

# **Geology BS Program Assessment Plan 2017-2018**

Prepared by the Geology BS Curriculum Committee  
Zeynep Baran (Chair)  
Tim Masterlark  
Gokce Ustunisik  
Larry Stetler

## **Summary: Tools, Instruments, and Methods Employed to Assess Student Achievement of Program Learning Outcomes**

Geology BS program learning outcomes mapped to Geology BS curriculum. Program learning outcomes assessment rubrics have been mapped out to three performance levels: 1) Masters 2) Proficient 2) Needs significant work. Each learning outcome is assessed in multiple required courses. Multiple elective courses also contribute to our program assessment. Faculty evaluate the technical and scientific content of the senior research projects. The data used for assessment and evaluation of program outcomes is derived from the faculty who teach multiple courses and provide information based on student performances in their courses. Faculty can use a wide range of sources including student assignments, exams, presentations to provide the data. Geology BS Committee collects course-based assessment data from each faculty; review all scores and evaluates results to improve curriculum when modifications are necessary.

### **Summary of Assessment Plan**

Geology BS Program has total eight learning outcomes with associated evaluation criteria listed in the assessment plan. These learning outcomes include:

1. Apply scientific and mathematical knowledge to problems in the geosciences
2. Analyze and interpret geological and other scientific data.
3. Work professionally with a team.
4. Collect geological data (from the literature, field, or laboratory) to answer a scientific question.
5. Understands and applies the ethical standards of the geoscience profession.
6. Communicate effectively in oral and written form.
7. Apply geological knowledge to global systems and human societies.
8. Investigate geological problems using appropriate technology.

Each learning outcome has been lined up with Geological Engineering ABET outcomes for consistency between programs available in our department. Geology BS Curriculum committee mapped out program learning outcomes assessment rubrics to three performance levels including 1) Masters 2) Proficient 3) Needs significant work.

Evaluation criteria for each outcome have been described in the rubrics provided in the assessment plan document. Multiple courses required by the Geology BS program will address and assess learning outcomes and associated criteria based on student performances evaluated by the course instructor.

Table-1 shows outcome criteria addressed in each required course and last row on the table shows how many times each criterion has been addressed. Number 1 indicates criterion with minor importance and number 2 indicates criterion with major importance. Similarly, Table-2 shows elective courses contribute to assessment plan.

In addition to the data derived from course-based assessment plan, each faculty evaluates the technical and scientific content of the senior research projects. Senior research projects provide opportunity to assess least 5 of 8 learning outcomes of Geology BS program through evaluation of student performance during their senior year.

The ability of the Geology BS program to influence student development is assessed by scoring cohorts first in GEOL110 when they enter as new students and in GEOL464 when they begin their final year. Field camp is a required course that addresses multiple learning outcomes and provide additional information during assessment of Geology BS program through comparison of our students' performance to other participants from different universities.

Senior Exit Survey is administered online at the end of required Senior Research class to collect data on student perception of their progress on each of the Geology BS program outcomes.

Graduates with a Geology BS will have the skills to...

Geology BS Program Outcome	GEOL Outcome #	GEOE ABET (C and I are not assessed)	Criteria for Assessment See page:	Assessment Goals	Performance Goals
Apply scientific and mathematical knowledge to problems in the geosciences.	1	A	4	Scored in Geol 464 and Geol 465 and at least 1 additional course	>80% of scores are proficient or better in scored criteria
Analyze and interpret geological and other scientific data.	2	B	5	Scored in Geol 464 and Geol 465 and at least 1 additional course	>80% of scores are proficient or better in scored criteria
Work professionally with a team.	3	D	6	Scored in Geol 410 and at least 1 additional course	>80% of scores are proficient or better in scored criteria
Collect geological data (from the literature, field, or laboratory) to answer a scientific question.	4	E & L	7	Scored in Geol 410 and Geol 465 and at least 1 additional course	>80% of scores are proficient or better in scored criteria
Follow the ethical standards of the geoscience profession.	5	F	8	Pre-scored in Geol 110; Scored in Geol 464 and at least 1 additional course	>80% of scores are proficient or better in scored criteria
Communicate effectively in oral and written form.	6	G	9	Scored in Geol 464 and Geol 465 and at least 1 additional course	>80% of scores are proficient or better in scored criteria
Apply geological knowledge to global systems and human societies.	7	J & H	10	Pre-scored in Geol 110; Scored in Geol 464 and at least 1 additional course	>80% of scores are proficient or better in scored criteria
Investigate geological problems using appropriate technology.	8	K	11	Scored in Geol 410 and at least 1 additional course	>80% of scores are proficient or better in scored criteria

## Methods of Assessment

### Senior Research I (Geol 464) and Senior Research II (Geol 465) Projects

The senior research course series provides the opportunity to assess the majority of the Geology BS Program outcomes. Students should be directed to develop a project that addresses at least 4 of the 8 outcomes. Typical projects are very likely to address at least the following outcomes:

1. Apply scientific and mathematical knowledge to problems in the geosciences.
2. Analyze and interpret geological and other scientific data.
4. Collect geological data (from the literature, field, or laboratory) to answer a scientific question.
6. Communicate effectively in oral and written form.
8. Investigate geological problems using appropriate technology.

For each outcome the project addresses, the student work should be evaluated by the research advisor using the associated rubric. For each outcome the project addresses, all relevant criteria should be scored. In some cases, a specific criterion within that outcome will not apply to the project – this criteria does not need to be scored. If an outcome cannot be scored using at least two of the criteria, then the project does not sufficiently address that outcome.

### Field Camp (Geol 410)

The required field camp course (Geology 410) addresses many of the Geology BS Program outcomes, but is particularly well-suited for assessing the following outcomes:

3. Work professionally with a team.
4. Collect geological data (from the literature, field, or laboratory) to answer a scientific question.
8. Investigate geological problems using appropriate technology.

The last assignment for the course will be retained and scored for all participating SDSM&T students. The same assignment may be used for all outcomes if applicable. If an outcome cannot be scored using at least two of the criteria, then the assignment does not sufficiently address that outcome and a different assignment should be selected for that outcome.

### Geol 110 to Geol 464 comparison

Some program outcomes address the mindset of Geology BS students and their ability to critically evaluate professional practices and the value of geological knowledge. These outcomes include:

5. Follow the ethical standards of the geoscience profession.
7. Apply geological knowledge to global systems and human societies.

For these outcomes, the ability of the Geology BS program to influence student development is assessed by scoring cohorts first in Geol 110 when they enter as new students and in Geol 464 when they begin their final year. In each course, faculty or student leaders should facilitate small group discussions relevant to these outcomes and their underlying criteria. Groups may be asked to create a written record of their discussions for scoring using the relevant rubrics. After small group discussion, a class-wide discussion with faculty

participation can be used to broaden the ideas students encounter. The differences in scores between Geol 110 and Geol 464 can serve as an additional metric for program assessment in these outcomes. Beginning discussion in Geol 110 also ensures that students encounter these concepts early and can develop the skills throughout the program.

### **Coursework Integration**

Continued reinforcement of skills underlying the program outcomes are necessary for the Geology BS program to reach its goals. Course material and assignments should be designed to target the program outcomes and the underlying skills. The outcomes the course targets should be listed on the course syllabus with the relevant criteria. For each learning outcome, at least 1 course in addition to Geol 410, Geol 464, Geol 465 should be evaluated. Outcomes may be evaluated in multiple courses.

Courses selected for assessment should be typically taken by juniors or seniors and required by the program (see page 12 and 13 for tables of outcome usage by required and elective courses). If possible, a single course should not be used for all of the above outcomes. For each outcome that the course will assess, an assignment, exam, or project should be scored for all participating Geol BS students. If an outcome cannot be scored using at least two of the criteria, then the material chosen does not sufficiently address that outcome and a different assignment or course should be selected for that outcome.

### **Senior Exit Survey**

Student perception of their progress on each of the Geology BS program outcomes will also be surveyed on the Senior Exit Survey administered online at the end of Geol 465 using a scale ranging from “I have no competence in this area” to “I feel very competent in this area.”

Outcome 1: Apply scientific and mathematical knowledge to problems in the geosciences.

Criteria	Masters (3)	Proficient (2)	Needs Significant Work (1)
1. Uses relevant math concepts and equations in a geologic context.	Virtually no errors in concepts or procedures in solving the problem.	Makes minor procedural errors when solving the problem, but demonstrates conceptual understanding.	Makes conceptual and procedural errors when solving the problem.
2. Can classify and identify geologic materials and features.	Can correctly identify geological materials and features by comparing and contrasting multiple relevant criteria.	Can correctly identify geological materials and features and give relevant criteria for their identification.	Cannot correctly identify geological materials and features <u>or</u> cannot give criteria their identification.
3. Recalls or uses relevant concepts and facts from geoscience disciplines to solve a problem.	Student recalls or uses facts and concepts that are relevant to the problem with only minor errors.	Student recalls or uses facts and concepts that are mostly relevant to the problem with few errors.	Student recalls or uses facts and concepts with frequent or major errors <u>or</u> facts and concepts recalled are irrelevant to the problem.
4. Recalls or uses relevant concepts and facts from other scientific disciplines (such as biology, chemistry, or physics) to solve a problem.	Student recalls or uses facts and concepts that are relevant to the problem with only minor errors.	Student recalls or uses facts and concepts that are mostly relevant to the problem with few errors.	Student recalls or uses facts and concepts with frequent or major errors <u>or</u> facts and concepts recalled are irrelevant to the problem.

Outcome 2: Analyze and interpret geological and other scientific data.

Criteria	Masters (3)	Proficient (2)	Needs Significant Work (1)
1. Completeness of Analysis	Thoroughly performs most or all tests or analyses relevant to the data or the question.	Performs multiple tests or analyses relevant to the data or the question.	Performs only minimal or basic tests or analyses relevant to the data or the question.
2. Evaluates data quality	Recognizes bias and incompleteness in the data and assesses methods to obtain better quality data	Recognizes any biases or incompleteness in the data set	Fails to identify biases and incompleteness in the data set
3. Interpretation of Results	Correctly interprets analyses and presents the implications of the results	Correctly interprets analyses	Misinterprets analyses
4. Evaluation of Results	Addresses the majority of relevant strengths and weaknesses of the study and discusses their impact on conclusions and/or for future work	Addresses the majority of relevant strengths and weaknesses of the study	Addresses the minority of strengths and weaknesses
5. Critically read and evaluate the results of others, including from the scientific literature	Synthesizes the information presented by multiple sources	Understands the information presented by the source and uses prior knowledge to support or question the information and results	Understands the information presented by the source, but takes information and results at face value without evaluation

Outcome 3: Work professionally with a team.

Criteria	Masters (3)	Proficient (2)	Needs Significant Work (1)
1. Communicates with team members.	Responds to all communications and solicits input from others through new communications.	Responds to the majority of communications, but does not generate new communications.	Does not respond to group communications or generate new communications.
2. Attends meetings regularly.	Attends all meetings.	Misses an occasional meeting, but gives timely notice to the group	Misses meetings and does not give the group adequate notice before absences
3. Contributes constructive ideas to project development.	Contributes ideas that promote group progress and positive group dynamics.	Contributes ideas, but some contributions are distracting from progress and group dynamics.	Does not contribute ideas.
4. Fosters positive team interactions.	Facilitates and manages positive, respectful, team interactions that include all participants.	Listens to and includes all members in team activities. Treats everyone with respect regardless of personal feelings.	Is disrespectful or unwilling to listen to the ideas of others, or excludes some members.
5. Completes tasks in a timely matter.	Completes all agreed upon tasks by the agreed deadline.	Completes all agreed upon tasks, but is sometimes late.	Fails to complete agreed upon tasks.
6. Completes an equitable amount of quality work.	Completes an equitable amount of high work.	Completes an equitable amount of acceptable work.	Completes a less than equitable amount of work or poor-quality work.



Outcome 4: Collect geological data (from the literature, field, or laboratory) to answer a scientific question.

Criteria	Masters (3)	Proficient (2)	Needs Significant Work (1)
1. Can pose scientific questions in a hypothesis framework	Provides a clear, testable, hypothesis statement	Provides a clear hypothesis statement	Cannot provide an answerable scientific question
2. Data Collection	Data gathered are complete and collection methods were consistent	Minor omissions and inconsistencies do not hinder addressing the scientific question	Data are gathered incompletely or inconsistently
3. Relevance of data to the question	Data directly address the question	Data are somewhat related to the question, but do not directly address the question	Data are not appropriate for the question such that the data have little value
4. Quality of the data	Data are the best possible given the circumstances and are adequate to answer the scientific question	Minor data quality issues do not hinder answering the scientific question	Major data quality issues hinder answering the scientific question
5. Formulation of methodology	Clearly defined and effective method choice	Valid method, but not most effective choice	Vague or inappropriate methods; proposes a method but does not appear to understand the method
6. Data management	Data organization and cataloging preserve data value for future research by others.	Data organization and cataloging slightly compromise data value for future research.	Data organization and cataloging severely compromise data value for future research.
7. Safety in data collection	Students were made aware of safety procedures.		

Outcome 5: Understands and applies the ethical standards of the geoscience profession.

Teaching resources:

AGI ethical professional conduct: <http://www.agiweb.org/workforce/ethics.html>;

Teaching GeoEthics: [http://serc.carleton.edu/geoethics/teaching\\_geoeth.html](http://serc.carleton.edu/geoethics/teaching_geoeth.html)

National Ethics center 2 minute challenges: <https://nationalethicscenter.org/tags/2mc/resources>

Book on GeoEthics: <http://www.sciencedirect.com/science/book/9780127999357>

Paleontology Ethics: [http://serc.carleton.edu/research\\_education/paleontology/ethics.html](http://serc.carleton.edu/research_education/paleontology/ethics.html)

Criteria	Masters (3)	Proficient (2)	Needs Significant Work (1)
1. Uses data appropriately		Analyzes all data and presents unbiased results	Manipulates data to achieve a desired result
2. Properly attributes the ideas and contributions of others	Synthesizes the ideas of others with their own and always properly cites the contributions of others	Notes when the ideas of others are used, but does not always properly cite contributions of others	Presents the ideas of others as their own
3. Recognizes ethical violations	Can present a reasoned evaluation of whether or not a situation was ethical	Can recognize when a situation is not ethical, but cannot explain why	Cannot recognize when a situation is not ethical
4. Makes ethical decisions	Makes decisions that are ethical and modifies behaviors to correct any unethical decisions	Makes decisions that are mostly ethical, but some behaviors may lead to questionable ethics	Makes decisions that are clearly unethical

Outcome 6: Communicate effectively in oral and written form.

Criteria	Masters (3)	Proficient (2)	Needs Significant Work (1)
1. Verbal Skill	Speaks confidently and clearly, engages the audience	Speaks adequately and clearly	Speaks awkwardly and unclearly
2. Writing Skill	Consistently uses professional language, minimal writing errors	Mostly uses professional language, writing errors present but do not affect understanding the work	Often uses inappropriate or colloquial language, contains errors that affect understanding the work
3. Rhetoric	Ideas clearly organized, arguments convincing	Ideas adequately organized, arguments reasonable	Ideas disorganized, arguments insufficient or poorly reasoned
4. Graphics	Graphics enhance the material; appropriately and effectively formatted	Graphics support the material; minor errors in formatting that do not affect understanding the work	Irrelevant graphics or lack of need graphics, common errors in formatting affect understanding the work

Outcome 7: Apply geological knowledge to global systems and human societies.

Criteria	Masters (3)	Proficient (2)	Needs Significant Work (1)
1. Relates project results to broader context	Discusses results in terms of implications and broader scientific or social context	Attempts to discuss implications and broader context, but connections tenuous	Does not address broader context of the results or their implications
2. Recognizes the contribution of geology to society at large	Can provide multiple examples with well-developed explanations	Can provide multiple examples with adequate explanations	Can provide few examples with very simplistic explanations
3. Recognizes the connections between geology and other disciplines	Can provide multiple examples with well-developed explanations	Can provide multiple examples with adequate explanations	Can provide few examples with very simplistic explanations
4. Can recognize and assess geological hazards	Can provide multiple examples with well-developed explanations	Can provide multiple examples with adequate explanations	Can provide few examples with very simplistic explanations
5. Recognizes the relationship between earth resources and the economy	Can provide multiple examples with well-developed explanations	Can provide multiple examples with adequate explanations	Can provide few examples with very simplistic explanations

Outcome 8: Investigate geological problems using appropriate technology.

Criteria	Masters (3)	Proficient (2)	Needs Significant Work (1)
1. Correctly uses computer software to format documents	Student uses tools (such as templates, and styles) inherent in the software to achieve consistent formatting and good logical flow	Computer formatted documents are well formatted and flow logically	Computer formatted documents have poor formatting and poor logical flow
2. Correctly uses computer software to organize, process, and interpret data	Data are well organized; shows sophisticated use of analytical tools to perform analyses and interpret results	Data are well organized and software tools are used appropriately	Data are poorly organized or software tools are not appropriately used
3. Correctly uses field and laboratory equipment	Maintains the equipment in good condition and produces high quality, accurate data for the geological problem with the equipment	Maintains the equipment in good condition and chooses the correct equipment and settings for the geological problem, produces reasonable quality data	Poorly maintains the equipment such that damage can be caused, is not able to produce data for the geological problem with the equipment
4. Uses spatial analyses and communicates via a computer-generated map	Can integrate multiple spatial analysis techniques to solve a complex problem and communicate results through high quality maps	Can apply basic spatial analysis tools to solve a problem and communicates results through an effective map	Performs little or no spatial analysis and communicates poorly through map

Table 1: Outcome criteria addressed in each course required by the Geology BS program. 0=not addressed by the course, 1=criterion is of minor importance, 2 = criterion is of major importance.

Outcome	1				2					3						4							5				6				7					8								
Criteria	1	2	3	4	1	2	3	4	5	1	2	3	4	5	6	1	2	3	4	5	6	7	1	2	3	4	1	2	3	4	1	2	3	4	5	1	2	3	4					
Required Courses																																												
GeoE 324	2	1	2	2	1	1	2	2	1	1	0	1	1	2	0	2	2	2	2	2	1	2	2	2	2	2	1	2	0	1	0	0	2	1	1	2	2	2	2	0	2	2	2	0
GeoE 482	2	2	0	0	2	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GeoL 110	1	0	0	0	1	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	2	2	2	1	1	1	0	1	2	2	0	0					
GeoL 201	1	2	1	1	0	0	0	1	0	0	2	0	0	1	0	1	0	0	0	0	0	0	1	1	0	1	0	0	0	0	2	2	2	2	2	2	0	0	0					
GeoL 212	1	2	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0			
GeoL 322	1	2	1	1	2	1	2	2	0	1	0	0	1	2	2	0	2	2	2	0	2	2	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	2	0			
GeoL 323	2	0	2	2	0	0	2	2	2	0	0	0	0	0	0	2	0	0	0	0	1	0	1	2	0	0	2	2	2	1	2	2	2	1	2	1	1	1	0	0				
GeoL 331	0	2	1	1	0	0	1	1	0	1	0	0	1	2	1	0	1	1	1	0	1	1	1	0	0	0	0	1	0	0	0	1	1	0	2	1	0	2	0					
GeoL 341	1	2	1	1	0	0	1	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
GeoL 410	2	2	2	2	2	2	2	2	2	2	2	1	2	2	1	2	2	2	2	2	2	2	2	2	1	1	1	2	0	2	1	1	0	1	1	2	1	2	1	2	0			
GeoL 416	0	0	0	0	1	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	1	0	0	1	0	2	0	0	0	0	0	2	2	0	2					
GeoL 461	2	2	2	2	1	1	2	2	2	2	0	1	2	2	1	2	1	1	1	0	1	1	0	0	0	0	1	1	1	1	1	1	1	1	2	0	0	0	1	0	0			
GeoL 464	0	0	1	0	1	1	1	1	2	0	0	0	0	0	0	2	1	2	1	2	1	1	2	2	1	1	2	2	1	1	2	0	0	0	0	2	1	0	0					
Usage Count for Required Courses	10	9	10	9	8	8	11	12	5	5	2	3	5	6	4	6	8	6	6	3	7	6	9	7	4	4	7	10	5	9	7	7	7	7	5	7	8	8	5	1				



Table 3. List of Geology BS program outcomes and associated evaluation criteria. Numbers in parenthesis are the mean usage score for each criterion across required and elective courses. 0=not addressed by the course, 1=criterion is of minor importance, 2 = criterion is of major importance.

<b>Outcome 1: Apply scientific and mathematical knowledge to problems in the geosciences.</b>	
1. Uses relevant math concepts and equations in a geologic context.	(1.16)
2. Can classify and identify geologic materials and features.	(1.16)
3. Recalls or uses relevant concepts and facts from geoscience disciplines to solve a problem.	(1.08)
4. Recalls or uses relevant concepts and facts from other scientific disciplines (such as biology, chemistry, or physics) to solve a problem.	(0.96)
<b>Outcome 2: Analyze and interpret geological and other scientific data.</b>	
1. Completeness of analysis	(1.12)
2. Evaluates data quality	(0.92)
3. Interpretation of results	(1.48)
4. Evaluation of results	(1.48)
5. Critically read and evaluate the results of others, including from the scientific literature	(0.72)
<b>Outcome 3: Work professionally with a team.</b>	
1. Communicates with team members.	(0.84)
2. Attends meetings regularly.	(0.60)
3. Contributes constructive ideas to project development.	(0.64)
4. Fosters positive team interactions.	(0.84)
5. Completes tasks in a timely matter.	(1.00)
6. Completes an equitable amount of quality work.	(0.72)
<b>Outcome 4: Collect geological data (from the literature, field, or laboratory) to answer a scientific question.</b>	
1. Can pose scientific questions in a hypothesis framework	(0.96)
2. Data collection	(1.00)
3. Relevance of data to the question	(0.92)
4. Quality of the data	(0.88)
5. Formulation of methodology	(0.64)
6. Data management	(0.84)
7. Safety in data collection	(0.72)
<b>Outcome 5: Understands and applies the ethical standards of the geoscience profession.</b>	
1. Uses data appropriately	(1.24)
2. Properly attributes the ideas and contributions of others	(1.16)
3. Recognizes ethical violations	(0.60)
4. Makes ethical decisions	(0.60)
<b>Outcome 6: Communicate effectively in oral and written form.</b>	
1. Verbal skill	(1.00)
2. Writing skill	(1.36)
3. Rhetoric	(0.56)
4. Graphics	(1.12)
<b>Outcome 7: Apply geological knowledge to global systems and human societies.</b>	
1. Relates project results to broader context	(1.04)
2. Recognizes the contribution of geology to society at large	(0.88)
3. Recognizes the connections between geology and other disciplines	(1.00)
4. Can recognize and assess geological hazards	(0.68)
5. Recognizes the relationship between earth resources and the economy	(0.92)
<b>Outcome 8: Investigate geological problems using appropriate technology.</b>	
1. Correctly uses computer software to create documents	(1.48)
2. Correctly uses computer software to organize, process, and interpret data	(1.40)
3. Correctly uses field and laboratory equipment	(0.68)
4. Uses spatial analyses and communicates via a computer-generated map	(0.52)