Department of Geological Sciences: Research & Services

UNIVERSITY OF SASKATCHEWAN

Dr. Bruce Eglington: Pyke Chair

Bruce Eglington's principal research focus is on developing and implementing systems and processes to better understand and visualize the development of Earth's crust and its associated ore deposits. To facilitate these objectives, Bruce and his research team and collaborators have developed the international, DateView and StratDB geochronology, ore deposit, lithostratigraphy and large igneous province databases which provide standardized formats to capture and extract relevant information. These data, together with suitably attributed digital geological map information, provide GIS layers for use in plate reconstruction software such as Paleogis and GPlates. Research is focused on creating an internally consistent, palaeomagnetically and geologically reasonable reconstruction from the present day back to the early Palaeoproterozoic. Diagrams (below) illustrate some of the data available, as well as a global reconstruction at 430 Ma.

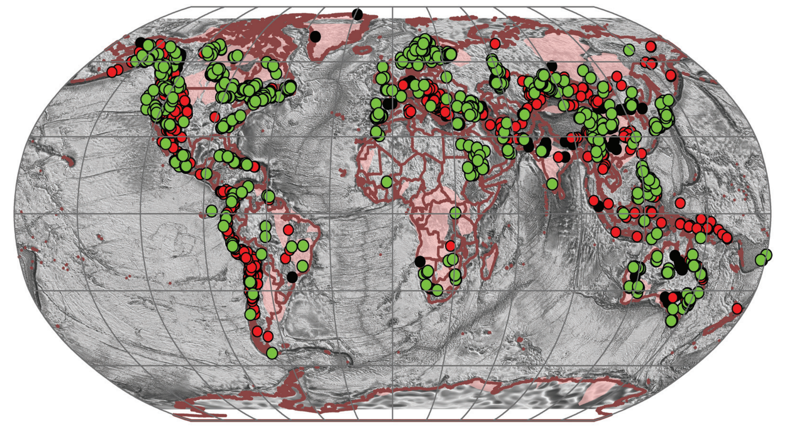


Fig. 2. Global compilation of VHMS deposits (green), porphyry deposits (red) and clastic Pb-Zn deposits black). All data from the StratDB database.

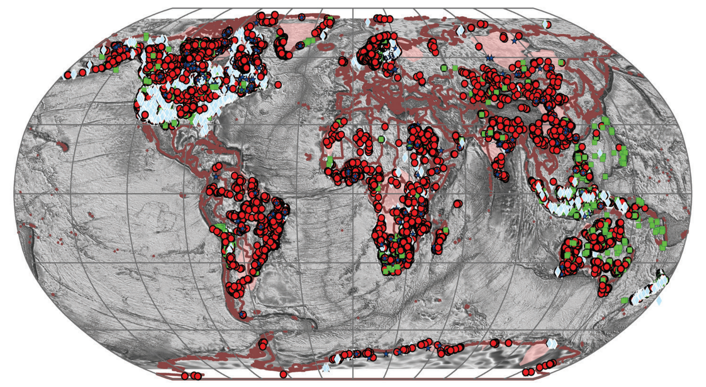


Fig. 1. Global geochronology data from the DateView database. Red symbols for plutonic igneous ages, green for volcanic ages, blue for metamorphic ages and pale blue for cooling ages. Over 107,000 records are currently available.

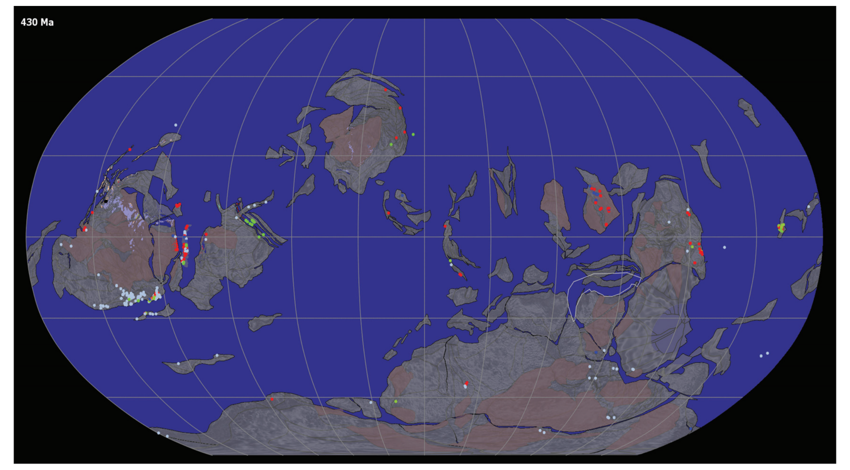


Fig. 3. Plate reconstruction at 430 Ma. Symbology as in Figures 1 and 2. Note the concentration of VHMS mineralization (green symbols) in the western Urals region, Norwegian Caledonides and eastern Canada.

Dr. Camille Partin
Precambrian Geologist

Research Areas: Tectonics • Precambrian Geology • U-Pb, Hf Geochronology • Isotope Geochemistry • Paleo-Redox Geochemistry • Stratigraphy • Basin Analysis • Sedimentary-Hosted Mineral Deposits • Northern Canada & Greenland

Ty Magee (MSc student) contemplating the nature of Paleoproterozoic Pb-Zn mineralization.

My website & link to current publications:

Dr. Partin's research group uses various tools to study the ancient Earth, including oxygen evolution of the Precambrian atmosphere-ocean system, and tectonics, especially of the Canadian-Greenland Shield.

Student projects:

• Re-Os age and origin of carbonate-hosted Pb-Zn mineralization in the Karrat Group (collaboration with **Geological Survey of Denmark & Greenland, MSc student: Ty Magee**)

• Age and provenance of the Karrat Group, west Greenland by detrital zircon U-Pb, Hf isotope analysis (collaboration with **Geological Survey of Denmark & Greenland, MSc student, Michael McConnell**)

• Provenance analysis by zircon U-Pb, Hf, O isotopes, Murmac Bay Group, NW Saskatchewan (GEM2 project, **MSc student: Christine Shiels**)

• U isotopes (238U/235U) in OAE-2 carbonates (**MSc student: Brayden McDonald**)

The famous Pb-Zn Black Angel Mine, Maarmorilik, west Greenland.

Dr. Partin on traverse during arctic field work in west Greenland in the Karrat Group.

Saskatchewan Isotope Laboratory

The Saskatchewan Isotope Laboratory (SIL) has facilities for the analysis of a wide range of stable and radiogenic isotopes for use in environmental, palaeoclimate and geological investigations. SIL contains a range of modern equipment, supported by an active group of staff and students. SIL provides analyses in many isotope systems, including Rb-Sr, Sm-Nd and Pb-Pb analyses of rocks, minerals, ores, water and other samples, as well as H, C, O and/or N analyses of water, carbonates, phosphates and organic materials. Analytical capabilities in non-traditional stable isotopes, including Cr, Ca, Mg and U, have been developed.

Projects undertaken at SIL range from local, provincial, national to international in scope, and are performed in collaboration with academics, government agencies, exploration and mining companies, and environmental consultants.

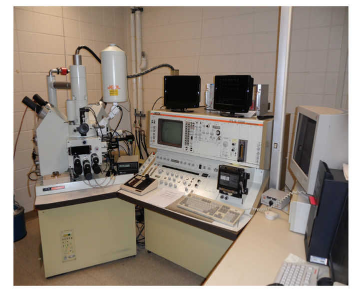
SIL also hosts a number of databases for international use, including DateView geochronology, StratDB lithostratigraphy and Ion Exchange Resin databases. Advanced exploratory data analysis and time series analysis techniques are routinely implemented in the assessment of data generated by SIL staff and students. Various software packages for the processing of isotope and geochemical data, developed by SIL staff, may be downloaded from the lab's website: http://sil.usask.ca

For more information, contact the Lab Manager: Sandra Timsic, or one of the directors of the facility: Chris Holmden, Bill Patterson, Bruce Eglington or Kevin Ansdell. Contact details are available on the facility website.

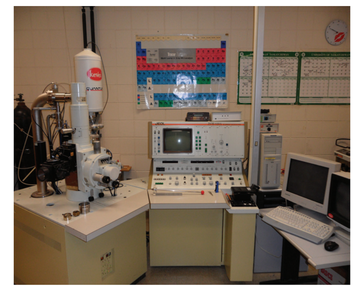
The Trace Metal Clean Lab, built to support SIL, was constructed of clean and sealed materials, such as using inert epoxy paints. Air supply is HEPA (high efficiency particle attenuation) filtered, and the lab is kept under positive pressure to ensure airflow is out of the room. Samples analyzed using TIMS or ICP-MS must be dissolved and chemically purified before analysis, which requires this ultraclean environment. All chemicals and equipment used must also be kept as clean as possible to minimize blanks, to allow for the accurate measurement of very small samples.

Electron Microscopy and X-Ray Diffractometry Laboratories

These labs service both academia as well as industry. Analytical capabilities include chemical (CHIME) age dating of APS and U-Th oxides, as well as qualitative and quantitative chemical analysis and X-ray mapping of geological, metallurgical and material science samples. Contact Tom Bonli: 966-8680 or tom.bonli@usask.ca

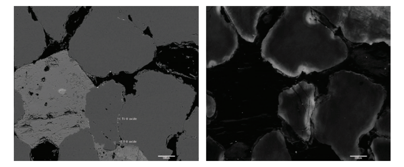


The electron microprobe analyzer (EMPA) has both imaging and analytical capabilities. It is equipped with both wavelength dispersive (WDS) and energy dispersive (EDS) spectrometers capable of measuring elements from B to U down to less than 100 ppm with spatial resolution down to 3 μm. Imaging capabilities include back-scattered electron (BEI), secondary electron (SEI) and cathodoluminescence (CL) imaging.

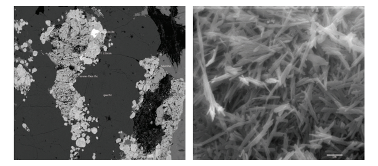


The scanning electron microscope (SEM) is equipped with both back-scattered electron (BEI) and secondary electron (SEI) imaging capabilities as well as an energy dispersive (EDS) detector. Images are acquired with a digital image acquisition system that includes image analysis software.

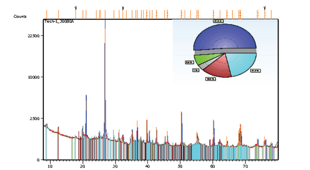
The XRD lab houses a state of the art PANalytical Empeream XRD installed in 2011. It is equipped with a multi array detector capable of rapidly collecting structural data for phase identification as well as high resolution data for quantitative analyses such as Rietvelt refinement. This instrument is also equipped with a micro capillary system, capable of analyzing very small or suspended samples.



BEI (left) and CL (right) images of pore filling calcite and fracture filling U-Y and Ti-U oxides in quartz sandstone. Bright rims of quartz grains demonstrate radiation damage in detrital quartz but not secondary quartz overgrowths.



BEI (left) and SEI (right) images of U-Th-Fe oxides and clays in quartz sandstone. The SEI image shows needle-like morphology of goethite and hematite.



XRD spectrum of pore filling clays and carbonates in quartz sandstone.

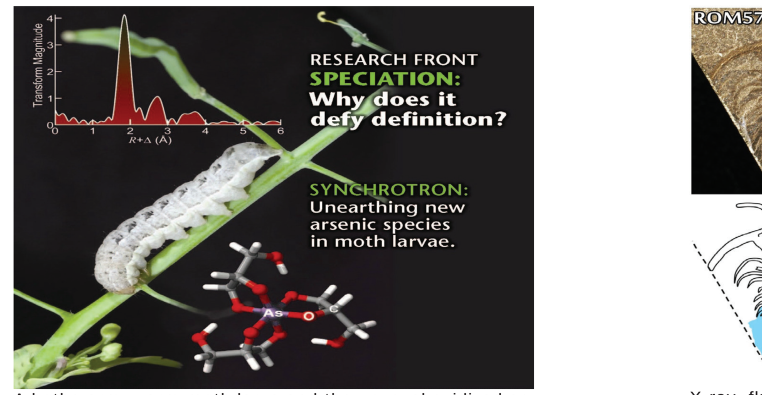
Dr. Matt Lindsay
NSERC Industrial Research Chair

The Environmental Geochemistry Group at the University of Saskatchewan is led by Dr. Matthew Lindsay, the NSERC Industrial Research Chair in Mine Closure Geochemistry and an Assistant Professor in the Department of Geological Sciences. Dr. Lindsay's research examines processes and conditions that control water quality within mining environments. More specifically, his group studies the complex interactions among chemical, biological and physical processes to better understand their combined influence on element mobility within groundwater and surface water at active and inactive mines. This research integrates field-scale studies, laboratory-scale experiments, molecular-scale measurements, and modeling. Results of this research are being applied to the development of new approaches for minimizing long-term impacts of mining operations on water resources.

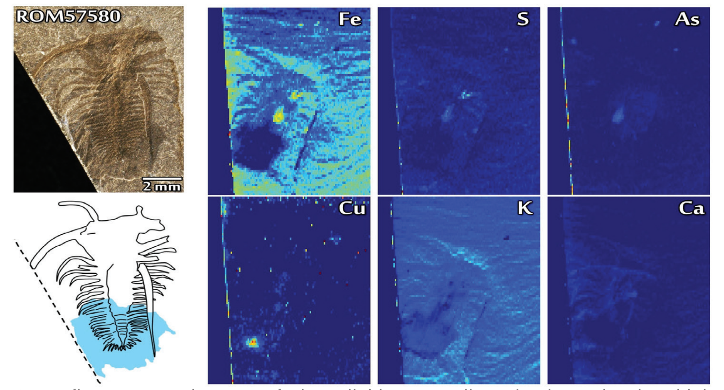
Dr. Lindsay is currently recruiting Ph.D., M.Sc. and B.Sc. students for fully funded research projects related to mine closure geochemistry. Please contact him at matt.lindsay@usask.ca for more information related to these opportunities. Also visit www.mbjlindsay.ca for details on active research projects.

Molecular and Environmental Sciences Research Group
Dr. Graham George and Dr. Ingrid Pickering

Synchrotron-based techniques such as X-ray absorption spectroscopy and X-ray fluorescence imaging play important roles in *Molecular Environmental Science,* an emerging field that involves molecular-level studies of chemical and biological processes affecting the speciation, properties and behavior of contaminants, pollutants and nutrients in the ecosphere. These techniques enable the study of metals in biological systems, microbial biofilm-heavy metal interactions, heavy metal-plant interactions and complex material microstructures. The figures below illustrate some of the current multidisciplinary research activities using the Canadian Light Source synchrotron located on the U of S campus.



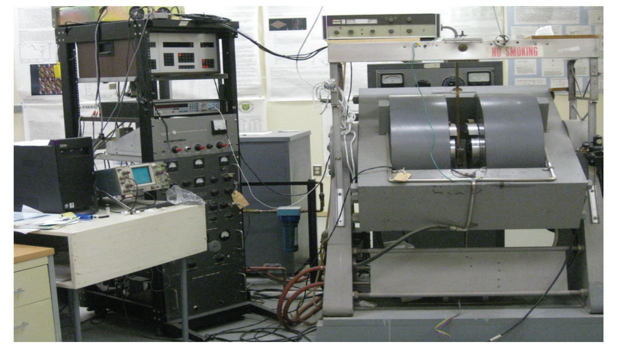
A betha armyworm moth larva and the unusual oxidized arsenic species it excretes. This compound was identified using synchrotron generated X-ray absorption spectroscopy.



X-ray fluorescence images of the trilobite *Marrella splendens* showing high concentrations of iron, sulphur and arsenic relative to the surrounding mudstone.

Hydrothermal and Saskatchewan Solid State EPR Labs, Dr. Yuanming Pan

Thermolyne High Temperature Furnace



Varian Spectrometer

Leco Cold-Seal Pressure Vessel

The hydrothermal lab contains a Leco cold-seal pressure vessel, four thermolyne furnaces and a series of Parr acid digestion bombs for hydrothermal experiments up to 12 kbar and 1800°C. This lab currently investigates halides and borates, with relevance to evaporite deposits.

The Saskatchewan Solid State EPR Lab has a Varian spectrometer and related accessories for EPR measurements at X-band frequencies. This lab specializes in measurements of radiation-induced damage in quartz, with applications to uranium and rare-earth element deposits.

Aqueous and Environmental Geochemistry Research Group, Dr. Jim Hendry

The focus of this group is contribution to important advances in the environmentally sound management of mine waste generated by Saskatchewan industries, including uranium mining. One major focus is the characterization of uranium tailings (geochemistry, redox, pH, mineralogy, sorption) as well as optimization of mill processes in an effort to stabilize elements of concern (EOC), such as arsenic, molybdenum, selenium and nickel. This group also conducts NSERC-supported research on deep marine deposits, as well as environmental and contaminant research in collaboration with industries such as agriculture, potash mining, nuclear waste disposal, and oil and gas extraction.

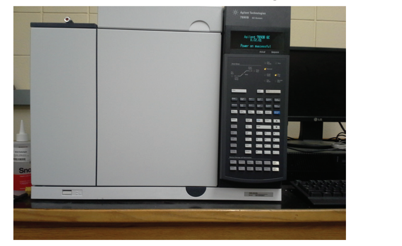
Analytical Geochemical Laboratory

Commercial services available.
Dr. Jianzhong Fan: 966-5742, j.fan@usask.ca
Fina Nelson: 966-5686, fina.nelson@gmail.com

CETAC LSX-200 LAS

PerkinElmer Flexar HPLC System

DIONEX ICS 2100



Agilent GC System

The Analytical Geochemical Laboratory houses a variety of state-of-the-art analytical instrumentation including:

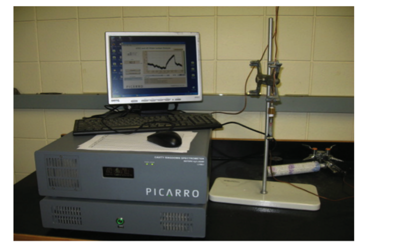
1. PerkinElmer NexIon 300D ICP-MS, which includes a dual-channel Universal Cell, allowing analysts to use Dynamic Reaction Cell (DRC) technology and/or Kinetic Energy Discrimination (KED) to remove polyatomic interferences on analytes of interest.
2. PerkinElmer Elan 5000 ICP-MS.
3. PerkinElmer Flexar HPLC System coupled with the NexIon 300D ICP-MS, which allows elemental speciation analyses to be achieved.
4. CETAC LSX-200 Laser Ablation System with laser spot size varying from 10 to 300 microns and pulse frequency of 1-20Hz on various samples. Maximum energy ~ 4mJ at 266 nm.
5. Dionex Ion Chromatography System 2100 for analysis of major anions including F, Cl, NO_2, Br, NO_3, PO_4 and SO_4.
6. Agilent Gas Chromatography System for analysis of CO_2, CH_4 and other light hydrocarbons.
7. SpectroBLUE Inductively-Coupled Plasma Optical Emission Spectrometer for analysis of major cations including K, Na, Mg, Ca, P and S, and trace metals including Se, As and Cd.

PerkinElmer NexIon 300D ICP-MS

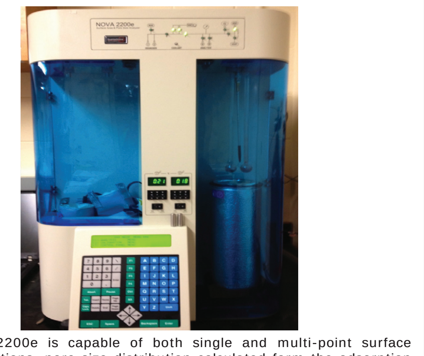
SpectroBLUE ICP-OES

The lab is a multi-user analytical facility for measuring up to 70 chemical elements with concentration ranging from parts per trillion to parts per million in diverse sample types from environmental, biological, geological and industrial sources. Certain anions (Br, Cl, F, NO_3, PO_4 and SO_4) in sub-ppm levels can also be measured.

Aquitard Laboratory



Stable isotopes of water are analyzed on a Picarro L1102-i Isotopic Water Liquid Analyzer and the resulting data are predominately used to determine the hydraulic properties of geologic media.

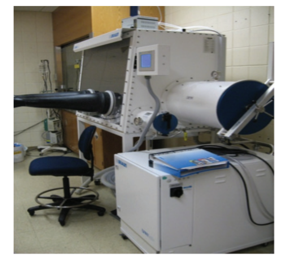


The Nova 2200e is capable of both single and multi-point surface area calculations, pore size distribution calculated form the adsorption or desorption isotherm, and total pore volume and average pore radius.

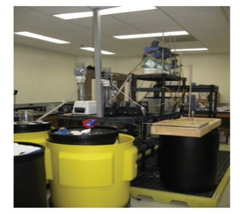
The Carver Auto NE Hydraulic Laboratory Press is used to extract pore water from samples to facilitate measurement of anion and cation concentrations, redox potential and pH. These data are used in conjunction with stable isotope data to determine contaminant transport as well as methods of containment.

The Mastersizer 2000 particle size analyzer uses laser diffraction to measure the particle size distribution of soils. It can measure particles sizes in the range of 20nm to 2mm, which easily covers all three soil fractions and allows the soil texture to be determined in one measurement.

NSERC/CAMECO Geochemistry Laboratory



An MBraun Unilab 1000 glovebox under N_2 atmosphere allows for reactions to take place under anaerobic conditions.



A pilot plant for neutralization of synthetic raffinate, modelled after Cameco's Key Lake mill operation, is used to characterize the secondary minerals that precipitate, and the behaviour of EOC accompanying changes in pH during successive processing steps. Optimization of the neutralization process with respect to EOC stability is also being investigated.