

FINAL TECHNICAL REPORT / RAPPORT TECHNIQUE FINAL STRENGTHENING RESEARCH AND TEACHING CAPACITY IN EARTH SCIENCES

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LaurentianUniversity
Université**Laurentienne**



GOODMAN SCHOOL OF MINES
ÉCOLE DES MINES

Final Technical Report to the IDRC

Project Title:

Strengthening Research and Teaching capacity in Earth Sciences

IDRC Project Number:

107969-99906054-001

Subtitle:

*Laurentian University Goodman School of Mines and University of Limpopo Department of Physics and
Geology Collaboration*

By:

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*Goodman School of Mines
Laurentian University*

Final Technical Report

1 April 2020 to 30 September 2021

Date: September 30, 2021

Country/Region: *Ontario, Canada and Limpopo, South Africa*

Name of Research Institution: *Goodman School of Mines, Laurentian University*

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Synthesis:

The Bushveld Igneous Complex located in South Africa contains some of the richest ore deposits in the world. Limpopo Province of South Africa, approximately 280 kilometres northeast of Johannesburg overlies the northeastern limb of the Bushveld Igneous Complex. This region is served by the University of Limpopo and is the result of a merger in 2005 of the former Medical University of Southern Africa with the University of the North. The University of North was established as one of several racially exclusive universities for black South Africans, under the University Education act of 1959. The vision for the University of Limpopo is to become a leading African University in global competitiveness while addressing the needs of rural communities. Many of the junior faculty at UL only have BSc and BSc honours degrees. One of the objectives of the collaboration between Laurentian University (LU) and University of Limpopo (UL) is to provide access to world-class research facilities and training opportunities available at Laurentian University for faculty and undergraduate students at University of Limpopo. The specific objectives of the collaboration are as follows:

1. To increase the number of students entering graduate studies with relevance for jobs in industry, government or as academics.
2. To increase the teaching capacity and graduate education opportunities for junior faculty.

Project implementation and management:

The project was managed by Goodman School of Mines (GSM), involving Dr. Nadia Mykytczuk, the Interim Executive Director, Denyse Leroy, the Administrative Assistant, all at Laurentian University. At the University of Limpopo, the project was managed by Professor John Dunlevy, Professor of Geo-chemistry, Dr. Napoleon Hammond, Professor of Geology and Dr. Tom Netshisaulu, the director of the newly founded Department of Geology and Mining.

For the five years since the start of the project in March 2015, it was anticipated that seven students would be admitted to Laurentian University's Harquail School of Earth Sciences (previously the Department of Earth Sciences) to undertake graduate studies. The IDRC scholarship agreement provided full funding for five, one-year MSc scholarships in Mineral Exploration and two, four-year PhD scholarships in Mineral Deposits and Precambrian Geology.

A similar scholarship agreement was signed between University of Limpopo, Laurentian University and the Queen Elizabeth II Diamond Jubilee Scholarship Program (QES) in May 2015. The QES agreement between LU and UL provided full funding for six, two-year MSc scholarships for Limpopo students or junior faculty at UL.

In addition to our agreements with IDRC and QES, Laurentian University Goodman School of Mines has had an MOU with the mining company, Ivanplats Mining Inc. since May 2015. This MOU, which was initially for the duration of five years, was extended to August 31, 2021. The MOU consisted of scholarship support for the following: the University of Limpopo students to upgrade their undergraduate degree, MSc and PhD grants for Canadian (Laurentian University) students to conduct projects in South Africa and Republic of Congo, MSc and PhD grants for Ivanplats staff to conduct MSc and PhD research in South Africa supervised by the LU faculty, research support for the faculty members supervising the students conducting research funded by the MOU, IDRC, and QES scholarship, and salary funding for administrative support for coordinating the MOU, IDRC and QES agreements.

Project outputs and dissemination:

Two University of Limpopo students were each awarded one-year MSc scholarships funded by IDRC to enroll in Laurentian's Harquail School of Earth Science one-year Applied MSc in Mineral Exploration programme in January 2017. Mr. Kevin Nkhohlo Baloyi's research topic was titled 'Geological interpretation of geophysical magnetic and electromagnetic data from Swayze Greenstone belt' and Mr. Edward Moloantoa Moswane's research topic was titled 'Tectonic setting and geochemistry of diabase dykes in Zimbabwe'. Both students finished their MSc studies at the end of December 2017.

Two, 2-year QES scholarship recipients, Mr. Malose Michael Langa and Ms. Francisca Maepa were offered the opportunity by their respective supervisors to upgrade their MSc research projects to PhD status and projects that would be funded through IDRC. Each received four years of scholarship funding through IDRC. Ms. Maepa defended her thesis successfully in June 2021. Mr. Langa will be defending on January 27th, 2022. One of the outcomes of the transfer from MSc to PhD status was the "freeing up" of funding for two, two-year MSc research projects. IDRC program Leader, Ann Weston approved the redirection of funds from one-year MSc research projects to two-year MSc projects in 2018.

Phathutshedzo (Molly) Nethavhani and Ms. Matshidiso (Tshidy) Modiba started their studies at Laurentian University in January 2019. Initially, both Molly and Tshidy were enrolled at Harquail School of Earth Sciences thesis based two-year MSc in Mineral Exploration program.

In March 2019, one student had to suspend their studies for personal reasons. Although they had been able to do some fieldwork with a research crew in northern Ontario without enough time to gather the data needed after consultation with the UL academic advisor, and the graduate coordinator, they changed to a course-based one-year MSc.

The following are the final progress reports of the four IDRC funded students:

PhD in geology – a candidate is deemed ready to defend their thesis when they have prepared three publishable papers on their research.

Michael Langa:

In our last report we anticipated that Michael would defend his thesis in April 2021, due to delays as a result of COVID-19 his defense was postponed to January 2022.

He wrote 3 scientific papers in the process of completing the requirements for his degree. The followings are the titles of his three papers:

Title of paper 1: **Chromite chemistry of a massive chromitite seam in the northern limb of the Bushveld Igneous Complex, South Africa: correlation with the UG-2 in the eastern and western limbs and evidence of variable assimilation of footwall rocks**

(<https://doi.org/10.1007/s00126-020-00964-y>)

Published online: 03 March 2020

Publication journal: Mineralium Deposita

Title of paper 2: **Sulfide mineral chemistry and platinum-group minerals of the UG-2 chromitite in the northern limb of the Bushveld Igneous Complex, South Africa.**

Paper should be available online by the end of next week

Publication journal: Canadian Mineralogist

Tentative title of paper 3: **Stratigraphic variations in major and trace elements in chromite through the UG-2 and UG-2E chromitite seams, Bushveld Igneous Complex.**

Not yet submitted for publication

Possible publication journal: International Geology Review

Francisca Maepa:

While initially anticipated that Francisca would defend her thesis in April 2021, due to delays as a result of COVID-19 her defense was postponed to June 2021, which she successfully defended.

She wrote 3 scientific papers in the process of completing the requirements for her degree. The followings are the titles of her three papers:

Title of paper 1: **Examining the controls on gold deposit distribution in the Swayze greenstone belt, Ontario, Canada, using multi-scale methods of spatial data analysis**

Published in *Ore Geology Reviews* (accepted July 2020, *Ore Geology Reviews*, vol.125, <https://doi.org/10.1016/j.oregeorev.2020.103671>

Title of paper 2: **Support Vector Machine and Artificial Neural Network Modelling of Orogenic Gold Prospectivity Mapping in the Swayze greenstone belt, Ontario, Canada**

Published in *Ore Geology Reviews* ((accepted December 2020, *Ore Geology Reviews*, vol. 130, <https://doi.org/10.1016/j.oregeorev.2020.103968>.

Title of paper 3: **Investigating the applications of Deep Neural Networks, Random Forest, and Transfer Learning in the Abitibi greenstone belt, Canada**

Status: currently under review with the journal *Economic Geology* (revised December 2020).

MSc in Geology - 2 year thesis-based - a candidate is deemed ready to defend their thesis when they either have prepared one publishable paper on their research or they have written an approved (by the student's thesis committee) traditional manuscript

Phathutshedzo (Molly) Nethavhani:

Molly faced two main challenges which caused a delay in the completion of her thesis. First challenge, her original supervisor, Dr. Leo Feltrin left his position with Laurentian University in December of 2020. Unfortunately, it took time to find a suitable supervisor whose research expertise matched Molly's thesis research. Second challenge was due to delays occurring because of COVID-19 which prohibited her to conduct field work during the summer of 2020. Her thesis was under review by her thesis committee members in September and she was expected to defend her thesis by the end of December 2021. She is set to defend by end of February 2022.

MSc in Geology – 1 year course-based – a candidate must take 6 courses and write a short report on a small project. The report will be reviewed by the student supervisor and the student's thesis committee.

Matshidiso (Tshidy) Modiba:

Tshidy completed a report on her project titled: **Aeromagnetic and electromagnetic interpretation of the Matheson area located in the northwestern end of the Abitibi greenstone belt of the Superior province, Canada**

She graduated with an MSc course-based in Geology/Geophysics in June 2021.

Impact:

There is no doubt that the project has had and will continue to have a positive impact on the lives of the students and of the Department of Geology and Mining at the University of Limpopo. Previously, Geology at the University of Limpopo was not an independent department but it was a program within the department of Physics and Mineral Sciences. This outcome would not have been possible without the support and funding from many sources including IDRC. As a result of the expansion of the Department of Geology at the University of Limpopo, Kevin Baloyi, a previous IDRC scholar who finished his MSc one-year at Laurentian University is now a lecturer at the Department of Geology and Mining at the University of Limpopo. Another IDRC scholar, Edward Mosoan, who finished his MSc one-year in December 2018, is employed by a geological laboratory as a lab manager in North Bay, Ontario. Tshidy Modiba has returned to South Africa and is applying to work as a geologist for a mining company.

Micheal Langa's story is an amazing accomplishment as he is the first in the family (included extended) to attend post secondary let alone complete a PhD! His family and Laurentian University staff are extremely proud of his accomplishment. This young man has also provided support to his immediate supervisor by taking on the teaching of a 6 credit undergraduate class when his supervisor was away on sabbatical. Because of this opportunity, Mr. Langa has developed an interest in pursuing a career in academia.

Francisca Maepa's professional path will be in the industry sector and she is currently seeking employment as a Geophysicist.

Recommendations:

Overall the combined funding envelope that supported this partnership between the University of Limpopo and Laurentian University in training exceptional graduate students, is an excellent model for future training of cohorts from specific sectors and/or geographic locations. The value of having a cohort of students participate in a program like this provides individual supports, improved adaptation and integration to the host local, and builds a level of community not only among the students, but program staff and faculty that will extend beyond the program. The success of this program is also reflected in the additional supports provided for program delivery and peripheral supports for the students. Engaging industrial partners for sponsorship of such programs is more easily accomplished when government investment and matching of industry contributions is available, and again was part of the successful strategy built in the "Limpopo Model". We at the Goodman School of Mines at Laurentian University aim to replicate this model with other international partners and communities in the coming year and hope to be able to continue working with IDRC in such initiatives.

A few additional recommendations/observations. The grant component which allowed staff travel is very beneficial to institutions. We highly recommend that this component continue to be offered for each grant and project. In 2019, the 2 Laurentian University coordinators travelled to Limpopo to visit the academic partner, The University of Limpopo which provided cultural sensitivity. This visit provided the opportunity to foster relations and discuss further academic partnerships. The coordinators also had the opportunity to visit the industry partner in this project, Ivanplats mine site in Polokwane and to discuss future partnerships. From this visit, Laurentian University is now fostering potential educational training opportunities with Ivanplats Kamoas division. The flexibility of allowing students to move from one category to another is a valuable allocation of the funds. This allowed the students the flexibility to complete a program better suited for their academic ability in the face of challenges. Without this flexibility some students may have abandoned their opportunity to complete their post secondary goals. Moving forward, this type of flexibility should continue to be part of the grant policy.