Mitacs Globalink 2021 Project Submission

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Project Information

Project ID	**22797**
Project Title	**Geological hazards associated with the Niagara Escarpment, southern Ontario**
Project Status	**Submitted**
Number of openings	**2**
Preferred Student's Academic Background	**Engineering, Earth Science, Geology, Engg-Environmental, Environmental Studies, Geomatics, Soil Science, Surveying**
Preferred internship start date	**2021-05-31**
Start Date is Flexible	**Yes**
Languages	**English**

If the project requires that the intern speaks a language in addition to English or French in order to conduct the research, please specify the language(s):

Please provide a brief description of your specialized research area:
I am a structural geologist focusing on deformation processes, and associated hazards as well as natural resources. Much of my research focuses on the structural, tectonic and magmatic evolution of rifted margins but I also work on geological hazards. My work to date has largely focused on the continental margins of the North Atlantic and surrounding regions, but I also work on projects focused on the continental interiors such as the causes of intraplate seismicity and magmatism. My work requires a multifaceted approach incorporating field-, computer, and lab-based studies.

Please provide a brief description of the research project:
The Niagara Escarpment is an ~1,000 km long discontinuous bedrock ridge that comprises a sequence of Palaeozoic sediments in Eastern North America. It runs from western New York near Niagara Falls, through southern Ontario and Michigan into eastern Wisconsin. In Hamilton in southern Ontario, the Niagara Escarpment bisects the city of Hamilton. Although this geological feature holds significant cultural and aesthetic value in the Hamilton area as part of the urban environment, it is prone to instability and collapse with the potential for damage to infrastructure and possibly human health. Numerous substantial recent and historic collapse events have been documented in the city. Collapses

largely affect access roads to the topographically higher 'Mountain' part of the Hamilton. The major controls on the stability of the Niagara Escarpment are yet to be established and constrained, including the roles of the highly variable sedimentary facies and fracture networks. Moreover, the role of climate change induced warmer, wetter winters upon erosion and stability is currently unknown. As such, the aim of this project is to unravel the mechanisms leading to instability of the Niagara Escarpment and use these to inform mitigation strategies for this geohazard. This project provides the opportunity to makes use of an extraordinary, and widely accessible geological feature, the Niagara escarpment, to collect data which can be used as an analogue for hydrocarbon and groundwater reservoirs.

Please describe the required skills/background of the student:

This project is intended for Geology/Earth Science students, and those interested in structural geology, geohazards, and geological engineering are particularly encouraged to apply. The project will include two components: 1) field-based data collection and 2) computer-based analysis and modelling. The field-based component will require geological mapping skills, with a focus on gathering accurate and representative structural data from complex fracture patterns. The computer-based component will utilise MOVETM, Google Earth and ArcGIS, and thus previous experience conducting research using these packages is desirable. This experience could either be in the form of taught courses or independent project and work experience.

Please describe the required role of the student:

The student will undertake both field and computer-based research. Fieldwork will be completed on outcrops in proximity to the city of Hamilton, Ontario and computer-based analysis will be undertaken at the McMaster University Campus, also in Hamilton. In the field the student will gather structural data from fractures on the escarpment. Specifically, the student will gather orientation, aperture, connectivity, and intensity measurements. This will largely be achieved using a compass-clinometer in the field. In addition, there will likely be the opportunity to incorporate drone work to gather data from inaccessible outcrops, as well as monitoring of stability using a DGPS (Differential Global Positioning System). The student will also be expected to gather lithological data, particularly when it pertains to fractures. For example, detailed description of fractures mineralisation will be required in the field, and subsequently using thin sections. The role of the student during the 2nd part of the project will be to undertake a computer-based analysis of the field results. This will include plotting the acquired data on stereonets and rose diagrams. The analysis will focus on comparing fracture stability at sites with different environmental conditions (e.g. altitude, exposure, aspect) and lithology. Locations in proximity to essential infrastructure such as highways will receive particular attention during this analysis. Then using the MOVETM structural geology software suite by Petroleum Experts, the stability of the fractures will be modelled under different stress regimes and fluid flow conditions. This will be achieved using a discrete fracture network (DFN) approach, allowing fluid flow through the DFN to be modelled to investigate its role in erosion and stability of the Niagara escarpment. Finally, the student will be expected to combine the results obtained through all the approaches into a written report with the intention that this work will contribute towards future publications.

Activities

Please indicate how frequently the Globalink Research Intern will be engaged in the following activities during their research internship:

Analyzing data or information:

Always

Conducting surveys or administering questionnaires:
Never

Conducting interviews:
Never

Creating drawings, models, or designs:
Very often

Gathering information from archives, published works, documents, or recordings:
Very often

Making observations outside of a laboratory or controlled environment:
Always
Please describe the protocols in place to ensure the safety of the student and success of the project:
In the field the student will follow the McMaster University fieldwork protocols and adhere to a strict health and safety policy.

Performing controlled experiements:
Never

Programming, scripting, or coding:
Almost never

Reading research literature:
Very often

Solving mathematical problems:
Often

Using hand or machine tools, laboratory equipment, or scientific instruments:
Often
Please describe the protocols in place to ensure the safety of the student and success of the project:

In the field the student will follow the McMaster University fieldwork protocols and adhere to a strict health and safety policy.

Writing reports:
Very often

Meeting or discussing with the supervisor:
Always

Working on tasks that require teamwork:
Always

Locations

Will the entirety of the research project take place at the university campus location indicated in your Profile?
No
In what province or town will the research take place?
Ontario
In what city or town will the research take place?
Hamilton
Will this location be the primary internship location?
No

Additional Comments

If you have any additional comments, please provide them here:

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