WWU Geology Department Outcomes Assessment

I. Program outcomes – B.S. Geology

These are our core learning goals for all students who complete a B.S. in Geology.

A. List of program outcomes

Cognitive outcomes - our students will have a deep understanding of the following foundational geologic principles:

1. Earth has a history of biological and physical change over billions of years
2. Earth's surface is affected by dynamic processes on a range of timescales (e.g. erosion, deposition, volcanic activity, earthquakes)
3. Earth's composition varies and these compositions provide the raw materials for the rock cycle
4. The Earth's interior is dynamic and drives plate tectonics
5. Earth scientists use repeatable observations and testable ideas to understand and explain our planet
6. Geology and society are fundamentally inter-related

Skills – our students will have critical skills required by professional geologists

7. Graduates have developed their observational, analytical and quantitative skills (field, lab, computer, and classroom)
8. Graduates can create maps and understand what they tell us about the Earth
9. Graduates will be able to apply physics, chemistry, and mathematics concepts to the study of Earth
10. Graduates (alone or in teams) will be able to present geological information clearly

B. Course outcomes linked to program outcomes

- Detailed course outcomes for all courses in the core major (the documents linked below show specific course outcomes and objectives)

- Geology 211 Physical Geology
- Geology 212 Historical Geology
- Geology 213 GIS in Geology
- Geology 306 Mineralogy
- Geology 310 Geomorphology
- Geology 318 Structural Geology
- Geology 352 Introduction to Geophysics
- Geology 406 Igneous and Metamorphic Petrology
- Geology 409/410 Field Methods/Geologic Mapping (capstone course)
- Geology 415 Stratigraphy and Sedimentology

- The following section explicitly links course outcomes to program outcomes and includes all outcomes in core geology courses that have such links. (numbers indicate core geology courses in which the outcome is addressed in a substantial way)

1. Earth has a history of biological and physical change over billions of years

- Understand how scientists study geologic time and the age of Earth via techniques such as radiometric dating and stratigraphy (211, 212)
- Understand how plate tectonics has influenced continental evolution and deposition (212)
Understand early evolution of Earth and how it came to support life (212)
Understand past and present climate patterns (212)
Understand how the geologic record can be used to interpret Earth history (212)
Understand major patterns in evolution of life (212)

2. Earth's surface is affected by dynamic processes on a range of timescales (e.g., erosion, deposition, volcanic activity, earthquakes)

- Understand how Earth’s landscape is affected by surficial processes such as the effects of water, weathering, and erosion (211)
- Understand the processes of landform formation in terms of interacting systems (lithosphere, hydrosphere, biosphere, cryosphere, atmosphere), specifically the relationships among uplift, weathering, erosion and deposition in fluvial, hillslope, glacial and coastal environments (310)
- Understand the processes by which sediment and sedimentary rocks form: production, transport, deposition, and diagenesis (415)
- Understand how Earth’s surface is affected by deformation (earthquakes, volcanos) (318)

3. Earth's composition varies and these compositions provide the raw materials for the rock cycle

- Understand the structure and composition of Earth (BOTH 211 AND 352)
- Understand the dynamic relationship between Earth processes and the formation of rocks (the rock cycle) (211)
- Understand the relationships among mineral structure, chemistry and properties (306)
- Understand how magmas are generated and how they change as they rise through Earth’s crust (and become igneous rock) (406).
- Understand how rocks change through metamorphism, and how the metamorphic rock produced depends upon protolith, P-T conditions, and H2O availability (406)
- Understand the relationship between types of igneous and metamorphic rocks and plate tectonic environments (406)

4. The Earth's interior is dynamic and drives plate tectonics

- Understand the theory of plate tectonics and how it relates to processes such as volcanoes and earthquakes (BOTH 211 & 352)
- Understand the formation of structures and the kinematics of deformation (318)
- Understand the relative timing of formation of structures and the kinematics of deformation (318)
- Gain a basic understanding of the material properties of rocks and the theory of their mechanical behavior under ductile and brittle conditions from natural and experimental data (318)

5. Earth scientists use repeatable observations and testable ideas to understand and explain our planet

- SWBAT (“Students Will Be Able To”) define the scope of a research problem (310)
- SWBAT formulate hypotheses and test them using rules of evidence (306, 310, 415, 409/410)
6. Geology and Society are fundamentally inter-related

- Understand how human activities have affected Earth’s resources, climate and the effects of natural hazards (211)
- An understanding of ocean/atmosphere/climate processes, including past climatic variations and anthropogenic impacts on climate (211)
- Understand the relative impact of human actions on landscapes relative to ‘natural’ processes (310)

7. Graduates have developed their observational, analytical and quantitative skills (field, lab, computer, and classroom)

- Understand scientific methodology, scientific standards, and how to evaluate sources of scientific information (outcome of GEOL 211 & 352)
- Understand how observations are made (visual, geophysical, geochemical, etc.) and how those observations can be used to make inferences (406, 318)
- Identify and describe minerals and rocks (211, 306, 406)
- SWBAT collect geochemical data using the SEM (306)
- SWBAT identify minerals using a petrographic microscope (306)
- SWBAT understand the usefulness and limitations of models (physical, analytical, computational) for understanding geologic processes (310)
- Identify, access, use, and critically evaluate previous research in literature (310)
- SWBAT use a pocket transit compass (318, 409/410)
- Understand how rocks are classified using modal as well as geochemical classification systems (406)
- Use observations of rock characteristics and rock classification to interpret rock origin (406)
- Understand stratigraphic units and their applications (415)
- Understand how to interpret depositional environment for sedimentary rocks based on rock properties (415)
- Understand the formation of structures and the kinematics of deformation (318)
- SWBAT use Excel, MATLAB, or Mathcad for organizing, plotting, and analyzing data (213, 352)
- SWBAT use Excel, MATLAB, or Mathcad for organizing, plotting, and analyzing data (213, 352)
- Students will have problem-solving skills (e.g., critically review interpretations to be consistent with geologic observations, decide if a result is physically meaningful) (352)
- SWBAT collect data, analyze, evaluate results (310, 318, 415, 409/410)

8. Graduates can create maps and understand what they tell us about the Earth

- Understand how information about Earth can be presented on maps and cross sections (aka 2D representations of 3D features) (211, 318, 409/410)
- SWBAT use ArcGIS to solve geologic problems and make geologic maps (213)
- Understand how to identify and describe landforms from direct observation in the field and from various kinds of representations (310)
- Understand stratigraphic units and their applications (415)
- SWBAT collect and organize field data to produce a geologic map (409/410)
- SWBAT measure and depict geological structures in the field on maps and reports (409/410)
- SWBAT recognize and describe geological units in the field, determine the contact relationships between these units, and depict their location on a map (409/410)
9. Graduates will be able to apply physics, chemistry, and mathematics concepts to the study of Earth

- Understand how to integrate physical principles and experimental data into the study of geologic processes on Earth and other planets (352, 318)

10. Graduates (alone and in teams) will be able to present geological information clearly in written, graphic, and oral forms

- Understand how to design, carry out, interpret, and present the results of research on sediment or sedimentary rocks (415)
- SWBAT communicate results (310, 415)
- SWBAT conduct a geomorphic investigation and effectively report its results in oral and written form (310)
- SWBAT prepare a report describing the geology and the geological history of an area or region based on field mapping results (409/410)
- SWBAT write a concise scientific report that is well-supported by data (306, 310, 318-field, 406-field, 415, 409/410)
- SWBAT produce written lab reports, useful field notes, well-drafted maps and cross sections (310, 318, 415, 409/410)
- SWBAT use discipline appropriate syntax, grammar, usage, punctuation, and spelling (310-318-field, 406-field, 415)
- SWBAT draft, rethink, edit, reconceptualize reports (310, 318-field, 406-field)
- SWBAT use references appropriately in scientific writing (310)
- Students work efficiently and effectively in small groups in the field, laboratory, and classroom to run experiments, make observations, collect data, or write reports (multiple courses)

C. Outcomes Assessment Matrix

- The department has chosen one or two courses in which to assess each of the ten program outcomes. The matrix below shows which courses are chosen for such assessment (red); yellow boxes indicate courses in which the program outcome is addressed but not assessed departmentally.
D. Other methods of program assessment data collection

1. **Passing rate on the Association of State Boards of Geology (ASBOG) Exams (geology licensing exam).** Some of our graduates take this exam, and it is an excellent assessment of Cognitive Outcome #1. The Geology Department will collect data on the number of students who pass the exam within 5 years after graduation. These data will be collected by a faculty member currently on the WA State licensing board, or the Chair. Anecdotal evidence suggests that our graduates have some of the highest rates of passing in the state. For our students who graduate with a BA in Education – Earth Science, the Washington State WEST-E exam can serve the same purpose.

2. **Successful employment in a geology field or acceptance into graduate school.** The chair will keep a record of the number of graduates employed in a geology field or accepted to graduate school. These data will be collected via the department
newsletter. Employment in the field or acceptance to graduate school reflects the preparedness of our students to move on in their profession, signifying that cognitive, behavioral, and affective outcomes of the program have been met by these students.

3. **Longitudinal studies.** We will assess one of the cognitive course outcomes, “*Students will understand how information about Earth can be presented on maps and cross sections*” over the duration of the major. A simple assessment will be given in Geology 211 (and 211a) each year, another more complicated one in Geology 318, and another in 409/410. The percent of students successful on these assessments will be recorded and evaluated by the chair. We will develop a similar assessment for GIS once this becomes established in all of our core courses.

4. **Course Linkage:** In addition to course outcomes and objectives, professors who teach courses for which there is a geology prerequisite will make a brief list of subjects they would like their students to have a working knowledge of when they come into their class. We encourage feedback between professors, e.g. tell a professor of a prerequisite class that students are (or are not) remembering how to identify rocks.

E. **How will the assessment data be used**

1. The assessment data collected through individual course assessments will be the evidence used for course revision. Each professor will submit, as part of their annual report, the outcome(s) assessed for their courses in that academic year and a summary of any changes made as a result of their assessment.
2. The Chair will collect annual course assessments and program assessments as described above and consult with the Geology Department Curriculum & Assessment committee. This group will submit an annual report to the Chair, who will include it in his/her annual report to the Dean and Provost.
3. The Chair will work together with the Curriculum & Assessment Committee to make changes in the program or allocate resources based on analysis of the data collected. This may involve request for resources from the college, changes in resource use, change in number of course offerings, changes in course structure, etc.

II. **Program outcomes – B.S. in Geophysics**

A. **List of program outcomes**

The B.S. in Geophysics requires all of the cognitive outcomes and skills of the B.S. in Geology, plus the following:

**Skill:**

*Il. Will be able to demonstrate general proficiency with concepts and quantitative problems involving Newtonian mechanics, energy and momentum.*

B. **Outcomes Assessment Matrix**

The department has chosen one or two courses in which to assess each of the eleven program outcomes. The matrix below shows which courses are chosen for such assessment.
<table>
<thead>
<tr>
<th>course number</th>
<th>Geol 211</th>
<th>Geol 311</th>
<th>Geol 352</th>
<th>Geol 452</th>
<th>Phys 161</th>
<th>Phys 326</th>
<th>Geol 213, CSCI 139, 140</th>
<th>Phys 363</th>
<th>HOW ASSESSED</th>
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</thead>
<tbody>
<tr>
<td><strong>Geophysics B.S. Cognitive Outcomes</strong></td>
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<tr>
<td>1. Earth has a history of biological and physical change over billions of years</td>
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<td>Outlines and exams that cover the geological time scale will be used to assess the mastery of concepts important to Earth history, including an understanding of &quot;deep time&quot;.</td>
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<td>2. Earth is affected by dynamic processes on a range of timescales (e.g. erosion, deposition, volcanic activity, earthquakes)</td>
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<td>Student understanding of the dynamics of surficial processes will be assessed based on their response to questions about the evolution of the Nooksack river in the stream lab.</td>
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<td>3. Earth’s composition varies and these compositions material properties that govern how the planet evolves</td>
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<td>Two assessments. First, track lab exam grades (igneous lab exam and metamorphic lab exam). Second, choose a subset of samples for which students must provide more detailed answers about rock formation (origin, source, protolith if applicable, plate tectonic environment, etc.) and linking related rocks through the rock cycle</td>
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<td>4. The Earth’s interior is dynamic and drives plate tectonics</td>
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<td>Student understanding of mantle structure and convection will be assessed based on the plate tectonics problem set.</td>
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<td>5. Earth scientists use repeatable observations and testable ideas to understand and explain our planet</td>
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<td>Analysis of the current debate regarding hot spots and mantle plumes</td>
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<td>6. Geology and society are fundamentally inter-related</td>
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<td>Track grades on the Humans as Geomorphic Agents Problem Set.</td>
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<td><strong>Skills</strong></td>
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<tr>
<td>7. Graduates have developed their observational, analytical and quantitative skills (field, lab, computer, and classroom)</td>
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<td>Since students may choose between GEOL 213 or CSCI 139 or 140, no individual assignment may be specified. Thus, course grades for these classes will be used for assessment.</td>
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<td>8. Graduates can create maps, analyze data, and understand what they tell us about the Earth and planets</td>
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<td>Students in GEOL 452 complete maps of the south campus ellipse and present geophysical data on them. Reports from 452 will be used for this assessment.</td>
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<td>9. Graduates will be able to apply physics, chemistry, and mathematics concepts to the study of Earth</td>
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<td>The final examination in Geol 352 (Geophysics) will be used to assess student performance for this outcome.</td>
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<td>10. Graduates (alone or in teams) will be able to present geophysical information clearly in written, graphic, and oral forms</td>
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<td>Reports from geophysical mapping of the south campus ellipse will be used to assess mapping, graphic and written presentation skills.</td>
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<tr>
<td>11. Graduates have demonstrated general proficiency with concepts and quantitative problems involving Newtonian mechanics, energy, and momentum.</td>
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<td>Assessment will be the course grade for Physics 363 as well as a Force Concept inventory.</td>
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