

Clayton H. Riddell Faculty of
Environment, Earth, and Resources
Department of Geological Sciences



University
of Manitoba

Graduate Programs Exploring Geoscience



umanitoba.ca/geoscience

Our Department



Clayton H. Riddell, O.C.

Clay Riddell received his B.Sc. Hons. in Geology from the University of Manitoba. He was a long-time supporter of the department and his namesake faculty. Clay was the founder of Paramount Resources (Calgary) and has had a long and distinguished career in the petroleum industry. He was known as well for his volunteer contributions. In 2004, he received an Honorary D.Sc. from the University of Manitoba.

The Department of Geological Sciences is part of the Clayton H. Riddell Faculty of Environment, Earth, and Resources. The Riddell Faculty provides interdisciplinary and integrated approaches to understanding the Earth, its environment and resources. The Wallace Building, which houses the Department of Geological Sciences, also includes the Centre for Earth Observation Science, the Nellie Cournoyea Arctic Research Facility, and the administrative offices of the Riddell Faculty.

This brochure will introduce you to areas specific to Geological Sciences: our research programs, our staff, and our world-class research facilities. If you are considering graduate studies, you are encouraged to contact potential supervisors who have research programs matching your interests.

In addition to reviewing this brochure, all prospective students are expected to read the information on applicable web-sites:

Faculty of Graduate Studies:

http://umanitoba.ca/faculties/graduate_studies/

Department of Geological Sciences Graduate program pages:

http://umanitoba.ca/faculties/environment/departments/geo_sciences/GraduateProgram.html



Why choose UM Geological Sciences?



Wallace Building

- multiple state of the art analytical labs
 - all research labs are located in the Wallace Building
 - dynamic learning community
 - wide range of research possibilities
 - recognized worldwide for its research
 - provides research and scholarship support for graduate students without external sources of major funding
- located on a large university campus with a full range of services
 - located in Winnipeg, a culturally diverse city
 - near the metal-rich Precambrian Shield (to the east)
 - near the petroleum-producing Western Canada Sedimentary Basin (to the west)
 - located near prime wilderness and recreation areas
 - located on the banks of the Red River and on the floor of the Glacial Lake Agassiz.



Geological Sciences Grad Students 2015



Corydon Street, Winnipeg



Canadian Museum for Human Rights, The Forks

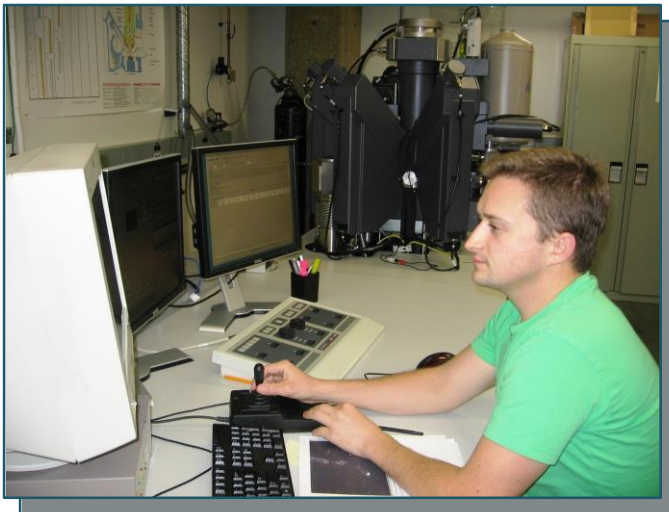
Over 100 years of history



As the oldest geosciences department in western Canada (est. 1910), the Department of Geological Sciences has produced outstanding graduates in industry, universities, and governments, and has developed an international reputation in a number of research areas.

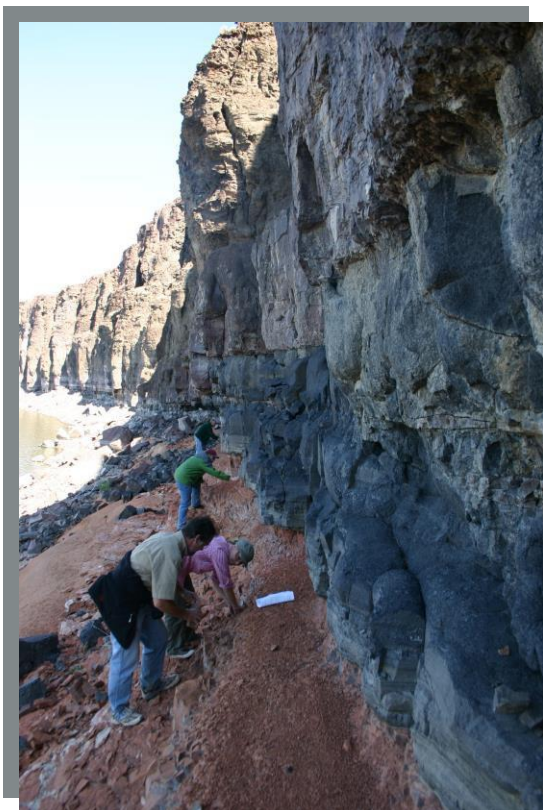
The Department has maintained strong ties with its alumni, who can attest to a sense of identity and community that begins when a student enters the Geology or Geophysics undergraduate program or when a new graduate student steps through the door. The generosity and appreciation of our alumni is reflected in visible features like the Cretaceous Menagerie Museum and the Department's History Wall (Centenary 2010), and scholarship and bursary support for our students.

A Vibrant Scientific Community



The Department fosters a culture that encourages community. We are large enough to have all the resources, but small enough to allow for personal interaction on a daily basis.

Graduate students are assigned a shared office in the Wallace Building in an area that includes a large lounge, wired and wireless internet and shared printer. Staff offices are a short walk down the hall. Research facilities are conveniently located within the building as well. Your thesis advisor will ensure that you have access to relevant research labs and receive training under the supervision of experienced technical staff.



Yellowstone Field Trip



Field work in Eden Lake area, northern Manitoba

Our graduate students have opportunities to apply for positions as lab instructors and markers, as teaching assistants at department field schools, and to participate as volunteers in our outreach programs to the general public. PhD students may be offered the opportunity to apply for sessional teaching positions to gain experience for careers in academia.

Field trips occur on a regular basis, organized by undergraduate or graduate student groups or by staff in the Department. Your thesis supervisor will generally provide funding for field work related to conducting your thesis research and will encourage you to attend and present at relevant conferences. In addition, your thesis advisor will normally cover the costs of expenses related to your thesis research.



Geophysics field work

Research Areas

With the expertise of faculty members and technical staff and instrumental facilities capable of producing seminal research on the physical, chemical and biological characteristics of Earth materials, the Department of Geological Sciences is contributing to the understanding of Earth history, current and past Earth processes, and environmental change. Our research is proving to have important applications in resource exploration and extraction and mineral processing and in addressing environmental issues.

Our research areas can be broadly broken into: Mineralogy and Crystallography; Environmental Mineralogy and Geochemistry; Sedimentary and Quaternary Studies; Vertebrate Paleontology; Crustal and Mantle Geophysics; Applied/Environmental Geophysics; Petrology and Tectonics; Mineral Deposits; Marine and Freshwater Systems.



Grad students working in the X-Ray Lab

Mineralogy and Crystallography

The University of Manitoba is widely recognized as a world centre for both theoretical and experimental Crystallography and Mineralogy.

Anton Chakhmouradian, Frank C. Hawthorne, Michael Schindler and Elena Sokolova work on a wide variety of topics in structural crystallography and mineralogy in collaboration with many scientists around the world.

Anton Chakhmouradian (below) is currently focused on the mineralogy and petrology of exotic mantle-



derived rocks (like carbonatites and kimberlites), as well as geochemistry and metallogeny of rare earths, niobium and other critical metals in the Earth's crust. He collaborates with scientists from the Manitoba Geological Survey, China, Russia, Norway, Australia and several other countries to develop comprehensive models of magma evolution and rare metal deposition in such complex geosystems as continental rifts (e.g., East African Rift) and transtensional orogenic structures (e.g., eastern Tibet). Exciting research projects from around the world are available to potential graduate students.

Frank Hawthorne has a major focus on bond topology and its relation to energetics, mineral chemistry and paragenesis. He also works extensively on the structural behaviour of oxysalt minerals in general and sulfates and borates in particular. Together with recent students, he has worked on the crystal chemistry and growth of tourmaline-group minerals in granitic pegmatites, and has a long-term focus on the crystal chemistry of the amphiboles (with colleagues in Pavia and Rome, Italy).

Elena Sokolova works extensively on Ti-silicate minerals in collaboration with colleagues at the Fersman Mineralogical Museum and IGEM (the Institute of the Geology of Ore Deposits: Petrography, Mineralogy and Geochemistry), Moscow (Russia) and in Pavia (Italy), focusing on their structure and the relation between chemical composition and structural arrangement. She also leads a project on the characterization of silicate minerals from the Kola Superdeep Borehole in Russia in collaboration with colleagues at IGEM.

All mineralogical work is supported by an extensive array of instrumentation and overseen by expert technical staff.

Environmental Mineralogy and Geochemistry

Building on work by **Petr Cerný** on the mineralogy and geochemistry of the TANCO pegmatite in the 1980s, this area of research has grown over the years. **Norman Halden** has demonstrated a strong synergic interaction between mineralogy, geochemistry and the environment. Important thrusts are emerging in non-linear dynamic processes, environmental mineralogy, microbial-mineral interactions and biomineralization. With such interactions occurring on a very small scale, microbeam analysis and crystal chemistry in these areas is paramount. With the local availability of expertise, the department's research in mineralogy and geochemistry is cutting edge. The interdisciplinary microbeam work on otoliths (fish ears) developed by Norm Halden provoked great interest from the fish biology community because otoliths record finely resolved details of environmental change.



*N. Halden - first you have to catch the fish!
Inset: SEM image of a fish otolith*

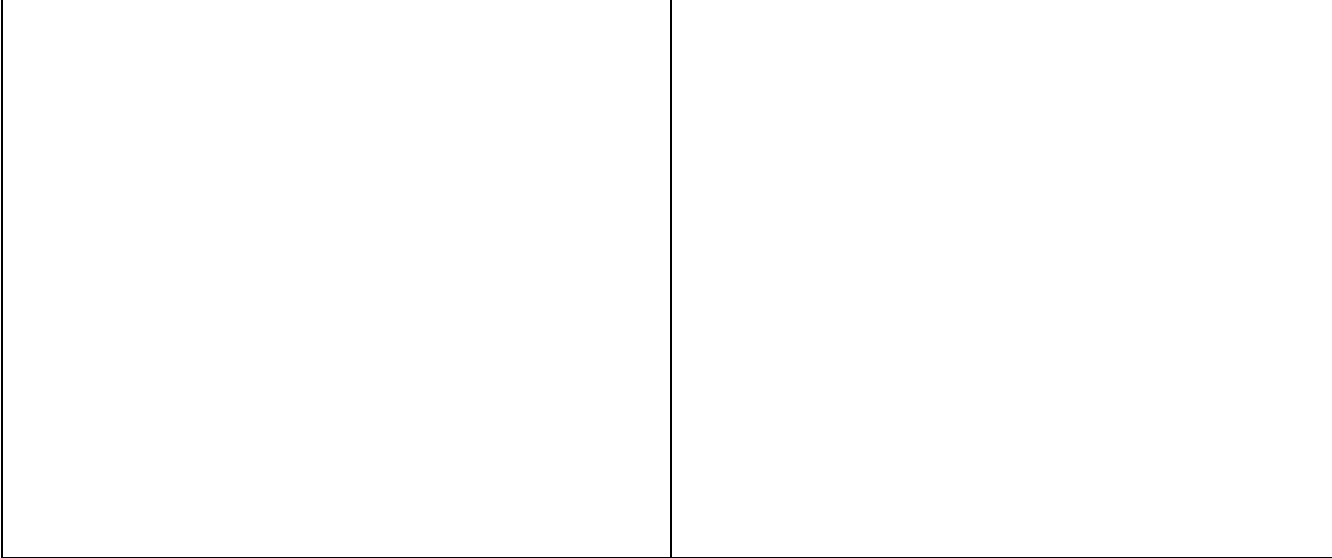
Mostafa Fayek brought another dimension to this research area and secured the addition of a Secondary Ion Mass Spectrometer. Mostafa is expanding on existing research by studying fluid-solid interactions at the atomic level and the linkages between specific isotopic signals and the mechanistic signatures and textures in environmental contaminations and nuclear waste disposal. His strong interest in geoarcheology focuses on sourcing and dating techniques for archeological artifacts throughout the southwestern United States and Mesoamerica.



*Mostafa Fayek (centre) and students examine uranium tailings.
Inset: SIMS*

Environmental Mineralogy and Geochemistry (con't)

An even newer and much smaller dimension has been introduced to the Department by the new Professor for Environmental Mineralogy **Michael Schindler** who studies environmental relevant processes at the nano-scale. His research includes the study of mineralogical processes in contaminated soils and sediments as well as mine tailings, the interaction of minerals with bacteria (see image to the left), dissolution and growth of minerals (see image to the right) and the fate of nanoparticles in the environment. His current research also explores the formation of salt minerals in Arctic Ice and the release, retention and transport of phosphate in over-fertilized soils and surface waters in Manitoba.

	
Bottom: Magnetite nano- crystals formed by magnetotactic bacteria	Parallel growth of Ni-bearing Fe-hydroxide nano-crystals in contaminated soils

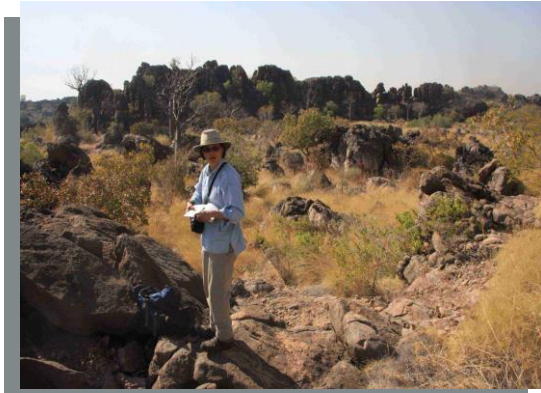
What's in a name?

The following minerals were named for faculty members or alumni of our Department:

Bobfergusonite, Burnsite, Cernyite, Ercitite, Frankhawthorneite, Gaitite, Griceite, Groatite, Harrisonite, Markcooperite, Nuffieldite, Sabinaite, Sokolovaite, Trembathite, Wicksite, Schindlerite

Teller Peak in Antarctica is named for Jim Teller

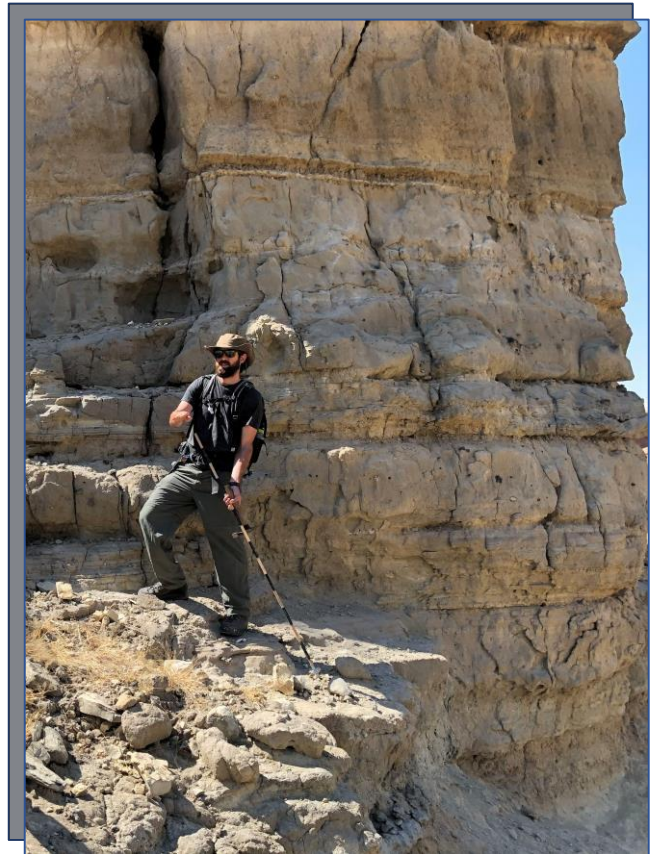
Sedimentology and Quaternary Studies



Nancy Chow in the Canning Basin, Australia

Nancy Chow is interested in all aspects of the sedimentology of Paleozoic carbonate rocks in western Canada. Her research focuses on Devonian carbonate platforms in Alberta and Manitoba and has taken her as far afield as northeastern Thailand and the Canning Basin of northwestern Australia. Her work has contributed to the understanding of environmental changes and tectonic events controlling reef growth and diagenesis.

William Last and **Jim Teller** are known for pioneering research on the sedimentology and paleolimnology of Quaternary lacustrine deposits in western, central, and northern Canada, and in semi-arid regions of Australia, the Middle East, South America, Africa and Asia. This research often focused on climatic and hydrologic change, and their environmental impact. William Last conducted applied sedimentological research on the Mesozoic reservoirs and source rocks of the Williston Basin. His research on evaporate sedimentology helped define the modern and past geochemical system of lakes across a large part of western Canada. Jim Teller's outstanding research on glacial Lake Agassiz and its overflow to the oceans has been widely recognized and is used internationally to model future climate change.



Paul Durkin in Olduvai Gorge, Tanzania, Africa

Paul Durkin is a clastic sedimentologist, with a particular focus on meandering fluvial deposits. His research is primarily field oriented, which ranges from outcrop studies of ancient fluvial and shallow marine deposits of the Western Canada Sedimentary Basin, to morphodynamics and sedimentology of modern rivers in Manitoba and South America. Dr. Durkin combines traditional sedimentary analysis with innovative data acquisition techniques, including Unmanned Aerial Vehicle (UAV) photogrammetry, to establish linkages between modern processes and their stratigraphic products.

Crustal and Mantle Geophysics



From left: R. Davidson, S. Perreault and A. Frederiksen

Andrew Frederiksen's primary focus is on the extraction of high resolution 3-dimensional Earth structure from large seismic data sets derived from earthquakes. His special interests include mantle

fabric and associated seismic anisotropy, inversion of receiver functions, scattered wave imaging using

teleseismic earthquakes, and tomography of the North American lithosphere. Current projects include detailed imaging of the lithosphere in the Grenville Province, and the relationship between crustal and mantle features; the large scale structure of the mantle root beneath the Superior Province and associated mantle fabric; and the on-going development of a tomographic inversion technique for scattered teleseismic waves at the sparse station arrays. **Ian Ferguson** is conducting large-scale electromagnetic studies of the crust and upper mantle in Canada. Ian has participated in large-scale electromagnetic studies across Canada and most recently in studies done in the Canadian GEM II Hudson-Ungava project. The aim of these studies is to arrive at a better understanding of the tectonic history and structure of these regions. Information obtained on the resistivity structure of the crust and mantle is also used to refine the modeling of geomagnetic hazards such as the currents induced on power-lines during magnetic storms.



Applied and Environmental Geophysics

Ian Ferguson (left) conducts geophysical studies of environmental, groundwater, archeological, and other near-surface targets. Recent projects include surface electromagnetic imaging at the Aquistore CO₂ sequestration site in Saskatchewan, investigating paleochannel aquifers in southwestern Manitoba, and mapping the radiometric and magnetic properties of an igneous intrusive complex.

Petrology and Tectonics

The Precambrian geology of Manitoba has long been a prime research interest in the Department.

Norman Halden continues to work on the tectonic and magmatic evolution of the Superior Boundary Zone (encompassing both the Thompson Nickel Belt and the Fox River Belt) as well as layered igneous intrusions.



Alfredo Camacho

Anton Chakhmouradian's expertise in alkaline igneous rocks is being brought to bear on the Eden Lake Complex.

Alfredo Camacho (left) is using theoretical and practical geochronology to constrain cooling histories and the rates of tectonic processes. Looking at spatial and temporal relations among shearing and fluid flow in subducting zones where rapid burial advects cold material into the mantle, he seeks answers to the following: what are the characteristics and origin of the fluids; can phase transformations occur under dry conditions or is a fluid always required; what are the durations heat by fluids or shear heating; and are exhumation histories diagnostic of the burial processes. He is also interested in addressing the fundamental processes that affect isotopic ages, including geological conditions that influence the mobility of isotopes, chemical factors that control the retentivity of minerals, diffusion mechanisms, and partitioning of isotopes between minerals.

Mineral Deposits

Mostafa Fayek, Anton Chakhmouradian, Alfredo Camacho, Stefanie Brueckner and others have research projects in areas relevant to mineral deposits, including studies of uranium, gold, kimberlite, rare earth, and massive sulphide deposits. **Mostafa Fayek**, for example, holds collaborative research grants with industrial partners aimed at understanding the mechanisms for uranium deposit formation in the Athabasca Basin and elsewhere.



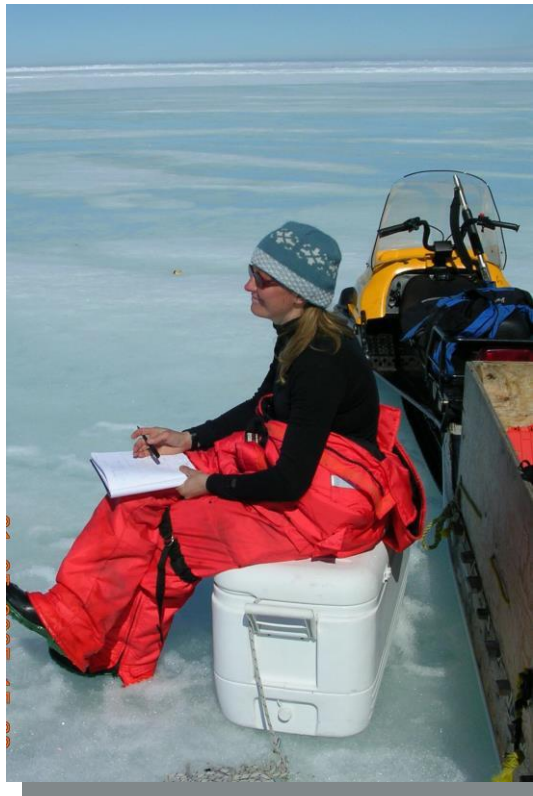
Field trip to Yellowknife and Diavik diamond mine

Marine and Freshwater Systems

An evolving area of research involves marine systems in the Arctic.

Zou Zou Kuzyk (below) studies the biogeochemical cycles of carbon and other elements in Arctic coastal and continental shelf areas, with an emphasis on how carbon cycling in these areas is impacted by environmental change, including changes on the land (e.g., river runoff and coastal erosion) and in the marine environment (e.g., sea ice cover and ocean currents). She uses marine sediment cores, together with a variety of geochemical tracers, including radioisotopes, stable isotopes, redox-sensitive elements and organic

proxies (e.g., lignin) for much of her work. She is also interested in tracing freshwater distribution using oxygen isotopes. She has worked on projects within ArcticNet (an Arctic Network of Centres of Excellence) and the Canadian International Polar Year (IPY) program, both in the Arctic Ocean and Hudson Bay.



Professors Emeriti and Senior Scholars

The retired staff members listed in this section are active in the Department in a variety of ways: supervising undergraduate theses and reports, outreach activities, and active research. They may be involved in graduate student supervision or advising (e.g., as a member of a thesis committee) but this is the exception rather than the norm.

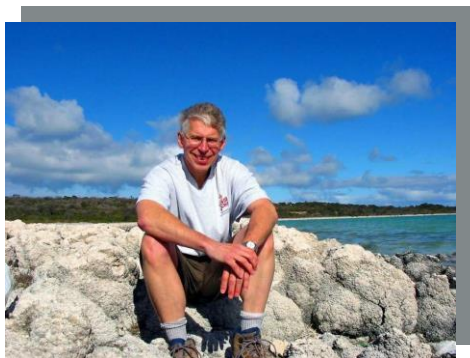
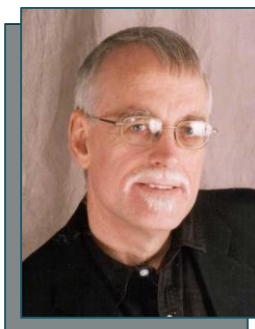


Robert Elias (left), Professor Emeritus, Ph.D. University of Cincinnati

Research interests: Coral faunas and environmental change during the great Ordovician biodiversification, end-Ordovician mass extinction, and Early Silurian recovery; Paleobiology of Ordovician corals and coral-like organisms; Paleoecological and paleoenvironmental reconstruction of Ordovician and Silurian units in Manitoba

Frank Hawthorne (right), Distinguished Professor Emeritus, Ph.D. McMaster University

Research interests: Crystallography and mineralogy; Architecture of crystal structures; Structural crystallography, particularly the solution of crystal structures of minerals, development of hierarchical schemes of structure architecture, application of crystal-structure refinement, mineral spectroscopy and microprobe analysis to problems in crystal chemistry; Bond topology and crystal structures



William Last (left), Professor Emeritus Ph.D. University of Manitoba

Research interests: Non-marine evaporite and carbonate sedimentology; clastic sedimentology and diagenesis; petrography, sedimentology and geochemistry of Mississippian and Jurassic sediments; sedimentology, stratigraphy, geochemistry of saline lakes (W. Canada and northern U.S.) and of organic rich rocks, western Manitoba; Quaternary paleolimnology of saline lakes in Australia

Wooil Moon (right), Professor Emeritus, Ph.D. University of British Columbia

Research interests: Satellite global geodynamics; microwave remote sensing theory and applications; satellite radar altimetry; geophysical application of synthetic aperture radar (SAR) and polarimetric SAR; geological and geophysical information fusion; GIS and spatial reasoning; global tectonics and geodynamics



Professors Emeriti and Senior Scholars (cont.)



Jim Teller (left), Professor Emeritus, Ph.D. University of Cincinnati

Research interests: Quaternary geology; paleohydrology and climatic impact of North American proglacial lakes and rivers; reconstruction and re-evaluation of shorelines and outlets in the glacial lake Agassiz basin; sedimentology and history of valley fills leading to glacial Lake Agassiz

George S. Clark, Senior. Scholar, Ph.D. Columbia University

Research interests: Isotope geology, geochronology

Elena Sokolova (right), Senior Scholar, Ph. D. & D.Sc Moscow State University

Research interest: Crystallography and crystal physics; Mineralogy of alkaline rocks; Crystal chemistry with emphasis on the silicate minerals; Isomorphism and topology of crystal structures; X-ray diffraction of new minerals and synthetic compounds



Most Cited Geoscientist

Named in Thomson Scientific as “the World’s most cited Geoscientist of the Decade 1997-2006”, Frank Hawthorne has garnered many honours. Among them: Officer of the Order of Canada (2006), the Carnegie Medal (2009), the Killam Prize in Natural Sciences (2008), and the Mineralogical Society of America’s Roebling Medal (2013).

Instructors

Instructors are not available for supervising graduate programs or serving on a thesis committee. However, they teach a number of advanced level undergraduate courses that may be available to graduate students and have frequently been involved in organizing and running field trips that include graduate student participation. They also provide important advice to graduate students on an informal basis.



Karen Ferreira , Instructor II, M.Sc. University of Manitoba

E-mail: karen.ferreira@umanitoba.ca

Research interests: Mineral exploration and technical communications



Russel Hiebert, Instructor I, Ph.D. University of Manitoba

E-mail: russel.hiebert@umanitoba.ca

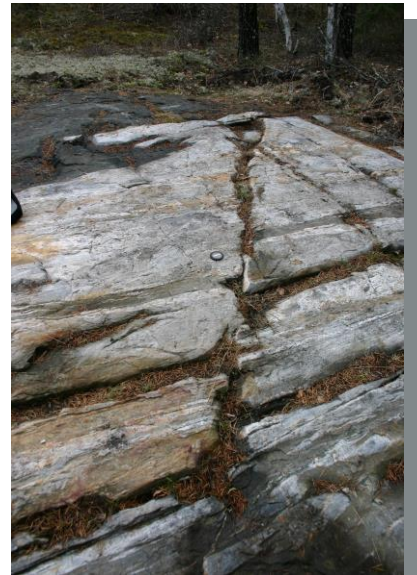
Research interests: Mineral deposits, igneous petrology, layered igneous intrusions, geochemistry



Mulu Serzu, Instructor I, M.Sc. University of Manitoba

Email: mulu.serzu@umanitoba.ca

Research interests: Geophysics



Jeff Young, Senior Instructor, M.Sc. University of Manitoba

E-mail: jeff.young@umanitoba.ca

Research interests: Structural geology



Potential Supervisors of Graduate Students



Kirstin Brink

- Vertebrate paleontology
- Histological analysis of bone and tooth microstructure
- Evolution and development of the dentition
- Paleoecology and diversification of synapsids and dinosaurs

Assistant Professor

Ph.D. University of Toronto

E-mail: Kirstin.Brink@umantioba.ca



Stefanie Brueckner

- Genesis of metamorphosed hydrothermal ore deposits using mineralogy, geochemistry and field methods
- Mineral chemistry, isotope chemistry, and lithogeochemistry of metamorphosed (precious metal-bearing) hydrothermal ore deposits
- Use of micro-analytical techniques (SEM, EPMA, LA-ICP-MS, SIMS) for applications in research and industry such as geochemical and mineral exploration
- Application of geochemical and mineral data in order to constrain the genesis of mineral deposits and to give indications regarding their tectonic setting
- Stable isotope geochemistry and its application to the genesis of hydrothermal ore deposits
- Method development of in situ techniques applied to the genesis of ore deposits
- Mineralogy and mineral textures of ore minerals and silicates

Assistant Professor

Ph.D. Memorial University of Newfoundland

E-mail: Stefanie.Brueckner@umanitoba.ca



Alfredo Camacho

- Heat distribution in the crust during orogenesis
- Genetic relationship between basin formation and orogenic activity
- Understanding earthquake activity in continental interiors and subduction settings
- Geochronology and diffusion rates of minerals: applying principles of diffusion to study geological processes and unravel thermal (T-t) histories of geological terranes

Professor and Head

Ph.D. Australian National University

Web-site: <http://home.cc.umanitoba.ca/~camacho/>

E-mail: alfredo.camacho@umanitoba.ca



Anton Chakhmouradian

- Economic REE, Nb and 3r deposits
- Igneous alkaline and carbonatitic rocks
- Magmatic and subsolidus processes in carbonatites and kimberlites
- Crystal chemistry of phosphates, titanates and titanosilicates
- Ti, Zr, Nb, and REE minerals in kimberlites, carbonatites, and alkaline igneous rocks

Professor

Ph.D. St. Petersburg State University

Web-site: http://www.umanitoba.ca/faculties/science/geological_sciences/faculty/arc/index.html

E-mail: Anton.chakhmouradian@umanitoba.ca



Nancy Chow

- Carbonate sedimentology
- Stratigraphy and sedimentology of Paleozoic carbonates in the outcrop belt and subsurface Manitoba
- Sedimentology of Devonian carbonates in the Alberta Basin and Canning Basin of Australia

Professor

Ph.D. Memorial University

E-mail: nancy.chow@umanitoba.ca



Paul Durkin

- Siliciclastic sedimentology and stratigraphy
- Processes and products of modern and ancient fluvial systems
- Application to oil and gas reservoir characterization

Assistant Professor

Ph.D. University of Calgary

Email: paul.durkin@umanitoba.ca



Mostafa Fayek

- Applications of Secondary Ion Mass Spectrometry (SIMS)
- Fluid-solid interactions at the atomic level including the mass transport of chemicals, elements and nutrients near the Earth's surface
- Environmental contamination and disposal of nuclear waste
- Sourcing and dating techniques of archeological artifacts
- Uranium and gold exploration

Professor

Ph.D. University of Saskatchewan

E-mail: Mostafa.fayek@umanitoba.ca



Ian Ferguson

- Application of magnetotelluric (MT) methods to define electrical resistivity and tectonic structure of the crust and lithosphere, especially in Precambrian terranes in Canada
- Surface controlled-source EM at the Aquistore CO2 sequestration site
- MT surveys to aid the modeling of GICs, electric currents induced on powerlines and pipelines during geomagnetic storms

Professor

Ph.D. Australian National University

E-mail: ian.ferguson@umanitoba.ca



Andrew Frederiksen

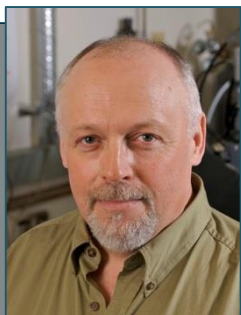
- Seismic imaging and methods
- Geophysical computation and inverse theory
- Applications of inverse theory to seismic imaging and tomography
- Lithospheric tectonics and continental roots
- Anisotropic fabric in the crust and mantle

Professor and Associate Dean, C.H. Riddell Faculty of Environment, Earth and Resources

Ph.D. University of British Columbia

Web-site: <http://home.cc.umanitoba.ca/~frederik/>

E-mail: Andrew.frederiksen@umanitoba.ca



Norman Halden

- Geochemistry and petrology of magmatic systems
- Chemical zoning in Earth materials
- Analysis of trace element partitioning between minerals and trace element distribution within minerals
- Non-linear modeling of trace element zoning patterns
- Image analysis of mineral textures and rock fabrics
- Otolith microchemistry

Professor and Dean, C.H. Riddell Faculty of Environment, Earth, and Resources

Ph.D. University of Glasgow

Web-site: <http://home.cc.umanitoba.ca/~halden/halden.html>

E-mail: norman.halden@umanitoba.ca



Zou Zou Kuzyk

- Impacts of environmental change on Arctic coastal and continental shelf areas
- Terrigenous organic matter in marine sediments: sources, pathways and sinks
- Sedimentation processes in Arctic coastal and shelf environments
- Diagenesis of redox-sensitive elements
- Freshwater sources and pathways in the coastal ocean
- Land-ocean interactions and the marine nutrient cycle
- Pathways and fate of contaminants in the Arctic Ocean

Associate Professor

Ph.D. University of Manitoba

Web-site: <http://umanitoba.ca/faculties/environment/departments/ceos/people/zkuzyk.html>

E-mail: ZouZou.Kuzyk@umanitoba.ca



Michael Schindler

- Environmental nanoscience
- Nano-Mineralogy
- Contaminants in soils and water
- Bio-mineralogical processes in Soils and Arctic Ice

Professor

Dr. rer Nat. Johann Wolfgang Goethe-Universitat, Frankfurt, Germany

E-mail: Michael.Schindler@umanitoba.ca



*Churchill River, northern Manitoba.
Photo: Graham Young, Professional Affiliate*

Adjunct Professors

Adjunct professors are actively engaged in research activities, often working collaboratively with full-time faculty members. They can serve as co-supervisors of graduate students or on thesis committees.

Genevieve Ali, Ph.D. Université de Montréal

Dr. Ali is an Associate Professor at the University of Guelph. Her expertise include hydrological sciences, water-sediment-nutrient connectivity, phosphorus dynamics in soils, geochemical tracer studies, hydrometric data and water quality monitoring, and environmental modelling.

Scott Anderson, Ph.D. Dalhousie University

Dr. Anderson is a Chief Geologist, Precambrian Geoscience with the Manitoba Geological Survey. His interests include structural geology, mineral deposits and Precambrian geology. His investigations with the Manitoba Geological Survey range from detailed to regional-scale projects. A recently initiated project focuses on the Au metallogeny in the Jeep property, Manitoba.

Andrey Bekker, Ph.D. Virginia Polytechnic

Dr. Bekker is an Associate Professor at the University of California, Riverside. Andrey's research includes: climate changes in the deep past; chemical composition of the atmosphere and ocean and the link with global tectonics; ocean redox state in the Precambrian, C, S, and Fe cycles; first appearance of marine sulfate evaporates; sedimentary mineral deposits; stable isotope geochemistry. Andrey is a former Associate Professor in Geological Sciences, University of Manitoba.

Christian Böhm, Ph.D. ETH Zurich



Dr. Böhm is Chief Geologist, Precambrian Mapping Section with the Manitoba Geological Survey. His expertise is in the field of Precambrian geology, isotope geology, geochronology, and their applications in geological studies. He has also been involved with diamond and uranium support in his position with the Manitoba Geological Survey. His career has spanned work in industry, government and academia.

Julie L. Brown, Ph.D. Australian National University

Dr. Brown is a Geoscience Assessment Officer at the Canadian Nuclear Safety Commission, Environmental Risk Assessment Division. Technical lead (for CNSC geoscience) on Canada's plan for the long term management of high level radioactive waste from nuclear power plants, includes reviews of deep geological repository plans and research reports.

Fiona Darbyshire, Ph.D. Université du Québec à Montréal

Dr. Darbyshire is a Professor in the Department des sciences de la Terre et de l'atmosphère at Université du Québec à Montréal. Her area of research is earthquake seismology, with an emphasis on lithospheric structure and dynamics. She is skilled in a wide range of techniques, from surface- and body-wave tomography to receiver functions and shear-wave splitting analysis.

Ryan (R.J.) Galley, Ph.D. University of Manitoba



Dr. Galley studies the physical properties and processes that occur in Arctic sea ice and snow, with the view to their role in modifying the exchange of climatically active gases between the ocean and atmosphere in polar oceans. In particular, his research program focuses on methodological development for the purpose of improving the characterization of sea ice crystallography, as well as the morphology and change in the liquid and gaseous inclusions in sea ice. The evolution of brine in sea ice and snow, both in time and space, in the context of the controls on its presence and movement is of critical

interest. This work is completed in laboratory microcosms, at the University of Manitoba's Sea ice Experimental Research Facility (SERF) and in the Arctic of Canada and Greenland under the auspices of the Arctic Science Partnership (asp-net.org). He is a Network Investigator in ArcticNet (phase IV, 2015- 2018) and holds an NSERC Discovery Grant (2015-2020).

Michel Houlé, Ph.D. University of Ottawa

Dr. Houlé is a research geoscientist with the Geological Survey of Canada. He specializes in the petrology, volcanology, and geochemistry of mafic to ultramafic igneous rocks and in economic geology. His particular areas of expertise are magmatic sulphide deposits (komatiite-associated Ni-Cu-PGE deposits and Cr-PGE layered intrusions). Prior to joining the Geological Survey of Canada, he was a senior geoscientist with the Ontario Geological Survey/ Ministry of Northern Development and Mines.

Gregory McCullough, Ph.D. University of Manitoba

Dr. McCullough is a Research Associate at the Centre for Earth Observation Science (CEOS) at the University of Manitoba. His expertise is in the earth surface processes including fluvial and glacial geomorphology, soil science, sediment transport, and sedimentation, and experience in northern Manitoba settings. He is an active collaborator on the BaySys project as well as projects funded under the ArcticNet Network of Centres of Excellence.

Urs Neumeier, Ph.D. Université du Québec Rimouski

Dr. Neumeier is a Professor in Marine Geology at Institut des sciences de la mer de Rimouski (ISMER), Université du Québec Rimouski. His research at ISMER focuses on sediment dynamics in the coastal marine environment and estuaries, with extensive work taking place in the Gulf of St. Lawrence and other seasonally ice-covered seas.

David Quirt, Ph.D. Carleton University

Dr. Quirt is a geoscientist with expertise in mineral exploration in uranium, and a variety of other commodities including diamonds, gold, base metals, and Rare Earth Elements. His research interests are in uranium deposit metallogenesis, geochemistry (lithogeochemistry and isotope geochemistry), and clay mineral alteration processes.

Christopher Spence, Ph.D. McMaster University

Dr. Spence is a Research Scientist with Environment Canada, National Hydrology Research Centre, in Saskatchewan. His expertise is in the hydrology and hydrometeorology of Canada's cold regions, especially the subarctic Canadian Shield, as well as hydrological processes in the Prairie Pothole region of Saskatchewan. He has also conducted research in the Experimental Lakes area of northern Ontario on the manipulation of headwater hydrology.

Gary Stern, Ph.D. University of Manitoba

Dr. Stern is a Professor in the Centre of Earth Observation Science (CEOS) at the University of Manitoba. His area of expertise is in the fields of organic geochemistry and petroleum chemistry. He is the Director of UM's Petroleum Environmental Research Laboratory (PETRL).

Professional Affiliate

Graham Young, Ph.D. University of New Brunswick



Dr. Young is the Curator of Geology and Paleontology at The Manitoba Museum and is actively involved in the department as a co-supervisor of graduate theses and as a contributor to and collaborator in research. His research interests involve: invertebrate paleontology, systematic, biogeography and paleoecology of fossil corals and associated organisms, modeling of colony growth.

Giants among us!

Robert Elias, Professor Emeritus and Graham Young (Professional Affiliate at the U of Manitoba and Geology and Paleontology Curator with The Manitoba Museum) led a project that resulted in the discovery in northern Manitoba of the world's largest trilobite. The fossil is on display in The Manitoba Museum and a replica may be also be viewed in the Cretaceous Menagerie, Wallace Building, University of Manitoba.

Research Facilities

The Department is uniquely equipped with analytical facilities that support the research of faculty members and graduate students. Access to these facilities is coordinated through the student's thesis advisor.

Ar-Ar Laboratory

- ARGUS VI gas mass spectrometer with five faraday cups and one electron multiplier
- Noble gas preparation system for purification of complex gas mixtures
- Analyte.193 ultra short pulse excimer laser ablation system
- CO₂ laser system for total fusion analysis
- Ultra-high vacuum sample cell for geochronology

Secondary Ion Mass Spectrometry (SIMS)



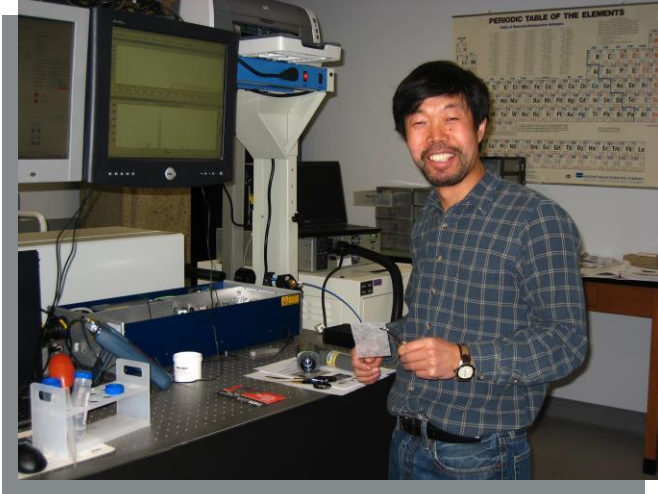
Ryan Sharpe, Manager, SIMS Lab

- CAMECA IMS 7f SIMS for trace element determination, isotopic measurements and depth profiles
- Capabilities:
 - Quantitative analyses on selected material based on the availability of standards
 - Stable isotopes H, C, O, S, Cu
 - U-Th-Pb geochronology-U minerals
 - Depth profiling
 - Ion imaging
 - Archeology, provenance studies, hydration dating



Kevin Jones, MSc student, in the SIMS Lab

Microbeam and Image Analysis Laboratory



Panseok Yang, Manager, LA-ICP-MS Lab

The Microbeam Facility in Geological Sciences is set up as a regional facility to serve the needs of universities, industry and government institutions with an electron microprobe and LAM-HR-ICP-mass spectrometer, and a scanning electron microscope and image analysis system, and includes the following equipment:

- CAMECA SX100 electron microprobe with PGT EDS and 5WDS spectrometers equipped with windows based operating system
- Thermo-Finnigan Element 2 HR-ICP-MS with New Wave UP213 nanosecond and Quantronix Integra-C femtosecond laser ablation system
- FEI Inspect S50 Scanning Electron Microscope with back-scattered electron (BSE), secondary electron (SE), and EDAX energy-dispersive X-ray (EDX) detectors
- Relion cathodoluminescence imaging system
- Fluid inclusion stage

Spectroscopy Laboratories

- Jobin-Yvon Horiba LabRam Aramis Raman microspectrometer:
This instrument utilizes inelastic scattering of monochromatic light to obtain structural information about solid, liquid and gaseous materials. Its versatile design allows for a wide range of samples to be analyzed, including minerals, gemstones, glasses, fluid inclusions, archeological artifacts, solutions, and tissue samples. The microspectrometer is fully confocal, equipped with three lasers and a motorized stage, and is capable of measuring Raman spectra with a spectral resolution better than 1 cm⁻¹ at a lateral spatial resolution better than 1 micron. The instrument is used routinely in geological research for material fingerprinting (rapid identification), quantitative characterization of minerals containing Raman-active molecular species, and inclusion studies.
- Bruker Tensor 27 FTIR with Hyperion 2000 IR Microscope including IR polarizers, horizontal ATR attachment, low-pressure diamond anvil cell for single-xtl IR and a Spex X-Press 35 ton hydraulic pellet press.

X-Ray Diffraction Laboratories



Mark Cooper, Manager, X-Ray Diffraction Lab

- Bruker Apex II Ultra TXS single-crystal diffractometer with a 6kW rotating anode (Mo) x-ray generator, HELIOS Mo x-ray optics, SMART APEX II CCD area detector, low pressure diamond anvil cell and both high- and low-temperature attachments
- Bruker P4 four-circle single crystal diffractometer on a 3kW sealed-tube (Mo) x-ray generator with SMART APEX CCD area detector
- Bruker D8 Discover TXS micro-powder diffractometer with a 6kW rotating anode (Cu) X-Ray generator, extremely fine beam collimation optics, an X-Y-Z sample stage with attached phi-rotation stage, laser/video sample alignment and a Hi-Star 2D area detector
- Siemens/Bruker D5000 powder diffractometer with rotating sample holder, graphite monochromator, scintillation detector and a 3kW sealed-tube (Cu) x-ray generator
- A broad assortment of crystallographic and mineralogical software (eg. MDI JADE+, SHELXTL, ATOMS, SHAPE, MIN-IDENT, etc.) as well as licensed databases (eg. ICDD PDF-4, ICSD, etc.) and including molecular mechanics and molecular dynamics software
- Single-crystal optics setup consisting of a Nikon E-600 POL polarizing microscope with photo capability, assorted bandpass filters, Supper spindle stage and Cargill refractive index oils ranging from 1.400 – 1.800
- Full sample preparation facilities including Nikon binocular microscopes, Leitz optical microscope, precision balances, Buehler Isomet Low speed saw, Buehler Isomet 1000 Precision saw, Buehler MetaServ 2000 Grinder/polisher, Buehler HandiMet II Roll grinder, Mitutoyo precision thickness measuring device, etc.

Invertebrate Paleontology Laboratory

- Stereoscopic and petrographic microscopes
- Cameras and accessories for photomicrography and macrophotography
- Computers, scanners, printers
- Sample preparation room with saws, grinders, and a thin section machine.

Sedimentological, Petroleum Geology, and Quaternary Studies Laboratories

- Automated size analyzers (Sedigraph and Galai PSA Laser 2010)
- RoTap sieve shaker, Soil-Test sieve shaker
- Drying ovens, muffle furnaces
- Nikon epi-fluorescence microscope
- Mettler analytical balances
- Fisher Accumet pH-Eh meters
- Carbonate analyzer, centrifuges, water chemistry field analytical kits, conductivity meters, specific ion electrodes
- Galai Image Analysis system (IAS) with colour and monochrome monitors, video camera, digitizing tablet, and statistical and GIS software

Watershed Research Facilities and Equipment

- Field work facilities and equipment: weather stations, river flow recording instrument, groundwater fluctuation recording instruments, automatic water samplers.
- Wet chemistry lab for water quality analysis

Geochemistry Laboratory

- Wet chemical laboratory fully equipped for sediment, rock and mineral analyses
- Mitsubishi CA-06 moisture meter with a VA-21 high temperature furnace
- Leco induction furnace sulphur analyzer
- Accumet 950 specific ion analyzer

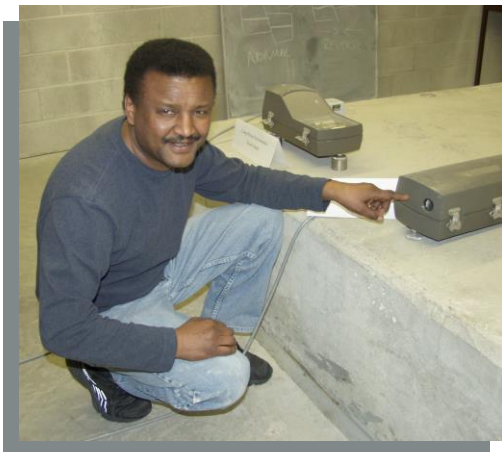


Misuk Yun, Manager, Geochemistry Lab

Stable Isotope Mass Spectrometry Facilities

- Thermo Finnigan Delta V Plus IRMS coupled to GasBench II (with PAL system and heating block), Costech ECS 4010 EA (with Zero-Blank autosampler: mainly for C and N analysis) and Thermo Finnigan TC/EA (with Zero-Blank autosampler)
- Thermo Finnigan Delta V Plus IRMS coupled to Costech ECS 4010 EA
- Thermo Finnigan ConFlo III and Conflo IV open-split interfaces
- Sartorius CP2P microbalance
- New Wave Micromill Sampling System
- Sample preparation facilities including water saws, grinders, polishers, pulverizers, furnaces, ovens, and pipettes
- Extensive rock collection of Precambrian carbonates, black shales, and iron formations

Geophysical Laboratories



Mulu Serzu, Geophysics Instructor

- Larger-scale research geophysical instrumentation includes a 7-instrument broad-band portable seismograph facility, a 3-component down-hole seismic system, and a Geonics PROTEM47 time-domain EM system
- Smaller-scale equipment including EM31, EM34, and EMP400 profiler instruments, a Geonics PROTEM47 time-domain EM Syscal DC-resistivity system, Geometrix GEM magnetometer-VLF system, Scintrex magnetic susceptibility meter, Exploranium gamma-ray spectrometer, GSSI Ground Penetrating Radar system Worden gravimeter, and Geometrics hammer seismograph
- Computing facilities including WinGLink magnetotelluric software, VISTA 2D seismic processing software, OASIS Montaj geophysical processing and display package, earthquake data processing software.
- Seismograph station with 3-component long-period and 3-component short-period seismometers, amplifier system, and helicorder display.

Departmental Field Station and Museums

Star Lake Field Station

The Geological Sciences Star Lake Field Station is approximately 170 km southeast of Winnipeg in the Precambrian Shield. The facility:

- is the base for undergraduate Geology and Geophysics field courses.
- has kitchen facilities, classroom buildings, bunkhouses.
- is available as a base for research projects via a graduate student's faculty advisor.



Ed Leith Cretaceous Menagerie



Opened in 2003, the Menagerie is a spectacular gathering place for students and visitors to the Wallace Building. Located in the main foyer of the building, the Menagerie contains four spectacular skeletal replicas of gigantic creatures of the Cretaceous Period as well as several interpretative panels. The gallery is dedicated to Ed Leith who taught in the Department from 1935 to 1971 and who continued to contribute to outreach, archival collections, and paleontological research during his long tenure as an Emeritus Professor.

Robert B. Ferguson Museum of Mineralogy

The museum contains more than 7500 mineral samples donated to or purchased by the Department of Geological Sciences over the last hundred years. A large number of the specimens are exhibited in cabinets in the Cretaceous Menagerie with the remaining samples displayed in cabinets lining the corridor of the main floor of the Wallace Building. The facility is named for Professor Emeritus Robert Ferguson who was instrumental in establishing the museum and who led the mineralogical and crystallographic research in the Department through three decades of rapid growth to its present level of international excellence.



Below: Some recent donations to the Mineralogy Museum (From left: Cuprite, Mesolite, Beryl)



Program Requirements

M.Sc. Program

- Minimum of 2 courses (6 credit hours) at the graduate (7000-) level, including GEOL 7200 - Earth Systems of Central Canada
- Completion of GEOL 7760 Seminar in the Geological Sciences (3 credit hours)
- Completion of an acceptable research project and thesis
- Projected time to completion based on full-time study: 2 years

Ph.D. Program

- Minimum of 4 courses (12 credit hours) beyond the M.Sc., including GEOL 7200 - Earth Systems of Central Canada, unless taken previously
- Completion of GEOL 7760 Seminar in the Geological Sciences (3 credit hours)
- Completion of an acceptable research program and thesis
- Successful completion of the Candidacy Examination
- Projected time to completion (based on full-time study): 4 years

Geological Sciences Course Descriptions: Course offerings will vary from year to year please consult with your advisor.

(Each course is 3 credit hours)

GEOL 7200 - Earth Systems of Central Canada

An overview of the Earth structure, bedrock geology, surficial geology and hydrology of Manitoba and adjacent regions from an Earth systems perspective; and the occurrence and development of mineral, petroleum and water resources. Prerequisite: enrolment in a M.Sc. or Ph.D. program, and permission of department.

GEOL 7230 Geophysics of the Earth's Crust and Mantle

Processes in crust-mantle evolution and geophysical methods used to study this region of the earth. Prerequisites: (GEOL 4320), and (GEOL 4330).

GEOL 7310 Quaternary Geology

Seminars and lectures on sedimentary aspects of the Quaternary Epoch with emphasis on glaciation. The glacial and interglacial stratigraphic record on the continents and in the ocean basins. Three-day field trip in mid-September. Prerequisites: (GEOL 3490), and (GEOL 3900).

GEOL 7350 Remote Sensing in the Earth and Planetary Sciences

Selected topics in remote sensing with emphasis on geophysical and geologic problems. Prerequisite: B.Sc. (Honours Geology, Geophysics, or Geological Engineering), or permission of instructor for graduates of other disciplines.

GEOL 7470 Advanced Petroleum Geology and Geochemistry

Lectures and seminars examining the four major components of petroleum geology: source and migration, reservoir, trap, and economics. Major emphasis on the origin and generation of petroleum and source rock geology. Field trip and core logging required.

GEOL 7480 Advanced Seismology 1

Theory of wave propagation; source mechanisms; other selected topics. Prerequisite: GEOL 7260.

GEOL 7490 Advanced Seismology 2

Seismic surface waves and normal modes of Earth, Earth tides and dynamic evolution. Prerequisite: GEOL 7480 or equivalent.

GEOL 7540 Isotope Geology and Geochronology

The principles and methods of isotopic age determination and the measurement of geological rate processes using certain radioactive nuclides and the variations of the isotopic compositions of their daughter products. The evolution of the earth's mantle, continental and oceanic crust. The application of light, stable isotope fractionation to understanding geological processes.

GEOL 7550 Hydrothermal Petrochemistry

The chemistry, mineralogy, and petrology of mineral deposits and alteration zones of the hydrothermal type, and their association with igneous and tectonic events. Theory and experimental data on metasomatic processes.

GEOL 7590 Advanced Paleontology 1

Topics in paleobiology of the invertebrates, and principles of paleontology. Upon request, course may be adapted to individual requirements of students in other disciplines (for example, specific groups of invertebrates, paleoecology, trace fossils, etc.). Prerequisites: (GEOL 3310), and (GEOL 4310), or permission of instructor.

GEOL 7600 Advanced Paleontology 2

Topics in paleobiology of the invertebrates, and principles of paleontology. Upon request, course may be adapted to individual requirements of students in other disciplines (for example, specific

groups of invertebrates, paleoecology, trace fossils, etc.).

Prerequisite: GEOL 3310, or GEOL 4310, or permission of instructor.

GEOL 7700 Advanced Clastic Sedimentology

Lectures and seminars on clastic depositional environments. Critical evaluation of accepted facies models followed in each case by examination of the ancient record. One week field trip and core logging required. Prerequisite: GEOL 3900, or permission of instructor.

GEOL 7720 Geophysical Imaging and Data Processing

Advanced frequency filter design; deconvolution methods for seismogram; velocity and wavefield stacking; various digital methods for potential field data; principles of tomography and geophysical imaging techniques. Prerequisites: (GEOL 3740), and GEOL 7260, or permission of instructor.

GEOL 7740 Workshop in the Geological Sciences 1

Critical, in-depth group study of problems and new concepts in the geological sciences; discussion of current research by staff and visiting scientists; students will pursue individual research interests and will work with staff on specific topics.

GEOL 7750 Workshop in the Geological Sciences 2

Critical, in-depth group study of problems and new concepts in the geological sciences; discussion of current research by staff and visiting scientists; students will pursue individual research interests and will work with staff on specific topics.

GEOL 7760 Seminar in Geological Sciences

A discussion of topics of current interest from the whole spectrum of geological sciences to inform students on research work outside their specialty. Required of all graduate students. For ancillary credit only. Geological Sciences Colloquium. Weekly discussion of topics of current interest. Presentation of recent research from geological literature, the department, and visitors. Required of all graduate students who have received credit for GEOL 7760.

GEOL 7780 Advanced Carbonate Sedimentology

Lectures and seminars on selected topics of carbonate sedimentology, including depositional environments, lithofacies sequences and diagenesis. Prerequisite: GEOL 3900, or permission of instructor.

GEOL 7790 Advanced Instrumental Techniques in Geology

Lectures and laboratory course covering the application of microbeam, mass spectrometer, diffraction and wet geochemical analytical techniques in mineralogy and geochemistry. Includes coverage of ICP, PIXE, powder and single crystal diffraction and electron microprobe analysis.

GEOL 7810 Electromagnetic Methods in Geophysics

Examination of the theory and application of electromagnetic methods in geophysics. Topics include: electrical properties of earth materials, review of EM methods, EM theory for layered media, EM responses of simple structures and case studies.

GEOL 7820 Environmental Geophysics (3 credit hours)

Examination of the application of geophysics to environmental targets. Topics will vary according to student interest and may include aspects of new-surface geophysics, engineering geophysics, geophysics of global climate change and geophysical risk assessment.

Program Fees and Useful Links

Fee information: Registrar's Office: <http://umanitoba.ca/student/records/fees/988.htm>

International Entrance Scholarship: The Faculty of Graduate studies has International Graduate Student Entrance Scholarships (for students coming into the first year of graduate studies), as well as Graduate Student Scholarships (for returning Ph.D. students who are proceeding to their second year). These scholarships effectively eliminate the fee differential for qualified students.

Information on these scholarships and minimum academic background to be eligible:

http://umanitoba.ca/faculties/graduate_studies/funding/international.html

Health and Dental Plans: Basic health care coverage is required for international students, and the MISHP program has been developed for international university students in the province.

http://umanitoba.ca/research/international_centre/health_coverage_faq.html

In addition, all students who are not covered by a supplemental coverage plan must enrol in the UMSU Health and Dental Plan:

<http://umanitoba.ca/student/bannatyne/umsu-health-dental.html>

Relocating to Winnipeg: International Centre for Students, University of Manitoba:

http://umanitoba.ca/faculties/graduate_studies/admissions/international.html

Housing and Student Life: <http://www.umanitoba.ca/student/housing/>

Living in Winnipeg: <http://www.tourismwinnipeg.com/things-to-do>

UM Graduate Students Association: <http://www.umgsa.org/>



Grad and undergrad students and staff: Field Trip to the Colorado Plateau

Thinking of Applying to our Graduate Program?

The most up-to-date information on requirements for admission and on application procedures is available from the Faculty of Graduate Studies web-pages: http://umanitoba.ca/faculties/graduate_studies/

Minimum Academic Background

M.Sc. Program

Generally, you should hold a four-year Bachelor of Science in geology or geophysics or a closely related field. Students with honours degrees in related disciplines (such as Geography, Soil Science, Biology, Chemistry, Environmental Science, Physics, Mathematics, Engineering Physics, and Geological, Civil and Electrical Engineering) may be accepted by the Graduate Admissions Committee providing their planned degree program involves studies in the geological sciences. The majority of the required courses taken by the student should normally be from the Department of Geological Sciences. The research should also be in the geological sciences.

Minimum grade requirements are noted in the Faculty of Graduate Studies web-pages under “Admission Information”.

Ph.D. Program

Successful completion of an approved M.Sc. program in a related discipline. In certain circumstances, students registered in a M.Sc. program may be allowed to transfer to a Ph.D. program without completing the M.Sc. degree. Minimum grade requirements are noted in the Faculty of Graduate Studies web-pages under “Admission Information”.

IMPORTANT: When applying to a graduate program, keep in mind that a position must be available in a research project and the prospective faculty supervisor must have funding to support the student and the research. There are often a number of highly qualified applicants wanting to work with a particular supervisor or in a particular area of research. Therefore, the application process is competitive and meeting minimum standards for admission does not guarantee a successful application.

Students who have contacted a prospective supervisor and who have received an encouraging response increase their chances of a successful application. Ensure that your inquiries are clear and well-written, that you have demonstrated a knowledge of the supervisor’s research, and that you include salient points (e.g. academic qualifications, relevant work experience and publications). If a particular supervisor has been recommended to you by a faculty member at another institution, mention this early in the e-mail. Keep in mind that we receive hundreds of inquiries annually. If, after several attempts, you do not receive a response, it is a good indication that the prospective supervisor is not interested in accepting another graduate student at this time.

Application Process and Required Documentation (ALL Applicants)

Apply on-line to the Faculty of Graduate Studies, using the UM GradConnect system:

http://umanitoba.ca/faculties/graduate_studies/admissions/index.html

Documentation requirements are noted here:

http://umanitoba.ca/faculties/graduate_studies/admissions/required_docs.html

Your application will be reviewed by the Department of Geological Sciences Graduate Admissions Committee as soon as the following are received:

- **A completed application form and remittance of the application fee.**
- **Three (3) Letters of Reference are required by the Department of Geological Sciences.** Your referees may load the letters directly to the GradConnect system.
- **Unofficial transcripts** (uploaded by the applicant) are sufficient for the review process. However, all students accepted to the graduate program will be required to submit official transcripts from all colleges and/or universities previously attended, prior to registration in the graduate program. Specific instructions on what constitutes an “official” transcript may be viewed on the web-site noted above. If the document is in a language other than English, the applicant must arrange for official translations.
- **A short summary of research interests (approx. 500 words) is required of applicants to Geological Sciences.**
- **A brief statement to indicate that you have a major external grant or scholarship support, OR, that you require departmental financial assistance.**

Additional Documentation Specific to International Applicants

- A successfully completed English Language Proficiency Test from the [approved list](#) is required of all applicants unless they have received a high school diploma or university degree from Canada or one of the countries listed on the [English Language Proficiency Test Exemption List](#).
- Submission of a Graduate Record Examination (GRE) score is optional for applications to the Department of Geological Sciences.

FAQ's and problems with on-line application:

http://umanitoba.ca/faculties/graduate_studies/admissions/admissions_faq.html

Still searching for an answer?

If you've "done your homework" and still have a question:

Graduate Student Coordinator
Clayton H. Riddell Faculty of Environment, Earth, and
Resources
(204) 474-6183
E-Mail: Riddell.Graduate@umanitoba.ca

Zou Zou Kuzyk
Associate Professor and Graduate Chair
Department of Geological Sciences
(204) 272-1535
E-Mail: Zou ZouZou.Kuzyk@umanitoba.ca

