Mitacs Globalink 2021 Project Submission

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Project Information

Project ID	**22794**
Project Title	**Causes and consequences of neotectonic deformation and seismicity in Eastern Canada**
Project Status	**Submitted**
Number of openings	**2**
Preferred Student's Academic Background	**Geology, Earth Science, Geography, Engg-Environmental, Geomatics, 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 present-day deformation and seismicity of continental lithosphere are characterised by a dichotomy between plate boundary zones and the more stable continental interior regions, also known as intraplate settings. Intraplate settings typically experience low rates and magnitudes of seismicity, with deformation typically concentrated into ancient plate boundary zones. However, large earthquakes within stable continental regions show that significant amounts of elastic strain can be released on geological structures far from plate boundary faults. Due to the lower strain and seismicity rates intraplate settings are often more problematic to measure and thus characterise. In addition, intraplate earthquakes can occur in

regions with no previous seismicity and no surface evidence for strain accumulation. Neotectonic seismicity need not repeat since the tectonic loading rate is close to zero. Therefore, concepts of recurrence time or fault slip rate do not apply. An example of such an intraplate, seismically active region is in Eastern Canada, extending along the St. Lawrence into the Lake Ontario region. This seismicity has been suggested to be highly controlled by reactivation of older pre-existing structures. However, their exact role of structural inheritance remains unknown, as well as how extensive neotectonics activity is. In addition, it is currently unclear how much of the seismicity is controlled by glacial isostatic rebound and how much is from tectonic processes. This work seeks to answer these questions through new field-based studies near Toronto, Ontario. In particular, the project will investigate whether neotectonic faulting has occurred near metropolitan Toronto. At this location previous work has documented structures that may be of neotectonic origin, however, this interpretation is questioned by other work. The aim of this project is to provide new insights into this process through rigorous field investigations followed by computational analysis and modelling of the candidate structures.

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 geological features. 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 Toronto, Ontario and computer-based analysis will be undertaken at the McMaster University Campus, Hamilton, Ontario. In the field the student will gather structural data from fractures in the Rouge River Valley, near Toronto. Specifically, the student will make observations on candidate neotectonics structures, as well as gathering 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. 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. 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:
Occasionally

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

Making observations outside of a laboratory or controlled environment:
Very 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.

Performing controlled experiements:
Almost never

Programming, scripting, or coding:
Occasionally

Reading research literature:
Very often

Solving mathematical problems:
Occasionally

Using hand or machine tools, laboratory equipment, or scientific instruments:
Never

Writing reports:
Very often

Meeting or discussing with the supervisor:
Very often

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?
Yes

Additional Comments

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

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