Overview

Geology is the study of the origin, composition, structure, and history of Earth and the complex geologic processes shaping and re-shaping the planet over time. Geologists have a diverse and critical role in society. They apply their knowledge of earth materials and structures to locate important life-sustaining mineral, energy, and water resources; they examine the historical record of geologic events preserved in the rock and fossil record to predict the behavior of Earth in the future; and they investigate geologic hazards such as volcanic eruptions, earthquakes, and floods to help prepare for future events.

Some of the greatest challenges facing humanity including declining supplies of energy and mineral resources, water shortages, pollution, and changing climate are directly related to geology. Solutions to these problems require highly skilled and broadly trained geoscientists. The United States Department of Labor projects that employment of geoscientists will grow by 21% in the next decade—much faster than the overall average†.

UWRF has a rich history of providing geology education. A geology course was listed in the very first River Falls Normal School catalog in 1875. Although much has changed from the late 1800s, our commitment to providing high-quality undergraduate education has remained central to our program. From its earliest beginnings, geology had a strong connection to soil science and agriculture and by 1966 the geology program was moved from the then School of Arts and Science and formally became part of the College of Agriculture, which was later renamed the College of Agriculture, Food, and Environmental Sciences (CAFES). This connection to agriculture gives our geology program a distinctive and unique identity compared to other geology programs in Wisconsin and nationwide. To our knowledge we are one of the only geology programs in the nation associated with a college of agriculture.

The mission of the geology program at UWRF is: To provide students with a strong foundation of geological expertise by providing rich classroom, field, laboratory, and research experiences that emphasize a multidisciplinary understanding of the Earth system.

Our program is committed to providing students a broad but comprehensive geology degree. Rather than specialize in a certain sub discipline, we offer a wide range of technical geology courses. Field work and hands-on learning are emphasized in all of our geology core courses. This is critical since geology is inherently a field-based science. Our program also requires that students complete at least one regional geology field course, where students spend approximately two weeks applying their classroom knowledge and learning about the geology of a different part of North America. A capstone experience at the end of their program gives students the opportunity to do undergraduate research with a faculty mentor. Our program prepares our students for diverse job possibilities both in government and the private sector as well as graduate school.

1. **Learning Outcomes**

1.1. **A graduate with an undergraduate degree in Geology will be able to:**

1. Demonstrate a fundamental understanding of earth history, earth materials, and how the Earth system responds to internal and external forces, including humans, and be able to apply their technical knowledge to address relevant problems.

2. Utilize geologic maps, field and laboratory equipment and instrumentation, software, and other technologies to produce, analyze, and interpret observational and numerical data to test hypotheses and generate conclusions.

3. Access, critically evaluate, and synthesize scientific information related specifically to geology and the physical sciences in general.

4. Effectively articulate scientific concepts or the results of scientific research in written and oral form to both technical and general audiences.

5. Develop professionally and confidently network and collaborate with professionals in the geosciences and related disciplines.

1.2. **Curriculum Structure**

All students within the Geology major follow the same academic plan and take all of the core geology courses. There are no options or tracks. In addition to the core geology courses, students select from a list of approved courses for elective credits. The program has assembled suggested emphasis areas for students interested in specializing in specific areas within geology. The program does not require a minor; however, students commonly complete minors in Hydrogeology and Geographic Information Systems.

1.3. **Learning Outcomes & External Stakeholders**

There is currently no geology higher education accreditation program in the United States. The program learning outcomes we have established reflect the standards and principles established by professional organizations such as the Geological Society of America and American Geosciences Institute. Our program outcomes are also aligned with the Earth Science Literacy Principles established by the Earth Science Literacy Initiative, a committee supported by the National Science Foundation. Students graduating with a degree in our program also meet the requirements for certification as a Professional Geologist in many states, including Wisconsin and Minnesota (not every state administers/requires this type of licensure).

Our faculty are well connected to local governmental agencies and private companies that hire geologists and several have worked themselves in private industry. With these connections, we have both informal and formal opportunities to communicate with employers regarding curriculum related issues and needs.
1.4. Learning Outcomes and the UWRF Strategic Goals

The geology program and its learning outcomes are well-aligned with the UWRF strategic goals:

1.4.1. Distinctive Academic Excellence: The Geology major at UWRF is a broad and comprehensive geology degree. We offer courses such as paleontology and geophysics that are uncommon amongst undergraduate institutions that enrich our students and enhance their expertise. Our program emphasizes field and other hands-on learning experiences taking advantage of the amazing outdoor environments such as the Kinnickinnic River and bedrock formations that we have locally available (supports learning outcomes #1 and #2). Nearly all of our core geology courses have at least one course field trip. Students also complete at least one regional geology field course, where they spend up to two weeks applying their classroom knowledge and learning about the geology of a different part of North America.

Our faculty have won teaching awards including the University Distinguished Teacher, Adviser of the Year, College of Agriculture, Food and Environmental Science Distinguished Teacher and the Keith Wurtz Award for their excellence and innovations in teaching in addition to the Compass Award for support of first year students. One of our core geology courses was one of the first upper division STEM (science, technology, engineering, and mathematics) courses on campus to be taught as a hybrid/flipped course and several other courses are utilizing non-traditional block scheduling to better facilitate integration of active learning experiences (supports learning outcomes #1-#4. Many of our course employ high impact teaching and learning practices such as inquiry-based learning, mock professional projects, etc.

All of our faculty participate in research and scholarly activity, including research with undergraduates, supporting the current UWRF Strategic Plan Initiative (supports learning outcomes #3, #4, and #5). Our students are required to complete an undergraduate project under the mentorship of a faculty member. Both our faculty and students routinely present their research at national and regional geology conferences. Our program has utilized the financial and other resources available from the Undergraduate Research, Scholarly, and Creative Activity office and support the office by serving on committees.

1.4.2. Global Education and Engagement: One of the unique aspects of geology compared to other STEM disciplines is that geologic environments are vastly different from place to place. We strongly encourage our students to explore the diverse geology in other parts of the world and our students have participated in a variety of global education opportunities including Study Abroad: Europe, International Travelling Classroom, and Wisconsin in Scotland (supports all learning outcomes). In addition, several of our faculty have served as program leaders, instructors, or mentors within these programs. Within our courses, activities and projects often include global examples, gleaned in part from our global experiences our faculty have had. A semester study abroad experience is one of the options our students have to complete their capstone requirement.

1.4.3. Innovation and Partnerships: Geology is a dynamic and evolving discipline, which requires us to continually reflect upon our program. Confronting the problems our civilization faces including declining supplies of energy and mineral resources, water shortages, pollution,
and changing climate will require geologists to collaborate with multidisciplinary teams of scientists from a variety of disciplinary backgrounds and perspectives. The geology program proactively seeks collaboration with other programs and departments at UWRF including Environmental Science, Soil Science, Conservation, Geography and Geographic Information Science, Chemistry and Physics.

2. Learning Profile

2.1. Course Assessment

Appendix A contains the course map showing the core geology courses and where knowledge and skills are introduced, emphasized, and reinforced. Since there are no options within the major, all students master the learning outcomes through the same geology core courses. Most students take one of the introductory courses during their first year in the program and then an additional 1-2 technical courses each semester during their second through fourth years.

2.2. Out-of-Classroom Experiences

The Geology program provides and/or facilitates a number of learning experiences outside of the classroom. These opportunities provide students valuable opportunities to apply their knowledge and network with professionals in the geosciences.

2.2.1. Regional Field Course: Regional field courses give students an opportunity to learn about the unique geology of a specific region of North America. The annual trips are developed and led by the geology faculty and include: Lake Superior (Wisconsin/Minnesota/Ontario, Canada), Southwest (Colorado/Utah), Death Valley (Nevada), Appalachian Mountains (North Carolina/Maryland/Pennsylvania), Northeast (Michigan/New York/Maine/Quebec, Canada), Southern (Oklahoma/Texas/New Mexico) and Northwest (Wyoming/Montana/Utah). Students enroll in a 1 credit course during the semester where they learn relevant background information and then spend 7-14 days on an intense field trip. On the trip students build and enhance their field skills including collection of geologic data, use of equipment to make measurements, interpretation of geologic structures, and geologic mapping. The trips also provide opportunities for students to network with local geologists and scientists from the region where they are studying. Although only one regional field course is required, many of our students go on several trips. This experience supports Learning Outcomes #1 and #2 and the UWRF Core Value Academic Excellence.

2.2.2. Capstone Experience: All of the student in the Geology major are required to complete a capstone experience prior to graduation. Students have the option of choosing either an 1.) Field camp (geology-specific field-intensive course taught by other universities), 2.) internship, 3.) research experience, or 4.) study abroad (semester long). The diversity of options allows students to select a capstone experience that best aligns with their career interests. In addition, the diversity of choices clearly align to initiatives within Academic Excellence and Global Engagement.
2.2.3. **Professional Development**: All students in the Geology major are required to complete a professional development requirement prior to graduation. The professional component requires students to attend at least one professional technical or field conference, attend at least two UWRF Geological Society speaker events, and engage in career exploration through events/workshops hosted by UWRF Career Services. A record keeping form is maintained by the academic advisor for each geology major. The advisor communicates to the Registrar’s Office when the student has completed the requirement. This experience supports Learning Outcomes #3, #4, and #5 and the UWRF Core Value Academic Excellence, Inclusiveness, and Integrity.

2.2.4. **UWRF Geological Society**: The UWRF Geological Society is an undergraduate student organization supported by the Geology program. The Geological Society is an active student organization that provides both professional and social opportunities for geology students. The Geological Society helps organize speakers (approximately 2-5 per semester) and other professional development events such as student-led mini-field trips. This experience supports Learning Outcomes #3, #4, and #5 and the UWRF Core Value Student Centered.

2.2.5. **International Experience**: All of our faculty strongly support global education and encourage students to participate in study abroad experience offered by UWRF. Although there is no formal requirement for students to complete an international experience, many of our students see the value in these experiences and participate in programs such as Wisconsin in Scotland, International Travelling Classroom, and Study Abroad: Europe. Students who participate in a global education experience may apply academic credits received to their geology elective credit requirement within our curriculum. This experience supports Learning Outcomes #1, #2, #3, #4, and #5 and the current UWRF Strategic Plan.

3. **Assessment Venues**

3.1. **Integrative Direct Assessments**

3.1.1. **Learning Outcome #1- Demonstrate a fundamental understanding of earth history, earth materials, and how the Earth system responds to internal and external forces, including humans and be able to apply their technical knowledge to address relevant problems.**

3.1.1.1. **Artifact 1a- Professional Knowledge Exam**: Incoming freshman complete a professional knowledge exam during Academic Day. The exam was collectively developed by the geology faculty and covers topics from each of the technical geology courses (Appendix B). The exam questions were carefully chosen to represent core concepts that all geology majors should know upon completing a geology degree rather than technical details. The same exam is administered to graduating seniors enrolled in Senior Seminar (GEOL 485). The overall scores are tabulated and compared.
3.1.1.2. **Artifact 1b- Technical Course Performance:** The faculty teaching each of the technical geology courses (GEOL 150, GEOL 230, GEOL 231, GEOL 326, GEOL 327, GEOL 362, GEOL 441, GEOL 445, and GEOL 450) maintain detailed records of student performance on exams and activities. The overall course performance is tabulated and examined over time to evaluate any trends within a given course. Due to differences in grading schemes and philosophies, these data are not compared between courses.

3.1.2. **Learning Outcome #2- Utilize geologic maps, field and laboratory equipment and instrumentation, software, and other technologies to produce, analyze, and interpret observational and numerical data to test hypotheses and generate conclusions.**

Although this learning outcome is addressed in all of our technical courses, three model assignment/activities used to assess this outcome. All artifacts apply the same evaluation rubric included in Appendix C.

3.1.2.1. **Artifact 2a- Mineral Identification:** After learning about microscopic and identification techniques, students in Mineralogy (GEOL 230) are given an unknown mineral to identify. Using their knowledge, they perform tests and analyses to determine what mineral it is and provide evidence to support their interpretation and conclusions.

3.1.2.2. **Artifact 2b- Groundwater Contour Map:** Students in Hydrogeology (GEOL 445) measure water levels in the network of groundwater wells and stream staff gauges on campus. Data are plotted to a map and contours are created to reveal patterns of groundwater-surface water interactions. The accuracy of the map is evaluated.

3.1.2.3. **Artifact 2c- Glacier Flow Inquiry:** Students in Geomorphology (GEOL 327) complete an inquiry activity examining the factors that influence glacial flow (temperature, basal condition, slope, etc.) and the corresponding magnitude of the impact. Teams of students collect data and evaluate different experimental conditions using the same glacial model setup.

3.1.3. **Learning Outcome #3- Assess, critically evaluate, and synthesize scientific information related specifically to geology and the physical sciences in general.**

This learning outcome is addressed in many of our technical courses to varying degrees. Two model examples are used to assess this outcome. All artifacts apply the same evaluation rubric included in Appendix D.

3.1.3.1. **Artifact 3a- Magma Ocean:** Students in Petrology (GEOL 231) are given a scientific journal article to read on the magma ocean concept. Student will read the article, respond to questions, and engage in a whole-class discussion on the significance and implications that it has for terrestrial planet formation and differentiation. Emphasis is placed on the petrologic interpretation and the viability of extending the idea to the Earth.
3.1.3.2. **Artifact 3b- Glacial Earthquakes:** Students in Geomorphology (GEOL 327) are given a scientific journal article to read on glacial earthquakes. This is a topic that the vast majority of students are completely unaware of and thus have little prior knowledge. Students read the article and respond to a series of questions independently and then as a group. Emphasis is placed on understanding the figures and datasets visually presented in the paper and the underlying processes responsible for the trends in the data.

3.1.4. **Learning Outcome #4- Effectively articulate scientific concepts or the results of scientific research in written and oral form to both technical and general audiences.**

This learning outcome is addressed in many of our technical courses; however, it is most emphasized in our two seminar courses- Sophomore Seminar (GEOL 285) and Senior Seminar (GEOL 485).

3.1.4.1. **Artifact 4a- Sophomore Seminar Paper:** The primary goal of the Sophomore Seminar course (GEOL 285) is to provide students opportunities to develop basic geological skills in addition to building critical thinking and communication skills. Students design and complete a mini-research project and present their findings to class. The project is evaluated using the rubric in Appendix E.

3.1.4.2. **Artifact 4b- Senior Seminar:** The Senior Seminar course (GEOL 485) is taken by graduating seniors. Student read a popular press book over the course of the semester and engage in discussions. Students complete several writing/presentation exercises targeting different audiences (professionals, non-science, general public, etc.). Evaluated using the rubrics in Appendix E and F.

3.1.5. **Learning Outcome #5- Develop professionally and confidently network and collaborate with professionals in the geosciences and related disciplines.**

3.1.5.1. **Artifact 5a- Professional Development:** As previously described, all students in the Geology major are required to complete a professional development requirement prior to graduation. The professional component requires students to attend at least one professional technical or field conference, attend at least two UWRF Geological Society speaker events, and engage in career exploration through UWRF Career Services workshops/events. A record keeping form is maintained by the academic advisor for each geology major. For assessment purposes, faculty tabulate the total number of conferences attended, speaker events, and UWRF Career Service events. A copy of the Professional Development form is included in Appendix G.
3.2. Indirect Assessment

3.2.1. **Student Course Satisfaction Survey:** Faculty teaching geology courses use the standard university course evaluation form to get feedback from students within a specific technical course. These data are tabulated and examined for trends in student satisfaction and course perceptions and compared to data from other majors (if available). In addition, some faculty administer a supplemental survey to collect more in-depth information about the course material and structure. Survey data are collected on a six point scale using the UWRF course survey.

3.2.2. **Student Learning Outcome Feedback Survey:** Each year the graduating students complete an annual survey to examine how students perceive their learning in the Geology program and how courses have helped them to meet their needs. Their perceptions of each learning outcome are evaluated on a six point scale (Appendix H).

3.2.3. **Alumni and Employer Advisory:** Each semester alumni and employers are invited to participate in the Senior Seminar to provide career advice and networking opportunities for our graduating seniors. These individuals represent diverse employment sectors (industry, consulting, government, academic, etc.). As part of their visits, program faculty engage in meaningful discussion about trends and issues in geology. Emphasis is placed on conversation that helps our faculty make decisions regarding curriculum needs and modifications we might consider to enhance the preparation, marketability, and success of our graduates. The salient points from the discussion are summarized and documented for future consideration. An electronic file is stored on the T: drive.

4. **Assessment Process**

4.1. **Accreditation and Program Stakeholders:** There is currently no geology higher education accreditation program in the United States. The primary stakeholders for the Geology program are enrolled students and geology faculty, while secondary stakeholders for the program include employers or graduate schools, geology alumni, and UWRF.

4.2. **Learning Outcome Assessment and Accountability:** Each learning outcome is assessed on an annual basis (note: not all artifacts will be collected every year since some courses are offered every other year). Data/artifacts are collected by the faculty member responsible for teaching the course. Numerical and rubric data are maintained in Excel files. Examples of projects and activities not submitted by students in digital format are scanned where appropriate. All electronic files are stored on the T: drive for access by faculty and stakeholders with proper credentials.

4.3. **Assessment Cycle and Accountability:** The Geology program uses a three-year assessment cycle (year=academic calendar year). For this assessment cycle, an Assessment Plan and Assessment Report are submitted to the UWRF Assessment Committee. All of the faculty participate in the assessment process; however, the program assessment coordinator is responsible for preparing reports, communicating with the Assessment Committee, updating the geology faculty with important assessment information.
4.4. Assessment Discussion and Review: The geology program faculty meet weekly throughout the academic year to discuss issues pertaining to the program including assessment items. These meetings provide a venue to continually engage in discussions on how to improve the program and better meet the needs of students and other stakeholders.

At the end of each academic year, the geology program assessment coordinator organizes and facilitates an assessment meeting. The meeting has four major components:

a.) Review and Discussion- review data and artifacts for each of the learning outcomes; discuss issues and concerns supported by the data; share insights, concerns, and course-specific happenings; document findings.

b.) Opportunities- faculty discuss potential opportunities to improve the program and students’ learning and potential revisions to learning outcomes.

c.) Action Plan- based on opportunities identified, the program assessment coordinator delegates faculty to further research and/or implement potential changes. Depending on the nature of the item, the program coordinator determines an appropriate timeline and schedule to meet for follow-up discussion and review.

d.) Documentation- the program assessment coordinator documents the above items and communicates any necessary findings, issues, or action plan items with the Department of Plant and Earth Science Chair. A document of the annual assessment meeting will be stored on the T: drive at the following address: T:\CAFES\Plant and Earth Science\GEOLOGY\Assess - Geology Program. These files can be accessed by faculty and stakeholders with proper credentials.
# Appendix A - Course Map

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<thead>
<tr>
<th>Introductory Courses</th>
<th>Outcome #1</th>
<th>Outcome #2</th>
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<th>Outcome #4</th>
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<td>GEOL 101: Introduction to Geology</td>
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<td>GEOL 150: Global Change</td>
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<td>GEOL 327: Geomorphology</td>
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<td>GEOL 362: Stratigraphy &amp; Sedimentation</td>
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<td>Geology Professional Courses</td>
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<td>GEOL 485: Senior Research Exp.</td>
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*I=introduced; E=emphasized; R=reinforced*
Appendix B - Knowledge Exam

Geology Major
Entrance Pre-Test

Welcome to the Geology program at UWRF!! We are excited to have you in our major and look forward to getting to know you over the next several years. We are committed to providing you the best possible learning experience. The following questions are used to assess your knowledge when you first enter our program. Complete the following questions to the best of your ability—no need to stress or overthink your answers. When you are near graduation you will be given the same questions and we will use the results to reflect upon your learning.

Welcome to the Geology program at UWRF!! We are excited to have you in our major and look forward to getting to know you over the next several years. We are committed to providing you the best possible learning experience. The following questions are used to assess your knowledge when you first enter our program. Complete the following questions to the best of your ability—no need to stress or overthink your answers. When you are near graduation you will be given the same questions and we will use the results to reflect upon your learning.

1. Diamond is harder than graphite because:
   a. diamond is made of a stronger material
   b. the chemical bonds in diamond are stronger than those in graphite
   c. graphite has a higher melting temperature
   d. diamonds are formed in mountain belts
   e. graphite is not a pure mineral

2. The ________ molecule is the foundation of 90% of minerals in the Earth’s crust.
   a. CO₃
   b. SO₄
   c. SiO₄
   d. O₂
   e. P₂O₅

3. Earth has many _____ mineral species than Mars because:
   a. more; life exists on Earth and indirectly led to new environments of mineral formation
   b. more; the number of mineral species decreases with distance from the Sun
   c. less; the number of mineral species increases with distance from the Sun
   d. more; Mars no longer has plate tectonics
   e. less; Mars is the “red” planet with >1000 species of Fe-bearing minerals

4. The specific arrangement of atoms to form minerals is primarily controlled by:
   a. the size of the central cation
   b. the size of the central anion
   c. the charge of the central cation
   d. whether or not the mineral is precipitating from water
   e. the ratio of the cation size to the anion size
5. As a basalt cools, the first mineral to begin to crystallize is almost always:
   a. Clinopyroxene
   b. Garnet
   c. Plagioclase
   d. Olivine
   e. Ilmenite

6. Stratovolcanoes are almost always associated with which tectonic setting?
   a. subduction zones
   b. hot spots
   c. continental rifts
   d. mid-ocean ridges
   e. continent-continent collisions

7. Mantle melting leads to the formation of:
   a. Gabbro
   b. Basalt
   c. Carbonatite
   d. Peridotite
   e. Fe-Ni alloy

8. Rocks formed under the same metamorphic conditions but containing different minerals:
   a. are in the same metamorphic facies
   b. must have had different protoliths
   c. must have had the same protolith
   d. a & b
   e. a & c

9. Which of the following geologic events has had the greatest effect on life?
   a. continental collisions
   b. extraterrestrial impacts
   c. volcanic eruptions
   d. earthquakes
   e. landslides

10. The geologic timescale was originally developed as the result of advances in our understanding of:
    a. geologic processes
    b. radiometric dating
    c. fossils
    d. tectonics
    e. geophysics
11. Which of the following groups of organisms lived during the same geologic era?
   a. Trilobites and Angiosperms
   b. Pentameroides and Mammoths
   c. Theropods and Archaeocyathids
   d. Receptaculitids and Eurypterids
   e. Nothosaurs and Mammoths

12. Fossil A has a range of Devonian through Permian. Fossil B ranges from Mississippian through Triassic. Fossil C ranges from Ordovician through Pennsylvanian. What is the age (period) of the rock unit containing fossils A and C, but not B?
   a. Permian
   b. Pennsylvanian
   c. Devonian
   d. Mississippian
   e. Ordovician

13. Suppose that we wanted to draw the cross section x-y to the right. Which of the following is a correct statement concerning the cross section?
   a. the fold that was shown would be overturned
   b. the cross section would display a syncline
   c. the beds would look as if they were dipping at an angle less than 35°
   d. the beds would show a strike-slip fault
   e. the vertical and horizontal scales would have to be the same

14. Which of the following would typify a mountain range such as the Alps, Appalachians or Himalayas?
   a. basaltic volcanism, minor folding and caldera formation
   b. gentle, folding, strike-slip faults and dynamic metamorphism
   c. craters, overturned folds and ejecta sheets
   d. tight folding, nappes, thrust fault sand regional metamorphism
   e. normal faulting, uplifted basement, upright folding and andesitic volcanism

15. Suppose that you found an outcrop that had inclined planes on which you saw chatter marks and slickensides. Perpendicular to these planes was surfaces showing layering with both cross bedding and graded bedding. Which of the following would be the best interpretation of this locality?
   a. a thrust fault, offsetting glacial lake sedimentary layers
   b. the limb of a fold showing flexural slip of sandstone strata
   c. strike-slip faulting of sediments formed in a desert environment
   d. the formation of a sill in an area that had been tilted
   e. impact of an asteroid had deformed shallow marine sedimentary layers

16. Which of the following factors increases the likelihood that a rock will break?
   a. a higher confining pressure (i.e. being buried deeper)
b. having a low fluid pressure within the pores
c. having no crystal boundaries (i.e. being uniform in texture)
d. developing small cracks throughout the rock
e. being subject to stresses that are almost equal in all directions.

17. Which of the following is the best interpretation of the data shown in the image?

a. this shows the first multiple of the seabed in an offshore seismic section
b. this is a side scan sonar image of the mid-ocean ridge
c. this is an image if two volcanic cones on the surface of Venus
d. this shows P and S arrivals from an earthquake as a function of epicentral distance
e. this demonstrates topographic variation as a function of distance from the coast.

18. Instrumental analysis discovers that there are equal amounts of Potassium-40 and Argon-40 trapped in the feldspars of an unmetamorphosed igneous rock. Which of the following is the best deduction.

a. since there has been no metamorphism the K\textsuperscript{40} decay system has not started
b. this ore can be mined for use in generating nuclear power
c. the rock is too old to be dated reliably using K-Ar
d. the Argon-40 concentration shows that the rock is about 1 billion years old
e. the time since the crystallization of this rock is approximately the half-life of K\textsuperscript{40}

19. If you needed to say something about the rate of continental drift in the Precambrian, what area of geology do you think would be the most helpful?

a. Paleontology
b. Paleomagnetism
c. Stratigraphy
d. Seismology
e. Tectonics

20. Which of the five indicated measurements in the diagram to the right is the critical one needed to determine how far away an earthquake is from where this record was made?

a. Point a
b. Point b
c. Section c
d. Section d
e. Section e
21. The advance or retreat of a glacier depends mostly on:
   a. the temperature of the ice
   b. the viscosity of the ice
   c. the hardness of the ice
   d. the amount of accumulation versus ablation
   e. the mean air temperature during winter months

22. Most karst features such as caves, sinkholes, disappearing streams, etc. are found in regions with bedrock containing calcite or dolomite. Calcite and dolomite are soluble in acidic waters. What is the dominant source of the acidity producing these karst features?
   a. sulfate from the atmosphere
   b. trace levels of sulfate in the bedrock
   c. carbon dioxide in the atmosphere
   d. carbon dioxide in the soil above the bedrock
   e. chlorine radicals in groundwater

23. Soils develop through the actions of physical and chemical weathering. Soils are most likely to be deepest and well-developed under which condition?
   a. warm and wet climate
   b. warm and dry climate
   c. bedrock containing high amounts of salts
   d. lack of vegetation
   e. near the margins of a tectonic plate

24. Base level of a stream is important because it controls:
   a. the velocity of water in a stream channel
   b. the amount of meandering a stream can do
   c. the size and amount of sediment a stream can carry
   d. extent to which a stream can downcut
   e. the susceptibility to pollution

25. The normal sequence of events in the production of sedimentary rocks is:
   a. weathering, erosion, deposition, lithification
   b. erosion, weathering, deposition, lithification
   c. weathering, erosion, lithification, deposition
   d. deposition, erosion, weathering, lithification
   e. lithification, deposition, weathering, erosion

26. How would you recognize a transgressive sedimentary sequence?
   a. change in the thickness of limestone beds
   b. change from nearshore to offshore rocks in a rock column
   c. change of offshore to nearshore rocks in a rock column
   d. the presence of a non-conformity
   e. the presence of plant fossils
27. Which one of the following is currently the dominant mechanism on earth for transporting and depositing geologic materials prior to the deposits forming sedimentary rocks?
   a. flowing water (current flow in water)
   b. strong winds over arid areas
   c. downslope mass movement due to gravity
   d. heating and melting of rocks
   e. cementation of grains

28. What is the significance of red colored sedimentary rocks?
   a. the red color is from red minerals such as potassium feldspar
   b. the red color indicates abundant organic material environment
   c. the red color indicates the potential for oil and gas deposits
   d. the red color indicates deposition in the presence of abundant oxygen
   e. there is no significance because minerals should never be identified by color

29. Artesian wells flow because the water in them is:
   a. confined and under pressure
   b. pulled to the surface by capillary action
   c. subject to low hydrostatic pressure relative to atmospheric pressure
   d. hard and resists the pull of gravity
   e. soft and fluid

30. Hydraulic conductivity is:
   a. the effectiveness of the driving force causing water movement
   b. the quantity of water moving through a rock in a given amount of time
   c. the average velocity in water-filled pore space
   d. the ease with which water flows through a rock
   e. how well a rock transmits water

31. An aquitard is a rock layer:
   a. with no water storage capacity
   b. that does not transmit water easily
   c. with high permeability
   d. that is not affected by groundwater pumping
   e. that is under pressure

32. If you wanted to direction the direction of groundwater movement, which of the following would be the most useful measurement?
   a. hydraulic head
   b. porosity
   c. permeability
   d. flux
   e. saturated conductivity
## Appendix C - Learning Outcome #2 Rubric

<table>
<thead>
<tr>
<th></th>
<th>Exemplary</th>
<th>Accomplished</th>
<th>Limited</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Problem and Hypotheses</strong></td>
<td>Problem is clearly stated; hypotheses are appropriate and supported by background knowledge</td>
<td>Problem is addressed but lacks full understanding; hypotheses are provided but not sensible or supported by background knowledge</td>
<td>Problem is poorly understood and articulated; hypotheses are not provided or relevant</td>
</tr>
<tr>
<td><strong>Data Collection/Implementation</strong></td>
<td>Proper use of equipment, maps, instrumentation, etc.; data is complete and collected in an orderly manner</td>
<td>Reasonable use of equipment, maps, instrumentation, etc.; data is mostly complete and collected in reasonable manner</td>
<td>Equipment, maps, instrumentation, etc. not used as intended; data is incomplete and collected in a disorderly manner</td>
</tr>
<tr>
<td><strong>Data Analysis</strong></td>
<td>Appropriate use of graphs, photos, tables, etc. to display data; professional quality visuals</td>
<td>Some use of graphs, photos, tables, etc. to display data; good quality visuals</td>
<td>Limited use of graphs, photos, tables, etc. to display data; poor quality visuals</td>
</tr>
<tr>
<td><strong>Data Interpretation/Synthesis/Conclusions</strong></td>
<td>Interpretations and conclusions are well supported by data; sources of error have been considered; explanation is made for how/why the hypotheses were supported or rejected</td>
<td>Interpretations and conclusions are supported by data but not clearly articulated; some sources of error have been considered; attempted explanation of how/why the hypotheses were supported or rejected</td>
<td>Interpretations and conclusions are not supported by data and not well articulated; sources of error have not been considered; incomplete explanation of how/why the hypotheses were supported or rejected</td>
</tr>
</tbody>
</table>
### Appendix D- Learning Outcome #3 Rubric

<table>
<thead>
<tr>
<th></th>
<th>Exemplary</th>
<th>Accomplished</th>
<th>Limited</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Content</strong></td>
<td>Detailed understanding of the paper’s core concepts; no misconceptions</td>
<td>Basic understanding of the paper’s core concepts; no misconceptions</td>
<td>Superficial or incomplete understanding of the paper’s core concepts; some misconceptions</td>
</tr>
<tr>
<td><strong>Data Interpretation</strong></td>
<td>Accurate explanation and identification of trends and able to draw appropriate conclusions from data; recognition of errors and inaccuracies</td>
<td>Reasonable explanation and identification of trends; some conclusions not supported by data; recognition of some errors and inaccuracies</td>
<td>Limited explanation and identification of trends; conclusions not supported by data; little or no recognition of error and inaccuracies</td>
</tr>
<tr>
<td><strong>Geologic Context and Processes</strong></td>
<td>Exceptional understanding of geologic processes and information discussed; connects information to material learned in class</td>
<td>Basic understanding of geologic processes and information discussed; partially connects information to material learned in class</td>
<td>Incomplete understanding of geologic processes and information discussed; little or no connection of information to material learned in class</td>
</tr>
<tr>
<td><strong>Implications and Scientific Merit</strong></td>
<td>Implications and the scientific merit of the research are clearly and thoughtfully explained; limitations of study are explained; strong understanding of how the information contributes to scientific knowledge</td>
<td>Implications and scientific merit are addressed but not well developed; limitations of the study are mentioned but not explained; basic understanding of how the information contributes to scientific knowledge</td>
<td>Implications and scientific merit are incomplete; limitations of the study not explained; minimal understanding of how the information contributes to scientific knowledge</td>
</tr>
<tr>
<td>Writing</td>
<td>Exemplary</td>
<td>Accomplished</td>
<td>Limited</td>
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<td>---------------------------------</td>
<td>----------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Grammar</td>
<td>Expresses ideas concisely and very clearly, with rare grammatical errors.</td>
<td>Some grammatical errors on each page, and occasional awkward or confusing sentences or paragraphs.</td>
<td>Difficult to understand meaning at all due to awkward sentence structures, very poor word choice &amp; abundant grammatical errors. Two or more key components missing. Inappropriate scientific writing, no citations, lack of formatting.</td>
</tr>
<tr>
<td>Paragraph structure</td>
<td>Nearly all paragraphs focus on distinct ideas.</td>
<td>Adequate citations.</td>
<td></td>
</tr>
<tr>
<td>Clarity of language Components</td>
<td>Consistent voice (use of tenses).</td>
<td>Some errors in scientific style &amp; formatting.</td>
<td></td>
</tr>
<tr>
<td>(Abstract, Intro., Methods, ...)</td>
<td>All components present &amp; in correct style.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Format (citations, units, ...)</td>
<td>Appropriate scientific writing style, formatting (use of units, significant figures), excellent use of citations throughout</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Graphics</td>
<td>Graphics are sufficient, appropriate, significantly enhance the paper.</td>
<td>Some graphics are used, but more than a few additional would greatly enhance the paper. Graphics express a concept, but some aspects are confusing. Not of professional quality. Required components are occasionally lacking.</td>
<td>Insufficient or no graphics are utilized, when graphics would be beneficial. When graphics are used, they are of such poor quality, that their meaning is obscure. Lack many needed components.</td>
</tr>
<tr>
<td>Appropriateness</td>
<td>Style is professional, aesthetically pleasing, clear, legible throughout.</td>
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<td></td>
</tr>
<tr>
<td>Aesthetics</td>
<td>All required components present.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Legibility &amp; Clarity</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Sufficiency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Components (scale, N-arrow, ...)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organization</td>
<td>Paper is extremely well structured. Each section flows logically to the next.</td>
<td>Paper has some structural problems. Overall, logic can be followed. Some confusing sections.</td>
<td>Lacks structure. Reader cannot follow logic. Confusing throughout.</td>
</tr>
<tr>
<td>Logical order</td>
<td>All components contribute to the line of reasoning.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Components (objectives, approach, results, etc.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Exemplary</strong></td>
<td><strong>Accomplished</strong></td>
<td><strong>Limited</strong></td>
<td></td>
</tr>
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<td>---------------</td>
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<td></td>
</tr>
<tr>
<td><strong>Introduction</strong></td>
<td>Speaker clearly introduces the topic and their research objectives in a meaningful way</td>
<td>Speaker introduces the topic and their research objectives</td>
<td>Speaker does not introduce the topic or state their research objectives</td>
</tr>
<tr>
<td><strong>Organization</strong></td>
<td>Speaker presents information in a logical, focused, and interesting sequence which audience can follow</td>
<td>Speaker presents information in a logical sequence which audience can follow</td>
<td>Audience cannot follow presentation</td>
</tr>
<tr>
<td><strong>Knowledge of Subject/Terminology</strong></td>
<td>Speaker uses scientific vocabulary and clearly defines terms; cites previous work from numerous sources</td>
<td>Speaker uses scientific vocabulary and defines terms; cites previous work (if available)</td>
<td>Speaker uses little or no scientific vocabulary and/or does not define terms</td>
</tr>
<tr>
<td><strong>Methods</strong></td>
<td>Procedures are clearly outlined and show thoughtful consideration of sources of error</td>
<td>Procedures are clearly outlined</td>
<td>Procedures are not outlined or are fundamentally flawed</td>
</tr>
<tr>
<td><strong>Summary/Conclusion</strong></td>
<td>Data is sound; data analysis is clear and shows impeccable logic and coherence</td>
<td>Data is sound; data analysis is clear and presenter uses logical explanations</td>
<td>Data is not sound and/or the data analysis is ambiguous</td>
</tr>
<tr>
<td><strong>Dictation &amp; Eye Contact</strong></td>
<td>Student is understandable and easy to hear; makes constant eye contact</td>
<td>Student is understandable and easy to hear; makes some eye contact but still dependent on notes</td>
<td>Student is hard to understand/hear and/or read during the entire presentation</td>
</tr>
<tr>
<td><strong>Visual Aids</strong></td>
<td>Diagrams and/or graphs relate to the research project but are not properly labeled</td>
<td>Diagrams and/or graphs convey relevant and accurate information about the research project</td>
<td>Diagrams and/or graphs help explain the research project and are properly labeled</td>
</tr>
<tr>
<td><strong>Appearance and Rapport with Audience</strong></td>
<td>Student has a professional appearance/ bearing but shows little enthusiasm for the topic</td>
<td>Student has a professional appearance and bearing; shows enthusiasm for the topic</td>
<td>Student has a professional appearance and bearing; shows great enthusiasm for the topic</td>
</tr>
<tr>
<td><strong>Questions and Answers</strong></td>
<td>Speaker recognizes the thrust of questions and attempts to answer them</td>
<td>Speaker recognizes the thrust of questions and answers them clearly</td>
<td>Speaker recognizes the thrust of questions and answers them clearly with some evidence</td>
</tr>
</tbody>
</table>
Appendix G - Professional Development Plan Form

University of Wisconsin - River Falls, Department of Plant and Earth Science
Geology Major

Professional Development Plan

Part 1: Student Information
Part 2: Program Participation
Part 3: Professional Development
Part 4: Career Exploration
Part 5: Capstone Experience
Part 6: Final Steps

Part 1: Student Information

Name: ________________________________ W#: __________________
Advisor: ______________________________

Program Entry: Fall Spring (circle one) Year: __________________
☐ Entrance pre-test completed (for program assessment purposes only) Date: __________________

Part 2: Program Participation

We are committed to providing you exceptional academic experiences as you prepare for your career in the geosciences. You will take a diverse number of courses from our outstanding faculty to broadly train you across all aspects of geology and the geosciences. In addition to classroom instruction, we provide valuable learning opportunities outside the classroom that we know you will benefit from participating in. Each year we work hard to bring several speakers to campus of local, regional or national distinction. These events offer great conversation and networking. In addition, the UWRG Geological Society (i.e. GeoClub) hosts a number of different professional, social, and service opportunities. At a minimum, prior to graduation you must attend at least two speaker events.

UWRG Geology Talks Attended (2 required)

<table>
<thead>
<tr>
<th>Name</th>
<th>Topic</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
</tbody>
</table>

UWRG Geological Society (not required but strongly encouraged)

☐ Officer Position(s)/year(s): __________________________
☐ Active Member Year(s): __________________________

UWRG Geology Service Activities (ex. Science Olympiad, Major/Minors Fair, Involvement Fair, etc.) (not required)

Activity: ____________________ Date: ____________________
Activity: ____________________ Date: ____________________
Activity: ____________________ Date: ____________________
Part 3: Professional Development

It is never too early to start establishing your professional network. There are a number of regional, statewide, and national professional organizations related to geology. Examples of local/statewide organizations include: Minnesota Groundwater Association, The Institute on Lake Superior Geology, Geological Society of Minnesota, etc. National organizations include: Geological Society of America (GSA), American Geophysical Union (AGU), American Geological Institute (AGI), etc. These professional organizations host conferences, speakers, field trips, workshops, publish newsletters, sponsor scholarships and a variety of other things that may benefit you even as a student. Many of these organizations have significantly reduced (or free) membership fees for students. We highly recommend that you consider joining one (or more) professional organization.

In particular, conferences are a great way to develop professionally. Most professional organizations sponsor at least one academic conference annually. These conferences provide an excellent opportunity to meet geologists and learn about new and exciting advances, discoveries, research, and technologies through listening to short presentations. In addition, some organizations sponsor field conferences/trips either in addition to, or part of, an academic conference. Field conferences/trips are a great way to see geologists in action and learn about the geology of a new place in a hands-on manner. Many conferences$field trips have significantly reduced participation fees for students. At a minimum, prior to graduation you must attend at least one academic or field conference/trip sponsored by a professional organization. To help defray (or even fully cover) the costs of attending, consider applying for a Falcon Grant through the Undergraduate, Research, Creative, and Scholarly Activity (URCSA) Office at UW-River Falls (http://www.uwrf.edu/SURSCA/FalconTravelGrants.cfm).

Professional Organization Membership (not required)

Organization: __________________________ Year(s): __________
Organization: __________________________ Year(s): __________

Professional Academic/Field Conference Participation (1 required)

Name of Conference: __________________________
Date(s): __________________________
Professional Organization hosting: __________________________
Location (City, State): __________________________

Name of Conference: __________________________
Date(s): __________________________
Professional Organization hosting: __________________________
Location (City, State): __________________________

*Attach documentation of registration/attendance to this document.
Part 4: Career Exploration

We want you to have a great career when you finish your geology degree at UW-River Falls. Doing so will require you to invest time and energy into preparing and planning right now. Preparing documents, applying for jobs, interviewing, and negotiating job offers can be daunting. Career Services at UW-River Falls can help you get prepared (http://www.uwrf.edu/CareerServices/Index.cfm). Their office sponsors events, workshops, career counseling, resources, etc. Their services are free to all students on campus and we want you to take advantage of what they have to offer to give you a jump up in the job marketplace. At a minimum, prior to graduation you must have completed at least two of the following events/services offered through Career Services.

UWRF Career Services Individual Services

☐ Resume Assistance  Date Completed: ____________________________
☐ Career Counseling  Date Completed: ____________________________
☐ Other: ____________________________  Date Completed: ____________________________
☐ Other: ____________________________  Date Completed: ____________________________

UWRF Career Services Events

Many of the events listed below are held twice per academic year. A current event schedule can be found at: http://www.uwrf.edu/CareerServices/Students/CareerEvents.cfm.

☐ Career Fair  Date Participated: ____________________________
☐ Career Fair Prep Session & Networking Social  Date Participated: ____________________________
☐ My First Resume  Date Participated: ____________________________
☐ Etiquette Dinner  Date Participated: ____________________________
☐ Mock Interview Day  Date Participated: ____________________________
☐ Mastering Graduate School  Date Participated: ____________________________
☐ GRE 101: Strategies and Tips for Success  Date Participated: ____________________________
☐ Graduate School Virtual Fair  Date Participated: ____________________________
☐ Other: ____________________________  Date Participated: ____________________________
☐ Other: ____________________________  Date Participated: ____________________________

* Attach documentation of registration/attendance for each session/event to this document.
Part 5: Capstone Experience

Before your last semester at UW-River Falls you will complete a capstone experience. Capstone is designed to be a culminating experience where you bring together all the skills, tools, and experiences you have learned in the classroom into an applied setting. At a minimum, you must complete a 3 credit capstone experience. If your capstone experience is more than 3 credits, the remaining credits may be applied toward directed electives. The following are options for your capstone experience:

Field Camp

Field camp is long tradition in training geologists. It is an intensive course that applies classroom and laboratory training to solve geological problems in the field. Field camps are a great way to learn a variety of skills used by geologists and are highly valued among employers and graduate schools (some even expect you to have completed one). Field camps are offered by a variety of universities and some have a specific focus (i.e. hydrogeology, paleontology, etc.). Field camps are generally 3-6 weeks during the summer. The deadline for application to most field camps is December-February. Students are responsible for course tuition and completing paperwork to transfer of course credits to UWRF; scholarships are available. Field camps generally range from 4-6 credits. Counts as GEOL 490.

Industry Internship

An industry internship is an opportunity offered by an employer to provide a work experience to a student for a limited time period (usually the summer). Internships provide students an opportunity to learn important job skills. Industry internships completed as part of the capstone requirement will be managed through the UWRF CAFES Internship Office. The Internship Office posts some internship opportunities; however, it is the responsibility of the student to find and secure an internship experience. There are many diverse opportunities with consulting/private companies along with state and federal agencies. Most industry internships are paid experiences. For summer internships it is best to be looking from January-March. In addition to work experience, students will complete a project as part of their internship with guidance from a faculty mentor connected with the Internship Office. Your faculty mentor will also visit your internship site during the experience. Industry internships must be a minimum of 380 hours (38 hrs/wk for 10 weeks) for a paid experience. Volunteer internships must be a minimum of 180 hours. Industry internships are taken as GEOL 490 and counts as 3 credits. Students are responsible for course tuition.

Research Internship

For students with a goal of attending graduate school, a research internship is a great choice. Research internships will provide students with the opportunity to conduct original research at a university or research facility. These experiences will build research-based skills such as hypothesis development, experimental design, data collection, instrument usage, data analysis, statistics, and presentation of results. There are a number of great programs that provide research internship experiences. One of the most widely recognized is the National Science Foundation's Research Experience Undergraduate (REU), which has a number of opportunities at institutions and facilities all across the United States. The program provides students with a generous stipend (salary), travel expenses, and housing/food allowances. A limited number of local (UW-River Falls) research internships may be available. These generally require the support of either external or internal grants. Research internships must a minimum of 180 hours. Research internships completed as part of the capstone requirement will be managed through the UWRF CAFES Internship Office with guidance from a faculty member. Your faculty mentor will also visit your internship location during the experience. Research internships are taken as GEOL 285/385 and counts as 4 credits. Students are responsible for course tuition.
Study Abroad

Study abroad experiences are a fantastic way to explore a different part of the world and see some great geology at the same time! UW-River Falls has a rich tradition in providing study abroad opportunities and offers some diverse experiences. To count for your capstone experience you must complete a semester-long study abroad experience. There are two traditional study abroad experiences, Wisconsin in Scotland and Experience China, where students take courses for credit at UW-River Falls. In addition to coursework, students would work with a geology faculty member to design a special project to count towards the capstone requirement. Semester Abroad: Europe is a popular non-traditional program that provides students a rich international research experience in a European country of your choice. Two geology faculty currently serve as coordinators in this program. Study abroad experiences are managed through the UW-River Falls Global Connections Office; additional fees apply. Counts as 3-6 credits of GEOL 490.

Capstone Presentation

Once completed, you will have an opportunity to share your capstone experience in a presentation to your fellow classmates. This is a great way to practice your technical presentation skills and for your classmates to learn about the diverse possibilities available. Your capstone experience faculty coordinator will work with you on the format for the presentation. Presentations will be 12-15 minutes at a UW-River Falls Geological Society (GeoClub) or other event. Your presentation must be completed prior to graduation. It is best to do it the semester after your capstone experience.

Presentation Title: _____________________________________________
Date: _______________________________________________________
Venue/Audience: _____________________________________________

Part 6: Final Steps

You are finally ready to graduate and earn your geology degree! Before your departure we have a couple of final items for you to do. These items relate to our geology program assessment. Your candid feedback and help us identify areas to improve and make our program even better.

☐ Exit Post-Test (for assessment purposes only) Date Completed: _______________________
☐ Exit Survey Date Completed: _______________________
☐ Submit completion to Registrar’s Office Date Completed: _______________________

Permanent contact information / email address: ________________________________

Congratulations! We sincerely hope you enjoyed your time at UW-River Falls. Be sure to stay in contact with us—we would love to know what geologic (and non-geologic) adventures you are up to. You might also want to connect with our Geology Alumni on Facebook.

Dr. Holly Dolliver Dr. Kerry Keen Dr. Ian Williams
# Appendix H - Student Learning Outcome Survey

<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Slightly Agree</th>
<th>Slightly Disagree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1. Demonstrate a fundamental understanding of earth history, earth materials, and how the Earth system responds to internal and external forces, including humans and be able to apply their technical knowledge to address relevant problems.</td>
<td></td>
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</tr>
<tr>
<td>Q2. Utilize geologic maps, field and laboratory equipment and instrumentation, software, and other technologies to produce, analyze, and interpret observational and numerical data to test hypotheses and generate conclusions.</td>
<td></td>
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<tr>
<td>Q3. Access, critically evaluate, and synthesize scientific information related specifically to geology and the physical sciences in general.</td>
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<td></td>
</tr>
<tr>
<td>Q4. Effectively articulate scientific concepts or the results of scientific research in written and oral form to both technical and general audiences.</td>
<td></td>
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<tr>
<td>Q5. Develop professionally and confidently network and collaborate with professionals in the geosciences and related disciplines.</td>
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</tr>
</tbody>
</table>