Review of the Department of Geology
University Regina

***External reviewers**:*

Dr. Katrina Moser, Associate Professor of Geography, University of Western Ontario
Dr. Mary Louise Hill, Professor of Geology, Lakehead University

Internal reviewer:

Dr. Martin Beech, Professor of Astronomy, Campion College, University of Regina

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Executive Summary

Geology is an important field in Canada, and particularly in Saskatchewan where mining and petroleum and natural gas extraction are critical to the economy. For example, Saskatchewan is the world's largest producer of potash, and oil and gas contributes 15% of the provincial GDP. The department of Geology at the University of Regina plays an important role in supporting the mining sector in Saskatchewan and Canada. The department is well known for contributing first - rate geoscientists to industry and government over many years, and for its excellent research that supports this resource sector. Traditionally geology has focused on exploration and development of resources, but today there is a growing need to also provide Earth scientists with the skills necessary to address environmental problems including climate change, human alterations of biogeochemical cycles, and the impacts of land use change, dust, and waste. Earth science education is critical to society if we are to effectively manage the environmental challenges now before us. The challenge to all Geoscience departments is to provide increasingly critical education in Earth Sciences, while maintaining innovative research.

The Department of Geology at the University of Regina is small (nine faculty), but dynamic, offering degrees in both traditional geology and environmental geosciences. The department is collegial and cohesive providing exceptional undergraduate and graduate education, while maintaining a strong research record. The department is commended for their success at fostering successful partnerships with government and industry. These relationships have clearly profited the department, strengthening both research and teaching. Present students and alumni described an excellent learning environment and experiential opportunities that provided them the necessary skills and accreditation to excel in their field. Teaching is supported by a good location with recently renovated teaching labs. The student and alumni reports were supported by present employers who described U of R graduates as being more well-rounded, better prepared, and more independent workers than peers from other universities. The faculty are

internationally recognized, and doing research across the globe. Five of the nine faculty members presently hold NSERC Discovery grants, and all faculty members are maintaining their research through numerous grants and partnerships with government and industry. The department is providing excellent service both to the university and Earth Sciences community. The review committee observed a highly successful department, particularly given the small size. We also observed a department at a critical juncture, and as a result make the following recommendations.

Summary of Recommendations

1. The department had a faculty retirement in April 30, 2019. To continue the success of the department, at a ***minimum,*** this position must be replaced. Although maintaining faculty numbers is urgent, any new hires need to be strategic with an eye to the future of the department.

2. The excellent support staff are essential to the faculty; any reduction in support to the faculty will be deleterious to the department. Given budgetary constraints, creative solutions to maintain this support may be required.

3. There is incredible support for the department from the Saskatchewan Geologic Survey (SGS), the mining industry and petroleum and natural gas sector. The relationships that the department has built with industry could provide support for facilities and field camps. These should be explored more thoroughly and worked on with the development office.

4. Although the program is well designed to provide excellent training for geoscientists, the department needs to consider attracting more students from the wider university community to provide a basic education in Earth Sciences to more students. Given pressing environmental issues students will face, Earth Sciences should be a core component of a broad range of disciplines, including engineering, social sciences and Indigenous education. The department should consider offering new courses to serve the greater university and renaming the department to make the program more appealing and accessible.

5. There are opportunities for more collaboration in terms of education and training with other departments and faculties, including the Faculty of Engineering, Department of Geography and Environmental Studies, and these should continue to be explored.

6. The department has very successfully promoted themselves outside the university. Now the successes and strengths of the department need to be better highlighted to the University of Regina and campus communities.

7. The department's successes align with the three pillars of the University of Regina strategic plan – student success, research impact and commitment to our communities. Future plans should find ways to better collaborate with and include Indigenous partners and students.

8. In order to thoughtfully address these recommendations, we would suggest that the department develop a new strategic plan to take them through the next 5-10 years.

Section 1. Research and Funding

The Department of Geology has an excellent research record, particularly given that there are only nine members to share a significant teaching load that provides excellent, experiential training to graduate and undergraduate students. For a department of their size their research productivity is outstanding.

The faculty has garnered funding to actively pursue research across the globe. Between 2014 and 2018 the faculty generated over 3 million dollars in grants and contracts. Over the last ten years the faculty has generated $5,361,877, which is approximately $600,000 per person. Of the nine faculty, five presently hold NSERC Discovery Grants. The faculty has also been successful in obtaining funds from CFI for research equipment and facilities.

Adding to this funding, the department has been very successful in gaining "in-kind" support. This is support that is not included in budgets, but is critical to the success of the department. Faculty have worked to build important relationships with industry and the Saskatchewan Geologic Survey (SGS), which takes considerable time. These relationships provide critical support for research (provincially and internationally – in particular China). As an example of "in-kind" support, faculty and students have free, nearly unlimited access to the Saskatchewan Geological Survey core facility, which has been used very effectively for teaching and research. Normally researchers pay $50/day to access this facility.

In the last ten years the faculty has published over 240 peer-review, journal articles which averages to 2.7 papers per person per year. Given the size of the department, teaching and service demands, this is very good. Many of these papers are published in the top-tier Earth Sciences journals, including *Economic Geology*, *Journal of Geophysics Research*, *Sedimentology*, *Quaternary Research*, *Earth and Planetary Letters*, *Journal of Paleolimnology*, and a top Science journal, *Proceedings of the National Academy of Science*.

Key Recommendations:

The Department of Geology is poised to reach a higher level of research excellence. To do this they require additional time to garner more funding and further increase high impact publications. At a ***minimum*** they must keep their faculty at nine; any reduction will have grave impacts on their present success. Ideally, additional faculty should be added. New hires need to be strategic and based on a comprehensive strategic plan developed by the department.

Support staff are incredible and have played an essential role to the faculty success; any reduction in support to the faculty will be deleterious to the department. Given budgetary constraints, creative solutions to maintain this support may be required.

There is incredible support from the Saskatchewan Geologic Survey (SGS) and the mining industry for the department. The relationships that the department has built with industry could support research facilities and endowed or industrial chairs. The department needs support from philanthropy and the administration to effectively seek such positions and raise funds for cutting edge facilities that provide the faculty with opportunities for innovation. The department has created strong relationships, and our discussions with alumni and industry suggest that there is support to help further the department's success. The contribution that the Department of Geology makes to the success of the mining and petroleum and natural gas sectors in Saskatchewan is very clear, and therefore support should be available.

Section 2. Teaching and Learning

Excellence in teaching and learning clearly stands out as a significant strength of the department. The review committee heard directly from industry and government employers who are eager to hire University of Regina geoscience graduates because of their excellent training and preparation. Faculty, lab instructors and sessional instructors work together to deliver the undergraduate programs and everyone takes their teaching responsibilities seriously. Attention is paid to the curriculum, and experiential teaching methods are employed to ensure that graduates are experienced, professional and job-ready. Graduate students in the MSc and PhD programs are taught and supervised by research-active faculty, and benefit from collaboration with government, industry and academic partners. Students enjoy the support and availability of their instructors and thesis supervisors, and describe the department as feeling like family.

Employers praised University of Regina geoscience graduates for their solid grounding in geoscience fundamentals. Students learn practical knowledge and skills, and employers report that graduates consistently demonstrate a high degree of competence in technical skills. Students present the results of their research at provincial, national and international conferences, and several have received awards at technical poster competitions in recent years. It is no wonder, then, that University of Regina graduates are sought by employers.

Significant laboratory and field components in the geoscience programs create practical experience and skill development for students. A noteworthy example is the use of the Saskatchewan Geological Survey core facility for student projects in a carbonate course. University of Regina graduates are known for superior mapping skills that are developed in two required field courses. Employers also appreciate the critical thinking and problem-solving skills that students develop through laboratory and thesis projects. While this experiential learning involves a commitment of resources, it is significant to the success of both students and

graduates of the programs.

The courses and programs offered by the department are rigorous and demanding, and at the same time there seems to be ample support available to help students achieve success. Faculty advisors provide counsel on course selection, and laboratory instructors are appreciated for their dedication to student learning. The undergraduate degree programs in Geology and in Environmental Geoscience meet the knowledge requirements for professional registration through the Association of Professional Engineers and Geoscientists of Saskatchewan (APEGS). As Geoscience is now a regulated profession in Saskatchewan and most other provinces in Canada, attention to aligning the curriculum with professional requirements ensures successful professional employment of graduating students. The undergraduate program prepares students to work in either the oil and gas sector or the mineral resource sector, both important to the economy of Saskatchewan. An industry employer commented that department faculty stay abreast of current trends through participation in industry events, and they incorporate this insight into the curriculum.

The number of undergraduate geoscience majors is strong at 163 in 2018, up from 75 in 2003. The number of majors peaked in 2014, and has declined in the past few years due to downturns in both the oil and mineral sectors. This recent decline in majors has also been seen in most other geoscience programs in Canada. Recovery seems to be starting in the mineral sector and this will likely result in increased enrolment in the near future. Given the considerable hands-on experiential learning component of the undergraduate geoscience programs, the current complement of nine faculty cannot be reduced. Additional faculty will be needed to maintain program quality as retirements occur and when enrolment increases. It is important to maintain a long-term view on enrolment despite cyclical fluctuations inherent in the resource sectors.

Course enrolments are also robust, peaking at 298 students taught in 2014, and declining slightly since that peak along with the decline in the number of majors. The department recognizes the importance of enrolment in the introductory course Geology 102 and declining enrolment in that course is a concern. This course is commonly taken as an elective by non-majors and therefore serves as a gateway to new majors who may not have been exposed to geology in high school.

The department offers MSc and PhD programs in Geology as well as in Environmental Geoscience. The breadth of thesis research projects reflects the breadth of research undertaken by the faculty of the department. The graduate programs benefit from good collaboration with the Saskatchewan Geological Survey, the Geological Survey of Canada, and industry. For instance, the Saskatchewan Geological Survey grants free access to the core collection in their Subsurface Geology Laboratory to University of Regina researchers (students and faculty), saving the department the cost of the user fee.

In 2018 there were 34 graduate students in the MSc and PhD programs. This enrolment represents a significant increase over 7 graduate students in 2009, and indicates confidence in the

quality of the graduate programs. Funding for students appears to be adequate, and students were also successful in obtaining internal scholarships. Students did note that an absence of certain facilities led to delays in their research and degree completion. Faculty agreed with this assessment. Additional faculty will be needed to serve additional growth in the graduate programs. Since some of these graduate programs are relatively new, some growth might be anticipated.

Key Recommendations:

Overall the department of Geology is providing both undergraduate and graduate students with excellent training. Both graduate and undergraduate students were satisfied with their education and learning experience. They spoke very highly of the faculty, support staff and the department. Perhaps more telling was the high praise from alumni now working in the mining industry. Although the department has provided a very successful program, they need to think to the future. Given the pressing environmental issues that students will face, Earth Sciences should be a component of a broad range of disciplines, including engineering, social sciences and Indigenous education. Courses designed to provide all students with the knowledge and understanding of Earth Systems to navigate what is likely a challenging future should be offered. Redesigning the first-year course or the creation of new courses to better serve the greater university will require additional teaching staff or faculty. The creation of these new courses also provides opportunities to work with other departments and faculties. We would further suggest renaming the department to something with greater appeal to a broader audience, such as Earth Sciences.

Section 3. Space and Facilities

The Geology Department faculty offices, main departmental office, staff offices, some teaching labs and displays are located in one area of the College West Building. This centralization has facilitated the cohesiveness of the department and positive relationships between students, faculty and staff. Some of the department's other space, including some graduate student space and specialized equipment laboratories, are spread over several locations on campus and this is not ideal. It was also noted that the Geology Department is physically separated from other departments in the Faculty of Science. This may impede informal communication with colleagues in other science disciplines.

It was noted that construction and renovations in the building during the last several years have created challenges to providing students with training typical of the program. Ongoing construction and associated noise may continue to be an issue, but hopefully this work is close to completion.

The Dean of the Faculty of Engineering and Applied Science discussed plans for a new building for that Faculty, and suggested that there might be space for the Geology Department in the new

building. There are already alignments between Geology and Engineering, and the planning for a new degree program in geological engineering would strengthen those ties. This possibility for new space, with its pros and cons, should be considered by the Geology Department together with the Deans of the Faculty of Science and the Faculty of Engineering. This could enhance Department cohesion and visibility if all of the departmental office, teaching and research space could be located together.

The undergraduate teaching labs are well equipped to complete their vital teaching role requirements, and space and equipment resources are near capacity. Teaching labs have been newly renovated, and will continue to help faculty provide excellent experiential learning opportunities. Both faculty and laboratory instructors are developing ways to enhance the undergraduate laboratory experience, and this is something that the University and Faculty should support as much as possible within the framework of current budgetary restraints. The teaching labs are well organized, and the teaching collection of rock samples is stored and catalogued in drawers within the labs. There is a good number of petrographic microscopes for student use, and these are well maintained by staff. The Department has expressed a wish for additional laboratory space to develop programs related to Environmental Geoscience and Paleontology. Both of these subject areas could see future undergraduate enrolment growth, and planning for a new laboratory space to support these endeavours is encouraged.

The review committee heard directly from the Department's graduate students and one common theme was the need for better access to work space as well as more speedy access to library and research resources. Discussions between the Department, the Faculty of Science and the University library are strongly encouraged to address this rather fundamental issue.

Graduate students and faculty were both excited about the recent arrival of the new scanning electron microscope (SEM) and Energy-dispersive X-ray spectroscopy (EDS) systems that were funded by CFI. At the time of our site visit, these had just arrived and were awaiting installation in the Electron Beam Facility. This is an exciting addition to the Department of Geology and will provide a wide range of research opportunities. It was noted that additional research facilities could further the University of Regina's competitive advantage. Of particular note was a laser ablation ICP-MS (inductively coupled plasma – mass spectrometer). This equipment allows for highly sensitive (ppb) element and isotopic analysis of very small solid samples. Presently students and faculty have to send samples out for such analyses and wait times were reported to be as much as three years. Clearly, these sorts of delays will negatively impact both graduate student success and research productivity. Obtaining funding for such facilities needs to be a high priority.

Key Recommendations:

The Department of Geology has the expertise, experience and excellence to take a next step in research. Limited access to cutting edge facilities, such as a laser-ablation ICP-MS, will inhibit their

potential. There is incredible support for the department from the Saskatchewan Geologic Survey (SGS), the mining industry and petroleum and natural gas sector. The relationships that the department has built with industry should be used to help establish such facilities in house. Having such facilities on campus will increase the potential for innovation for the University of Regina, increase research productivity, help to attract graduate students, and increase collaborations with other departments at U of R and with government and industry.

Section 4. Service

The Department has a strong presence in the local community, and has an excellent track record with respect to public outreach, and working with local schools to foster an understanding of Geology and Geoscience. The Department has additionally fostered extremely strong links with industry (both within the Province and internationally), and it has developed an especially positive connection with the core-lab of the Saskatchewan Geological Survey. The committee heard from several industry representatives and were highly impressed by the praise offered-up to the Department for both its research and high-level of undergraduate training. The committee also heard strong support and words of praise for the Department from its alumni. There is a lot of good will towards the Department from government, industry and alumni and this is something about which the Department can rightfully be proud and the University celebrate.

The faculty are active in service both on and off campus, and it can be difficult, particularly with a small department, to balance research and teaching excellence with service. Many faculty members are editors or serve on editorial boards, are active members of Geosciences Societies and have served on various university committees. Contributions to service and outreach are recognized by several service awards to faculty. For example, Professor Chi and Professor Qing have been awarded the Canadian Society of Petroleum Geologists volunteer awards for 2012-2014 and 2016, respectively. Professor Chi was also awarded the Service Award from Ore Geology Reviews. Professor Janis Dale has served on the Board of Governors of the Royal Canadian Geographic Society for two years. She was awarded a Geoscientist Canada Fellowship for recognition of her service to the provincial (APEGS) and the Canadian Geosciences Board. It is also noted that Professor Bethune is presently serving on the NSERC Geosciences panel, which is both a prestigious and very time-consuming position. Faculty also contribute significantly to outreach in the community.

Key Recommendations:

The faculty are encouraged to continue to provide service to the university, their discipline and the community. To do this successfully it will be important to at least maintain faculty numbers. In the future, the department should expand their community service to include Indigenous students and communities.

Section 5. Budget

The Department budget has remained essentially flat for the past decade despite significant increases in enrolment. It is hoped that recent reductions due to constraints in Provincial funding to the University will be addressed and re-instated in the near future.

One of the largest components of the Department budget is that related to the delivery of the two geology field courses, Geology 396 and 496, both of which are required by APEGS for professional registration. While money for these courses is recovered by charging additional fees to students, this is far from ideal. The review committee heard from students about hardship in funding this required extra expense. It is recommended that ways to generate further monetary support for the field schools from both industry and the Faculty of Science be explored to offset these additional costs to the students.

Key Recommendations:

The Department has made efficient use of scarce funds and further growth will require additional funding. Efforts should be made to offset the additional costs to students associated with the two required field courses.

Section 6. Role in Meeting University's Strategic Plan

The University of Regina's Strategic Plan 2015-2020 identifies three strategic priorities: Student success, research impact, and commitment to our communities. Within these priorities, indigenization and sustainability are emphasized.

Student success. The Department's efforts support this aspect of the Strategic Plan. The department offers excellent training in Geosciences, as was evident meeting with representatives from government and industry, allowing us to hear first-hand their high praise for U of R students and their training. During our visit we also had the opportunity to meet several successful alumni who are now in key positions in industry and government, and they recognized the role of the Department of Geology in their success. The department is clearly playing a key role in providing highly skilled professionals in a key economic sector in Canada. The highest quality of training is achieved by dedicated faculty providing excellent experiential learning opportunities. In looking to the future, the department should increase its Indigenization efforts.

Research impact. One focus of the Strategic Report is increased Tri-Council funding, and the Department has been successful in this regard, with five of nine faculty presently holding NSERC Discovery Grants. Faculty has also been successful with NSERC Collaborative Research and Development Grants and CFI. Perhaps more impressive has been the success of all faculty to support their individual research around the world obtaining funding from a variety of sources. Through a variety of research collaborations and training, the department contributes

significantly to the success of mining and the petroleum and natural gas sectors in Saskatchewan. Faculty are also working to address green energy initiatives. For example, Professor Dale has developed subsurface geological criteria for small modular reactors and is exploring geothermal energy prospects in Saskatchewan. The department's successes are well known in industry and Saskatchewan, but not within the university. The department needs to work to better promote their own success. Also, the department should work to increase partnerships and projects with First Nations and Métis people. One idea might be to have an Indigenous mentor-in-residence.

Commitment to our communities. The Department's efforts also align well with this aspect of the Strategic Report, and there is a commitment to continue to improve in this area. The department is routinely involved in annual outreach programs on campus, including the Faculty of Science Orientation Week, Science Rendezvous, Science Fairs and summer camps. When faculty are available they have taught the first-year course in smaller Saskatchewan communities, including Weyburn, Estavan and La Ronge. Anecdotally it was reported that the proportion of Indigenous students in the class was much greater for sections taught in La Ronge than for sections taught on main campus. Perhaps the best example of how the faculty have contributed to a commitment to communities is the very collegial and supportive environment that has been created in the department.

Key Recommendations:

The department's goals and successes are well aligned with the University of Regina's strategic plan. For the future, the department should find ways to include Indigenous perspectives and students in their programs, and collaborate with Indigenous people on research projects.

Section 7. Appendix

Schedule for Site Visit:

Monday, 22 April - Tuesday, 23 April, 2019

1. Dr. Thomas Chase (Provost) and Dr. Kathy McNutt (Associate Vice President (Research) and Dean of Graduate Studies). One hour meeting with External Reviewers

2. Dr. Douglas Farenick (Dean, Faculty of Science). Twenty minute meeting with Review Team

3. Dr. Kathryn Bethune (Chair, Department of Geology) and Geology AUR Steering Committee (Dr. Guoxiang Chi, Dr. Ian Coulson and Dr. Maria Velez). Twenty minute meeting with Review Team

4. Geology Undergraduate Advisors and Graduate Coordinator (Dr. Guoxiang Chi, Dr. Janis Dale and Dr. Hairuo Qing). Twenty minute meeting with Review Team

5. Geology Laboratory Instructors (Dr. Jeanette Roelofsen and Dr. Richard From). Thirty minute meeting with Review Team

6. Geology Staff and Technical Support (Ms. Van Tran, Mr. Trent Kostelny and Mr. Mets Ritsema). Thirty minute meeting with Review Team

7. Dr. Ulrike Hardenbicker (Chair, Department of Geography and Environmental Studies). Twenty minute meeting with Review Team

8. Dr. Jason Cosford (Sessional Instructor). Twenty minute meeting with Review Team

9. Research discussion with Geology faculty (Dr. Kathryn Bethune, Dr. Guoxiang Chi, Dr. Ian Coulson, Dr. Maria Velez, Dr. Janis Dale, Dr. Hairuo Qing, Dr. Osman Salad-Hersi and Dr. Tsilavo Raharimahefa). Thirty minute meeting with Review Team

10. Geology student alumni (three alumini). Thirty minute meeting with Review Team

11. Dr. Esam Hussein (Dean and Professor, Faculty of Engineering and Applied Science). Twenty minute meeting with Review Team

12. Tour of teaching classrooms and laboratories (Dr. Jeanette Roelofsen and Dr. Richard From). Forty minutes

13. Geology undergraduate majors (four students, 2^{nd}-4^{th} year). Thirty minute meeting with Review Team

14. Geology graduate students and Postdoctoral Fellow (five graduate students, one Postdoctoral Fellow). Thirty minute meeting with Review Team

15. Dr. Gary Delaney, P.Geo. (Chief Geologist, Saskatchewan Geological Survey). Thirty minute meeting with Review Team

16. Robert McDonald, P.Eng. (Executive Director, Association of Professional Engineers and Geoscientists of Saskatchewan). Thirty minute meeting with Review Team

17. Dr. Patrick Ledru, P.Geo. (Vice President Exploration, Orano Canada Inc.). Thirty minute meeting with Review Team

18. Melinda Yurkowski, P.Geo. (Assistant Chief Geologist, Saskatchewan Geological Survey, Petroleum Geology Branch). Thirty minute meeting with Review Team

19. Pamela Schwann, P.Geo. (President, Saskatchewan Mining Association). Thirty minute meeting with Review Team

20. Brian Brunskill (President, Helix Geological Consultants Ltd.). Thirty minute meeting with Review Team

21. Dr. Thomas Chase (Provost), Dr. Kathy McNutt (Associate Vice President (Research) and Dean of Graduate Studies) and Dr. Douglas Farenick (Dean, Faculty of Science). One-hour exit interview with Review Team