an MSc in Geophysics from University of Tehran in 2003 and a BSc in Mining Engineering from Shahid Bahonar University, Iran, in 2000. He did post-doctoral research at the University of Calgary and University of Alberta, and worked at Shell Energy Canada as a processing geophysicist. Mostafa has arrived and started working on the *Metal Earth* project in September 2017.

Dr. Stéphane Perrouty, Precambrian Geology

Stéphane obtained his PhD in Earth Sciences in 2012 and MSc in Earth and Solid Planets Science in 2008, both from University of Toulouse III, France. His PhD research project was titled *Structural Evolution of the Mineralized Ashanti Belt, Southwest Ghana*. Stephane has gained valuable experience working on the *NSERC-CMIC Exploration Footprints* project as a post- doctoral researcher and research associate at Western University since 2013, and prior to that worked on the AMIRA-WAXI (West African eXploration Initiative) project. Stéphane will arrive and start working on the *Metal Earth* project in January 2018.

Dr. Jeremy Richards, Tier I Canada Research Chair in Metallogeny

Jeremy received his PhD from the Australian National University in 1990, MSc from the University of Toronto, and BSc from Cambridge University. He has extensive research experience in the fields of economic geology and metallogeny, and has worked on a wide variety of hydrothermal deposits, particularly porphyry copper deposits, and on the regional tectonic and magmatic controls on mineralization. Jeremy comes to us from University of Alberta, and arrived July 01, 2017.

Metal Earth Update from the Director, Dr. Harold Gibson

Metal Earth, MERC's 7-year, fully-funded, $104M flagship research project is underway. Our first field season was a success, on time, and on budget. Metal Earth comprises 4 research activities that are designed to improve assessment of metal endowment during greenfields exploration, these activities include: Craton-scale, Transect-scale, Thematic and Data Analytics. In 2017, Metal Earth focused on implementing Transect-scale research, which aims to provide crust-mantle slices through endowed and less endowed greenstone terrains to

identify crust- and mantle-scale controls on metal endowment and the location of mining districts. Results of the research will aid industry in area selection and will reduce exploration and opportunity costs, resulting in increased exploration success. Highlights of Metal Earth's progress since the last newsletter are described below.

Building Scientific Capacity

Building the scientific capacity to undertake Metal Earth has been a challenge given the short time frame to get the program up and running.

Metal Earth's areas of Focus within the Canadian Shield over the seven-year program.

Here is what we have accomplished to date:

1. Established formal research and support agreements with key researchers at our five university partners (University Laval, University of Quebec at Chicoutimi, University of Toronto, University of Ottawa and University of Alberta)
2. Hired five tenured and tenure-track Metal Earth funded faculty including Ross Sherlock, Research Chair in Exploration Targeting, MERC Director and incoming Director of Metal Earth as of July 01 2018. Built the Metal Earth administrative and technical/scientific support team (2 administrative and 4 technical positions)
3. Hired six Research Associates/PDFs to help lead and to undertake the Targeted Transect Mapping and Craton-scale compilation projects;
4. Selected 3 PhD, 9 MSc and 15 BSc students to undertake the Transect geological and gravity mapping projects conducted this summer

5. Acquired the needed office and research space within the Willet Green Miller Centre, which houses the Harquail School of Earth Sciences, the Ontario Geological Survey, and the Ontario Government Laboratories
6. We are still building and are in the process of hiring 2 Research Associates to assist in processing and interpreting the seismic and upcoming MT data, and we are advertising for 3 Research Associates, and 6 graduate and 24 undergraduate students to join the Transect Research team for next summer's field program

Transect Targeted Mapping

After a weeklong Health and Safety course followed by a 5 day Abitibi field trip our field crews started mapping on June 15. Here is what we have accomplished:

1. Transect work began in the Abitibi Greenstone belt in northeastern Ontario and northwestern Quebec. Transects studied include Swayze, Larder Lake, Rouyn-Noranda, and Malartic. The geological, and geophysical (gravity survey) work was undertaken by 3 Research Associates, 12 Graduate Students and 15 Field Assistants, under the supervision of 7 Principal Investigators from Laurentian University and the University of Quebec at Chicoutimi.

2. Our inaugural annual field workshop was conducted on Sept 13th and 14th. The workshop was well attended with a total of 55 industry, government and academic participants. A copy of the field guide book can be downloaded from the MERC website (http://merc.laurentian.ca/news/field-trip-guide-for-2017-transects).

3. Results of this summer's geological field work will be published as five Summary of Field Work papers with the Ontario Geological Survey (OGS) and seven papers from the Quebec transects will be published in French with Ministere Engergie et Resources Naturelles (MERN) as a special publication; all will be available on line through the OGS, MERN and MERC websites

Transect 2D Seismic Surveys

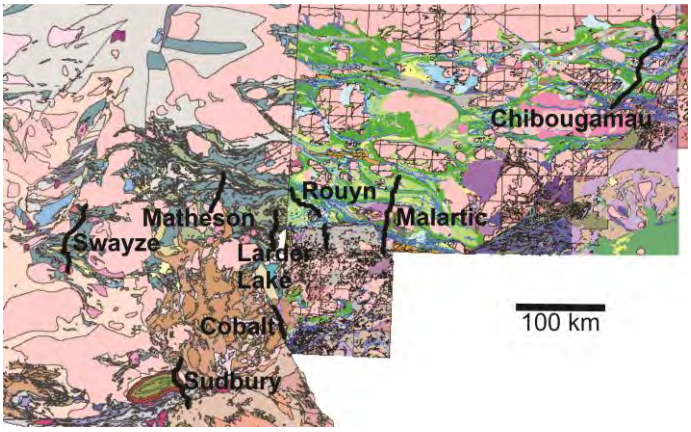
On February 15th 2017, SAExploration Ltd of Calgary Alberta was awarded a $5.5M seismic reflection contract for a total of approximately 900 line km. Following transect route checks and permitting the survey began along the Chibougamau Transect on August 10.

The seismic data is being acquired in three modes (R1, R2, R3) and will cover 13 transects through base and precious metal endowed and less endowed segments of the Abitibi and Wabigoon greenstone belts, and across the Sudbury structure and Cobalt embayment; each transect ranges from 40 to 130 km in length.

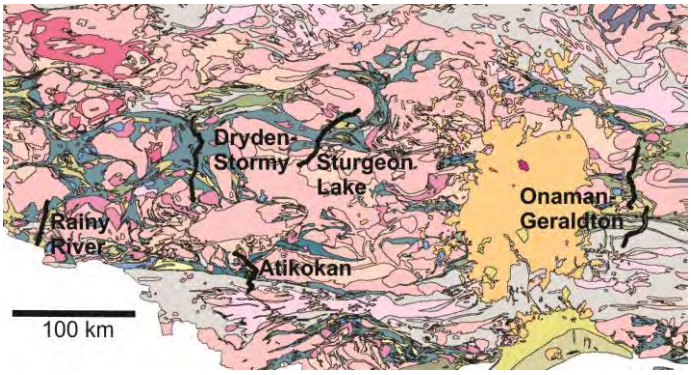
All transects are covered, in their entirety, by the R1 mode, which is designed to image reflective structures down to about 50 km depths, using 50 m spacing for vibration sources and 25 m spacing for recording geophones. The two other modes, R2 and R3, have been restricted to shorter segments where more detailed, higher resolution shallow imaging is required (e.g. along significant crustal structures such as Cadillac-Larder Lake break).

R2 is similar to R1 but uses closer spacing of vibration sources (25 m) and geophone spacing (12.5 m). This mode will image reflectors down to about 15 km with considerably better resolution than R1. The R3 mode, utilizes new technology called "Full Wave Form Inversion". It maps seismic wave speeds to shallower depths (about 10 km), has superior resolution and has the potential to better image features of any dip (in particular steep structures which are challenging for R1 and R2 modes). The R3 mode uses vibroseis trucks as in R1, and supplements these with small (2-12 kg) explosive shots at long offsets. This is the first time Full Wave Form Inversion has been applied to crystalline rocks. Discussions with IBM to improve algorithms, and to decrease processing time for inversion of R1, R2, and in particular R3 data, are in progress.

To date, seismic data has been acquired on lines in the Chibougmau, Malartic, Rouyn-Noranda, Larder Lake, Matheson, Swayze, Cobalt and Sudbury areas. Seismic data acquisition will continue in 5 transects areas in the Wabigoon subprovince of Northwestern Ontario. Preliminary assessment of raw data from the early l transects shows it to be excellent; the survey will be completed in late November.



Black lines indicate the 8 areas with completed 2D seismic transects in Northeastern Ontario and Northwestern Quebec in 2017. Work during the summer of 2017 also included geological mapping and graduate thesis projects, gravity measurements and data collection on the Swayze, Larder Lake, Rouyn, and Chibougamau transects. Transect work will continue in 2018 and will also include magnetotelluric surveys.



Transects for 2D seismic, gravity and magnetotelluric surveys along with geological mapping and data collection in the Wabigoon Subprovince in Northwestern Ontario.

In conjunction with the Transect and Craton-scale research activities a compilation of geophysical data (magnetic and gravity initially) for the Superior Province has started. This compilation has an initial focus on the Abitibi greenstone belt to support our transect research. A contract for the MT survey is in process and the winning contractor has been selected. This survey will include 2D magnetoteluric (MT) data acquisition (MT and AMT) along the transects covered by the seismic reflection survey. The MT survey will begin in April 2018.

Craton-Scale, Thematic, and Data Analytics Research

Craton-scale research was initiated in 2017. The Mantle Group, centred at the U. of Alberta and Carnegie Institute for Sciences at Washington, has been identifying Superior province samples and new sample sites, for mantle probing rocks (komatiites, kimberlites, ultramafic xenoliths). Using trace elements, including the PGEs, and extinct and active radionuclide tracers they aim to map the age and geochemistry (metal reservoirs) of the Superior province mantle lithosphere, which may have exerted a profound influence on the location of mining districts. Results of this research will have implications for, and aligns with, the goal of identifying larger-scale features responsible for metal endowment. In parallel, a compilation of Superior Province U-Pb zircon geochronological data was initiated in September. Once finalized, selected zircons from our partner's archives (provincial, territorial and Federal governments) and zircons from new sampling will be analyzed for radiogenic isotopes and trace elements to construct, for the first, time-slice maps of the Superior craton. These maps have the potential to identify early, pre-accretionary crustal-scale structures, which may have controlled the location of mining districts. Analyses for this research will be conducted at our new LA-ICP-MS facility, which will be operational in December.

Lastly, the thematic and data analytics research activities will start in 2018. However, we are in discussions with IBM to develop new inversions and algorithms for integrating and visualizing the geophysical data collected along the transects.

Building Scientific Capacity

Principal Investigators:

Prof. Harold Gibson, Laurentian U, Director, VMS deposits, Volcanology, Geochemistry
Prof. Bruno Lafrance, Laurentian U, Associate Director, Structural Geology and Tectonics
Prof. Ross Sherlock, Laurentian U, MERC Director, Exploration Targeting
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. Leonardo Feltrin, Laurentian U, Earth Systems Modelling (Jan. 2018)
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. Lucie Mathieu, U Québec - Chicoutimi, Economic Geology
Prof. Mustafa Naghizadeh, Laurentian U, Geophysics, Seismology
Prof Stéphane Perrouty, Laurentian U, Precambrian Geology (Jan 2018)
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

Research Associates (PDFs)

Esmaeil Eshangi, Geophysical compilation
Rasmus Haugaard, Geology, Swayze Transect
Taus Jorgensen, Geology, Rouyn Transect
Jeff Marsh, PDF and ICP-MS Technician
David Mole, Craton isotopic compilation
Xiaohui Zhou, Geology, Malartic Transect

Grad students, thesis areas

Tom Gemell, PhD, Geology, Swayze Transect (OGS staff geoscientist and OGS supported)
Marina Schofield, PhD, Geology, Rouyn Transect
Eric Roots, PhD, Geophysics, Magnetotelurics
Sean Brace, MSc, Geology, Larder Lake Transect
Amir Maleki, MSc, Geophysics, Gravity and Magnetics
Wiliam McNeice, MSc, Geophics, Rock Properties
Blake Mobray, MSc, Geology, Swayze Transect (OGS supported)
Adrian Rehm, MSc, Geology, Rouyn Transect
Brendan Samson, MSc, Geology, Malartic Transect
Daniel Shiriff, MSc, Geology, Malartic Transect
Jonathan Sutton, MSc, Geology, Rouyn Transect
Nadia St. Jean, MSc, Geology, Larder Lake Transect

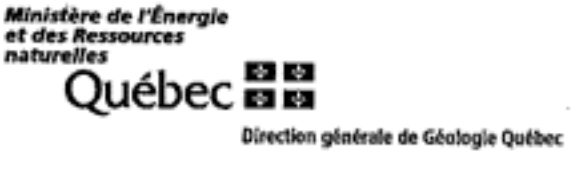
Administrative and Technical Staff

Jackie Edwards, GIS technician
Kip Grose, Information Technology
Natalie LaFleur-Roy, Finance and Operations Administrative Manager
Rebecca Montsion, GIS technician
Ryan Paquette, Database Technician
Christine Rodrique, Admin. Assistant

New Equipment

A new multi-collector laser ablation ICP-MS has arrived and is being assembled to complement existing ICP-MS instruments for advanced isotope and metal analysis, and an application for further instrumentation is in the pipeline.

Metal Earth Partners



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GEOSCIENCE TITIGAKVIIT

MERC Foundation Members

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