UNIVERSITY OF CALGARY | FACULTY OF SCIENCE

CURRICULUM REVIEW REPORT

DEPARTMENT OF GEOSCIENCE

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Curriculum Review Team

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Executive Summary

This report expresses the Department of Geoscience's intent and its plans to strive for excellence in Teaching and Learning as an integral part of the University of Calgary's continuing *Eyes High* strategy. A variety of relevant data is presented in the form of 2014-2016 Student Exit Surveys, a Faculty member survey focused on Curriculum Mapping and explicit faculty- and department-level Guiding Questions, and a recent Geoscience Alumni survey. This university-wide effort in Curriculum Review builds upon the newly developed 2009-2013 department-level redesign of its undergraduate curriculum in Geology, and provides an appropriate, forward-looking framework for future developments in Teaching and Learning.

Altogether the data indicate that the Department is doing many things very well in fulfilling its role in Geoscience undergraduate education. Although at times stressed because of it, the Department has been blessed by high student enrolments, and has grown in breadth and diversity to be able to offer students a broad background in geosciences as well as opportunities for specialized courses in senior years. Nonetheless, this review has highlighted a number of items to be addressed in the short to long terms (1 to 5+ years) if we wish to attract the best Canadian and International students.

Based on our findings, key Action Items proposed herein include deliberate plans to: *(i)* Increase the amount and quality of student's Geology Field experiences while aiming to make them sustainable for the institution and affordable for the students; *(ii)* Investigate the possibility of establishing a co-op or internship program in Geoscience, a senior capstone project course, or other mechanisms to bridge the gap between knowledge and skills learned in academia and applied career skills; *(iii)* Improve our student's quantitative reasoning and numerical analysis skills, and; *(iv)* Reconcile the range of opinions regarding the style and quality of assessment tools most commonly used in geoscience courses, by undertaking a comprehensive inventory and evaluation to establish guidelines for effective formative and summative assessments.

Aside from these explicit goals, the Curriculum Review initiated herewith provides a timely framework to evaluate and improve the linkages between Course Learning Outcomes, Program Learning Outcomes, and Faculty of Science Graduate Attributes across the undergraduate Geology and Geophysics curricula. Importantly, the university-wide scale of these efforts ensures that the curriculum-building experience of the Department of Geoscience, as well as that of all other units, will be mutually beneficial to all –the markings of a truly integrative achievement.

Overview and Context of the Program

Formed in 1963, the Department of Geoscience is a vibrant cornerstone of the University of Calgary. Originally the Department of Geology, the growth of additional disciplines such as geophysics, hydrogeology and environmental geology brought about the name change to Department of Geoscience. The Department is internationally and nationally recognized for its strengths in seismology, petroleum geology, hydrogeology, petrology and regional tectonics, among others. Currently the Department offers Bachelor of Science degrees in both Geology and Geophysics, as well as a BSc/Geology with a concentration in Petroleum Geology. Although not the object of this review, the Department also offers thesis- and course-based MSc degrees, an interdisciplinary MSc in Reservoir Characterization, and PhD programs of graduate study.

The Department is ideally located in at least two ways. It is situated in 'Canada's Energy Capital' that provides a fertile ground for Petroleum related research and educational programs and it is located next to world-class geological laboratories exemplified by the Canadian Cordillera (or Rocky Mountains) and the Western Canada Sedimentary Basin. The Department continues to be the Geoscience Department with the highest number of undergraduate students in North America despite the recent downturn in the economic outlook for the energy sector. The department plays a major role in advancing research strategies and priorities of the University of Calgary (*e.g.* Energy Research Strategy) and the Faculty of Science (Toward Low Carbon Energy, Space and Planetary Science). Further, department members play key roles in other high profile institutional research initiatives, including CFREF, that drive institutional aspirations (*Energizing Eyes High)* with the goal pf becoming a top-5 research university in Canada.

Program Outcomes

Geology Program Learning Outcomes:

Graduates from the geology degree program should be able to

1. Identify common Earth materials and interpret their composition, origin and uses.
2. Describe the various geological processes that operate at a variety of temporal and spatial scales and the resulting planetary features.
3. Outline the broad physical and biological history of the Earth and the evidence for that history.
4. Explain the components of the Earth system, and how humans affect, and are affected by, global change.
5. Apply biology, chemistry, mathematics, and physics concepts to analyze geoscientific ideas.
6. Use specific skills such as field methods, analytical techniques, and image/data processing to solve pure and applied problems related to Earth materials, processes and history.
7. Locate, acquire and critically assess relevant Earth science literature and spatial resources such as maps and images.
8. Design and complete independent research in the form of regular term work and/or a senior thesis.
9. Present geoscientific information effectively in a variety of written, graphic, visual and oral formats.
10. Articulate the benefits and responsibilities of working as a member of a team.

Geophysics Program Learning Outcomes:

Graduates from the geophysics degree program should be able to

1. Explain the physical and mathematical principles underlying geophysical systems (including governing equations, kinematics, boundary conditions).
2. Explain and illustrate fundamental geophysical theories (acoustic/elastic waves, potential fields, fluid dynamics, electromagnetics).
3. Incorporate knowledge from other disciplines (e.g. geology, physics, mathematics, environmental science, computer science) into geophysics applications.
4. Discuss how the practice of geophysics (in particular, the search for natural resources and contaminants and characterization of natural hazards) affects different societal stakeholder groups.
5. Formulate geophysical models and assess the validity of a given model based on quantitative and qualitative information.
6. Extract key information and apply a broad range of scientific skills to solve practical geophysical problems.
7. Perform mathematical and physical calculations in an efficient manner using modern computational tools.
8. Contribute effectively and productively to a team that may include members from a variety of disciplines (including geophysicists, geologists, engineers, environmental scientists, entrepreneurs/economists, lawyers, policy analysts).
9. Communicate in written, graphical and oral form the results of geophysical investigations (acquisition, processing, interpretation) to peers in the scientific community and the general public.
10. Direct their own studies and seek out information to gain skills and solve problems that go beyond the scope of the curriculum.
11. Synthesize ideas from multiple aspects of geophysical theory and other disciplines to create novel solutions to familiar and unfamiliar problems.
12. Manage their time to contribute to multiple projects and a range of career aspects including both technical and administrative responsibilities.

Guiding Questions

Faculty-Wide Questions:

1. To enhance the student experience throughout the years in program, are you implementing high-impact practices in this course?
2. If you answered yes, which of the following HIPs have you implemented in this course?
3. If you answered no, what are some of the impediments to implementing HIPs in this course?
4. Are You Interested in Implementing HIPs in Class?

Departmental Questions:

1. Do you feel the Geoscience Program has a competitive edge over similar programs? In what way? What improvements can be made
2. Do students arrive in your class adequately prepared for the course material? If they are under prepared, in what way are they lacking and how could that be addressed within the program?
3. Do you feel that student assessment strategies across the geology and geophysics programs support and capture student learning? To what extent?

Action Plan

Action Plan:

This section is a concise Summary Table of how to address changes emerging from the curriculum review process. Some of the Action items pertain to the Department as a whole (G&G) and others focus specifically on the Geology (GLGY) or Geophysics (GOPH) programs.

Note that a column of 'Who is responsible?' is omitted because the ongoing Curriculum Review can only be successful if it is teamwork, and as such it will be carried-out by all of the faculty in the department with support and feedback from staff and students. The Undergraduate Committee of the Department will serve as main coordinator of tasks with the support of the Dean's office (Associate Deans – Undergraduate and Teaching & Learning).

Recommendation	Action Item	Timeline

S1/G&G – Ensure consistency of curriculum review mapping data.	• Review curriculum mapping data and revise with the guidance of a curriculum review lead:
	  • Individual course instructors.
	  • Groups of instructors within given streams.
		Short term (1-2 yrs)

S2/G&G – Investigate the possibility of programs to bridge the gap between academia and career planning.	• Task interdisciplinary sub-committee to initiate discussions regarding the possibility of a co-op or internship program, a senior capstone project course, or other mechanisms.	Short term (1-2 yrs)
S3/G&G – Provide information and examples on effective assessment strategies used in Geoscience courses.	• Incorporate brief presentations/demos in departmental meetings.	Short term (1-2 yrs)
M1/G&G – Based on results of discussions on Action Item S2/G&G, plan for development of such a support program.	• Collaboration of the S2/G&G sub-committee with Undergraduate Committee.	Medium term (2-4 yrs)
S3/G&G – Examine the scaffolding of program learning objectives (PLO) that focus on science communication.	• Task interdisciplinary sub-committee to conduct inventory of teaching and learning activities focused on oral and written science communication skills	Short term (1-2 yrs)
M2/G&G – Based on results of S3/G&G Action Item, improve the scaffolding of program learning objectives (PLO) that focus on science communication.	• Collaboration of the S3/G&G sub-committee with Undergraduate Committee.	Medium term (2-4 yrs)

Recommendation	Action Item	Timeline
S1/GLGY – Evaluate the need to require additional, upper-level Field Schools in the Geology curriculum, and the feasibility to offer them.	• Monitor enrollments. • Investigate funding models. • Modernize delivery of field schools.	Ongoing and short-term (1 year)
S2/GLGY – Review and modify original design of 'new' GLGY curriculum core courses. *[in conjunction with S1/G&G Action Item].*	• Task course- and stream-based sub-committees with re-evaluation of core courses. *[starting with 1st and 2nd year courses, then 3rd year]*	Short term (1-2 yrs)

M1/GLGY – Evaluate extent of quantitative/numerical skills of geology students and knowledge base of fundamental science concepts (Chem, Bio, Phys) as applied in geoscience.	• Conduct inventory of problems used in teaching of all GLGY courses, which include:
	  • Quantitative/numerical reasoning and skills.
	  • Application of fundamental science concepts (Chem, Phys, Bio).
		Medium term (3-4 yrs)

L1/GLGY – Improve quantitative/ numerical skills and knowledge of fundamental science concepts based on results of M1/GLGY Action Item.	• Task course- and stream-based sub-committees to make recommendations to improve:
	  • Quantitative/numerical reasoning and skills.
	  • Application of fundamental science concepts (Chem, Phys, Bio).
		Long term (5+ yrs)

M2/GLGY – Evaluate the types of assessment tools used in Geology courses and perceived effectiveness	• Conduct inventory of assessment tools in all GLGY courses, which include:
	  • Types and styles of questions.
	  • Knowledge/skills required to provide answers.
		Medium term (3-4 yrs)

L2/GLGY – Improve assessment tools used in Geology courses based on results of M2/GLGY Action Items.	• Task course- and stream-based sub-committees to make specific recommendations to improve assessment tools.	Long term (5+ yrs)

Recommendation	Action Item	Timeline
S1/GOPH – Compile all Course Learning Objectives currently assigned to courses, and examine them in isolation from their courses, identifying connections with Program Learning Objectives.	• Compile comprehensive list of GOPH CLOs • Map low level CLOs to PLOs	Short term (1-2 yrs)
S2/GOPH – Discuss any significant gaps in the GOPH curriculum identified in S1/GOPH Action Item.	• Present results of mapping from S2/GOPH Action Item to GOPH faculty, students and other stakeholders • Gather feedback on any gaps observed by stakeholders • Special attention to integration of fundamental mechanics and mathematics concepts throughout the GOPH curriculum	Short term (1-2 yrs)
M1/GOPH – Building on the S1/GOPH and S2/GOPH Action Items, revise the PLOs and fundamental CLOs of the GOPH program to categorize the fundamental learning objectives.	• Revise top-level PLOs for GOPH program: o Add bottom level CLOs to GOPH program based on gaps identified in S2/GOPH Action Item o Delete redundant bottom level CLOs from GOPH program to reduce overlap between courses o Modify existing bottom level CLOs to improve alignment with modern practice of geophysics • Update mapping between bottom level CLOs and top level PLOs	Medium term (3-4 yrs)
L1/GOPH – Revise and/or restructure the GOPH curriculum to support the revised top level PLOs, scaffolded by the revised bottom level CLOs from M1/GOPH Action Item.	• As applicable: o Re-assign revised CLOs to existing courses o Eliminate redundant courses to improve program efficiency o Add courses or modules to fill gaps identified in curriculum o Modify structure of GOPH program to improve support for student-centered learning paradigm	Long term (5 yrs)