Western UNIVERSITY · CANADA

Earth Sciences

Final Assessment Report & Implementation Plan

Faculty / Affiliated University College	Faculty of Science
Degrees Offered	B.Sc.
Modules Reviewed	Honours Program in Geology – for Professional Registration, Honours Program in Geophysics – for Professional Registration, Honours Program in Environmental Geoscience – for Professional Registration, Honours Specialization in Geology, Honours Specialization in Geophysics, Honours Specialization in Environmental Geoscience, Honours Specialization in Geology and Biology, Honours Specialization in Integrated Science with Earth Sciences, Specialization in Geology, Specialization in Geophysics, Specialization in Environmental Geoscience, Specialization in Geology and Biology, Major in Geology
External Consultants	Dr. Claudia Schröder-Adams, Professor, Department of Earth Sciences, Carleton University Dr. Jeffrey McKenzie, Associate Professor and Chair, Department of Earth and Planetary Sciences, McGill University
Internal Reviewer	Dr. Susan Knabe, Associate Dean, Undergraduate, Faculty of Information and Media Studies
Date of Site Visit	March 12-13, 2020
Evaluation	**Good Quality**
Approval Dates	SUPR-U: February 24, 2021 SCAPA: March 3, 2021 Senate (for information only): March 12, 2021
Year of Next Review	Year of next cyclical review – 2027-28

Overview of Western's Cyclical Review Assessment Reporting Process

In accordance with Western's Institutional Quality Assurance Process (IQAP), the Final Assessment Report (FAR) provides a summary of the cyclical review, internal responses, and assessment and evaluation of the undergraduate modules delivered by the **Department of Earth Sciences in the Faculty of Science.**

This report considers and reports on the following documents: the program's self-study, the external consultants' report and the responses from the Department and the Associate Dean of Science.

This Final Assessment Report (FAR):

i) provides an Executive Summary of the Review Process, including an overview of the Department as outlined in the Self-Study brief;
ii) identifies the strengths of the program;
iii) identifies opportunities for program enhancement and improvement; and,
iv) prioritizes the recommendations of the external consultants in the Implementation Plan.

The Implementation Plan details the recommendations from the Final Assessment Report that are required for implementation, identifies who is responsible for approving and acting on the recommendations, outlines any action or follow-up that is required, and provides the timeline for completion.

The Final Assessment Report and Implementation Plan is sent for approval through SUPR-U, SCAPA, Senate and the Ontario Universities' Council on Quality Assurance and is made available on a publicly accessible location on Western's IQAP website. The Final Assessment Report with the Implementation Plan is the only document resulting from the undergraduate cyclical review process that is made public; all other documents are confidential to the Program/School/Faculty and SUPR-U.

Executive Summary

Overview

The Department of Earth Sciences resulted from the integration and merger of the Faculty of Science's Geology and Geophysics Departments in 1993; it creates, disseminates and applies knowledge of Earth and other planets for the benefit of society through excellence in teaching, research and scholarship. In its brief, the Department describes its body of faculty, research staff, graduate students, undergraduate students, and research facilities as dynamic, creative, and diverse. This, coupled with their numerous field schools, provides a rich learning and research experience that prepares its students for future career success in the discipline.

With a complement of 19 fulltime faculty, 13 Adjunct Professors, and 32 Limited Duties Instructors, the Earth Sciences Department offers the following 13 modules:

- Honours Specialization in Geology - For Professional Registration
- Honours Specialization in Geophysics- For Professional Registration
- Honours Specialization in Environmental Geoscience - For Professional Registration
- Honours Specialization in Geology and Biology
- Honours Specialization in Integrated Science with Earth Sciences
- Specialization in Geology - For Professional Registration
- Specialization in Geophysics - For Professional Registration
- Specialization in Environmental Geoscience - For Professional Registration
- Specialization in Geology and Biology
- Major in Geology
- Minor in Geology
- Minor in Geophysics
- Minor in Planetary Science & Space Exploration

With a concern for declining enrolments and an eye to recruitment, the Department plans to create a Major in Geophysics and a Major in Planetary Geoscience.

The curriculum is well-rounded and offers breadth through pure and applied courses. The programs' Learning Outcomes have been developed in the context of the Western Degree Outcomes, and encompass Knowledge, Literacies and Interdisciplinarity, Communication, Resilience and Life-Long Learning, Global and Community Engagement, Critical Inquiry and Creative Thinking, Professionalism and Ethical Conduct. Outlines for each of the 50 half courses and one full course offered each year map onto and reflect the Learning Outcomes for optimal student learning.

"Hands-on, real-world" experiential learning is a critical component of the curriculum and field trips are an integral component of each course. In addition, the Department offers six formal field courses including a residential field experience to world-class mineral deposit localities offered jointly with an internationally recognized team of academic researchers, government survey personnel, and industry leaders. Western students participate in a "state-of-the-art" research level field experience combining geological investigation and geophysical techniques, learn about fundamental problems in our understanding of primary Earth science processes, travel to a world-class field locality, and have an opportunity to interact with peers from top institutions. Field and technical skills acquired by students during this program prepare them for a bright future in research or industry. Funding comes from a

mixture of university support, student fees, and industry sponsorship. Students have travelled internationally to localities such as South Africa, the Philippines, Turkey, the Sultanate of Oman, and Ecuador.

At the same time, writing and peer review is an expected outcome as students have courses in which they write, gain experience in peer review methods, and publish in national and international journals.

The focus on teaching effectiveness has resulted in high student evaluations for faculty teaching effectiveness and Earth Studies faculty have won several teaching awards at the local, provincial and national levels.

Strengths/Innovations of the Program (as identified in the brief)

- Small faculty/student ratios ensuring that all students have regular guidance throughout their studies as well as intensive hands-on laboratory experience
- Accreditation requirements are met for professional registration in the Canadian Council of Professional Geoscientists
- Large population of students from other disciplines take ES courses, thus educating a large population of students about various aspects of ES; brings together students from multiple departments and faculties
- MiHR Summer Internship Program – a paid work-integrated learning internship
- Responsible Mining Summit - shares the Canadian perspective on mining.
- Department maintains a close relationship with the mineral exploration sector through alumni so there is a high success rate in placing undergraduate students in internships in the industry
- Field course Earth Sciences 4451Z runs in partnership with Queen's University, Laurentian University, and Carleton University allowing students to work and collaborate with faculty and students from other institutions
- Technology-Enabled Learning
- High alumni satisfaction in that 92% would recommend Western
- 95% of graduates remain working in Earth Sciences after eight years

Self-Study Process

The self-study document was a collective effort involving participation from all members of the Earth Sciences Department. Multiple faculty meetings and retreats were designated for the purposes of reviewing the undergraduate modules and resulted in the recent mapping of the curriculum to the Learning Outcomes. Through recent curriculum revision, the Undergraduate Committee thoroughly examined all program offerings. In addition, feedback about the effectiveness of the curriculum was solicited from students, alumni, and past and present graduate teaching assistants.

Review Process

During the external review, the review committee (comprised of the two external reviewers and one internal reviewer (Associate Dean, Faculty of Information and Media Studies) were provided with Volumes I and II in advance of their visit and then met over two days with:

- John Doerksen, Vice Provost (Academic Programs)
- Karen Campbell, Vice Provost (Academic Planning, Policy and Faculty Relations)
- Jeff Hutter, Associate Dean (Academic), Faculty of Science
- Dazhi Jiang, Undergraduate Chair, Department of Earth Science
- Patricia Corcoran, Department Chair, Department of Earth Science
- Undergraduate Faculty, Department of Earth Science
- Undergraduate Students, Department of Earth Science
- Shiyi Xie, Associate Librarian, Teaching & Learning (STEM)
- Administrative Staff, Faculty of Science

The reviewers also engaged in a tour of the Faculty building, observing the facilities that support teaching, learning, and research.

Following the onsite review, the external reviewers submitted a comprehensive report of their findings which was sent to the Chair and the Dean for review and response. These formative documents, including Volumes I and II of the Self-Study, the External Report, and the Faculty response, have formed the basis of this summative assessment report of the Earth Science undergraduate programs.

Summative Assessment – External Reviewers' Report

Western's Strategic Plan identifies 12 major priorities for the university, of which six are directly applicable to the Earth Science undergraduate program, including:

i) Innovate our pedagogy through alternative means of undergraduate and graduate program delivery
ii) Promote excellence and innovation in teaching and learning opportunities
iii) Engage more undergraduate students in the research enterprise
iv) Maximize our libraries' contribution to supporting student success and scholarly excellence
v) Enable interdisciplinary study
vi) clarity and appropriateness of the program's requirements and associated learning outcomes in relation to the Western Degree Outcomes

The reviewers outlined numerous strengths of the program as well identifying some challenges for the future.

Strengths of the Program

- Size of faculty cohort (19 FT plus LD) with good faculty/student ratio and evidence of teaching effectiveness
- Faculty scholarship as evidence by winning research and teaching awards
- 16 staff members who support ES programs
- Curriculum covers most sub-disciplines in depth with 50 half courses
- Abundant field programs
- Program meets professional accreditation standards
- Modular system allows students to combine units from different disciplines across the university including, within the Faculty of Science, Biology, Physics, Astronomy, Chemistry, Environmental Science, and Applied Mathematics
- Newly formed module of Integrated Sciences includes Earth Sciences and offers a potential future recruitment base
- Range of diverse pedagogies used as well as varied assessment methods of student learning
- Library and laboratory resources
- Dedicated, articulate and focussed students

Challenges for the Program

- A course in Earth Evolution combining paleoenvironmental change with biotic events in chronological order appears to be missing. Such a course effectively helps students to understand the bigger picture of our planet
- Program requires a new strategic plan that addresses dramatically changing landscape in geosciences
- Declining undergraduate numbers (consistent with national trends)
- Need to create a greater representation of Earth Sciences in the introductory year of the Science Faculty in order to gain an increased exposure to a broader student body. (*e.g.,* develop courses that the large units such as the Bachelor of Medical Sciences stream would regard as essential for their students to take.)
- Structure of not mandating Earth Sciences in the first-year curriculum does not prepare students well for their entry into second year in Earth Sciences.
- Some overlap in course content

Summary Statement

We found that DES's activities and mission align well within the broad University mission and vision statements. Faculty members are distinguished by notable research and scholarly records as documented in their scholarly output, high success in receiving funding of multiple sources and winning research and teaching awards. Numerous faculty members are able to support technical staff members and Research Associates in their research groups, which is not always common attesting to a highly successful funding program.

Summary of the Reviewers' Key Recommendations and Department/Faculty Responses

The overarching recommendation from the reviewers is that that the Department of Earth Sciences develops a five to seven-year vision plan to a) maintain their excellent international reputation, and b) combat declining enrollment. This plan will need to address and guide the shape of the DES as it responds to imminent faculty retirements in the face of both changing student demographics and a changing landscape in geosciences. The individual recommendations below identify specific elements that can help guide that strategic planning process. The department has indicated that the new strategic plan will be developed by the Chair with critical input from all faculty members, which will clarify the long-term vision and priorities for the Department. Depending on the situation with COVID-19, the aim is for the strategic plan to be released by May 1, 2021. This timeline may be altered somewhat, as this process is taking place alongside of the development of a University-wide strategic plan in early 2021.

REVIEWERS' RECOMMENDATIONS	**DEPARTMENT/DECANAL RESPONSE**
1) The recommendation from the reviewers is that that the Department of Earth Sciences develops a five to seven-year vision plan to a) maintain their excellent international reputation, and b) combat declining enrollment.	The new strategic plan will be developed by the Chair with critical input from all faculty members, which will clarify the long-term vision and priorities for the Department. Depending on the situation with COVID-19, the aim is for the strategic plan to be released by May 1, 2021.
2) The DES needs to explore how the flexibility in the accreditation program might allow for faculty replacements that respond to both PGO accreditation needs, as well as the need to adapt course offerings to reflect the changing landscape of geoscience and that resonate with current students.	No future retirement replacements will be based on undergraduate teaching alone. The future development of our graduate program and progression of our research strengths are already being considered in a dynamic geoscience landscape. The Department continues to build its national reputation in Planetary Science. Just recently, the Center for Planetary Science and Exploration has become the Institute for Earth and Space Science. Our department is the main stakeholder in this institute, with one of our faculty members serving as the institute director (Dr. Gordon Osinski). As previously mentioned, a new major in Planetary Geology is being structured. We also have a strong faculty cohort centering around environmental science and environmental geoscience (Corcoran, Goda, Longstaffe, Molnar, Schincariol, Webb), which will reinforce the appeal of our new

	Environmental Science modules. Our clear vision will be articulated in the new Strategic Plan
3) Declining student enrolments in Earth Sciences are a Canada-wide trend. The recommendations below identify some potential opportunities for the DES to address these challenges within a Western context.	As noted by the Reviewers and pointed out in the Self-Study Report, the decline in Earth Sciences enrollment from 2015-17 is a cross-Canada trend, not fully understood. Since 2018, our numbers have started to climb back up and we expect this trend to continue. The Department Chairs note that, "Two new Majors, one in Geophysics and another in Planetary Geoscience, are being planned and will help increase the program enrolment in Earth Sciences. In addition, we have recently been given approval for the Faculty of Science to offer the Environmental Science program through the Department (currently it has no departmental home). In discussions with chairs of Earth Science departments across Canada, Dr. Corcoran has learned that offering an Environmental Science program is a major draw for students, especially considering the current environmental issues facing planet Earth and its inhabitants."
3) a) There is a need to create greater representation of Earth Sciences in the introductory year of the Science Faculty in order to gain an increased exposure to a broader student body.	A greater representation of Earth Sciences in the introductory year of the Science Faculty will help enormously in increasing the number of students who choose an Earth Sciences module. We welcome discussion with the Faculty of Science on possible means to realize this.
3) b) Western is well known for its BMSc program, which in turn determines the vast majority its undergraduate student body in Science. The department needs to find a way of taking advantage of this. With future faculty replacements, maybe a course in Medical Earth Science for example can be created that has such an appeal that it may become a required course.	The reviewers note that, "with future faculty replacements, maybe a course in Medical Earth Science for example can be created that has such an appeal that it may become a required course. However, the decanal response indicates that with such heavy course load in the BMSc program, this is not likely to happen. Further, the departmental response to the suggestion that they take advantage of the concentration of BMSc bound students in first year noted that they have tried this in the past, with the offering of ES 1088F/G (A Foundation of

	Medical and Forensic Geology). While this course was well enrolled, it did not attract BMSc students.
3) c) Participation of the DES in the Integrated Science Module has resulted into recruitment of four students into Earth Sciences. However, the first year of this program does not include Earth Science despite its naturally integrated scientific nature. We suggest creating an innovative course of earth related matters that would be fundamental in its importance to all students in the Integrated Science Module to be presented in their first year. These discussions have to take place on Science Faculty level.	There appears to have been some miscommunication with the reviewers on the details of this joint program. In Year 1 of the Honors Specialization in Integrated Science, the students are exposed to a considerable amount of Earth Sciences material in Integrated Science 1001X- Exploring the Landscape of Science. This course constitutes 4.0 HCE and uses an integrated approach to learning. The calendar description reads: "Foundational topics of biology, chemistry, computer science, earth science and physics learned through an integrated problem-based approach". There are approximately 40 students in the program each year and our 3M and OCUFA award-winning instructor (Dr. Cam Tsujita) co-teaches the course, with Dr. Patricia Corcoran and Dr. Sheri Molnar giving guest lectures. We are indeed, heavily invested in this program. Unfortunately, the students in this program have selected majors that reflect the enrollments in the Faculty of Science as a whole. Of the 72 students who took the program since its introduction, 32 selected Biology/Genetics, 16 selected Physics, 13 selected Chemistry, 5 selected Earth Sciences, 3 selected Environmental Science, and 3 selected Computer Science.
4) Western has an Innovation Fund and an Academic Priority Fund that supports interdisciplinary initiatives in the form of innovative and outside of the box teaching approaches. We encourage DES to examine applying for these funds for initiatives to expand the role of earth science instruction at the undergraduate level, especially for first year students. The repeated argument that in the Faculty of Science modules there is very little room for earth science related courses needs to change. These discussions should be held at the Faculty of Science level to convince the other units that a strong collective improves the faculty standing within the university. The Planetary Science Module with its Astrobiology course and Exploring Planets course has made strides into the right direction. Non-life sciences need more	Agreed - This is certainly a good suggestion. We will consider applying for these funds to further expand our innovative teaching methods in our current modules, as well as in the planned Environmental Science modules.

effective promotion in form of advertisement on various modern platforms.	
5) The DES has been successful in raising considerable donations to build the Richard W. Hutchison Geoscience Collaborative Suite. This building, with its fantastic collections, has tremendous potential for future outreach activities to Western students and the local high school communities. Such undertaking becomes more effective if the dedicated staff member is supported by individual faculty members that can provide wide ranging subject matters to the public.	The Department already has several faculty members who are involved in outreach teaching (Corcoran, Flemming, Osinski, Tsujita, Webb). Corcoran and Flemming interact regularly with Geoscience Collections Curator, Dr. Alysha McNeil. In addition, Dr. McNeil, in consultation with Corcoran, are planning to offer a summer camp for children ages 6-9 in the summer of 2021. We also plan to offer an Annual Geo-Challenge, which is meant to recruit high school students into the Earth Sciences programs at Western. Each year, 1 student from Grade 11 in each of the 26 high schools in Middlesex County will participate in a day of geo-related activities. The students will be divided into teams that will compete in geology-related competitions to win the Geo-Challenge Cup. Competitions could include events such as a mapping exercise, hammer swing (seismic recording), geology-themed scavenger hunt, compass and pace traverse, and mystery rock challenge (using microscopes and hand samples). The day would also include presentations from faculty and/or graduate students.

Other Opportunities for Program Improvement and Enhancement

- Introduction of a course in Earth Evolution. While this course has previously existed but was cancelled by a previous chair, the department response indicated that they might consider introducing a course like this as a capstone experience.
- Streamlining course curricula to minimize overlapping content while recognizing that some degree of overlap, especially because there is no common first year required course, and students may take courses out of sequence, is inevitable. This streamlining might include a repository to share course syllabi or some other means of encouraging faculty teaching in cognate areas to strategize about how to reduce overlap and enhance content integration across the curriculum.

Implementation Plan

The Implementation Plan provides a summary of the recommendations that require action and/or follow-up. The Department Chair/Director, in consultation with the Dean of the Faculty/Affiliated University College Principal will be responsible for monitoring the Implementation Plan. The details of progress made will be presented in the Deans' Annual Report and filed in the Office of the Vice-Provost (Academic).

Recommendation	Proposed Action and Follow-up	Responsibility	Timeline
1. That that the Department of Earth Sciences develops a five to seven-year vision plan.	Development of DES strategic plan, in conjunction with the University Strategic plan	Chair with critical input from all faculty members	May 2021
2. Continue and expand undergraduate recruitment opportunities through curriculum development, service teaching, and outreach	Work with the Faculty of Science to continue to include Earth Science material in the Integrated Science 1001X, develop a recruitment strategy and to help coordinate the current recruitment efforts	Undergraduate Chair, Chair, input from all faculty members	Ongoing
3. Examine applying for APF and Innovation funds for initiatives to expand the role of earth science instruction at the undergraduate level, especially for first year students.	Identify initiatives (see recommendation 1) and potential sources of funding through the Faculty of Science and Western	Chair, Undergraduate Chair	Ongoing