2012-2013 Annual Assessment Report
BS and BA Geology Programs
Department of Geology

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This assessment report explicitly addresses the assessment plan for our BS and BA programs in Geology. These programs have a great deal of overlap, and our assessment activities tap students from both programs. Please see the end of the report for an addendum on our other programs: BA in Earth Science, the Geology minor and MS program in Geology.

For the sake of clarity and completeness, this report is structured as a series of answers to the prompts in this year's Assessment Report Template

1. As a result of last year's assessment effort, have you implemented any changes for your assessment including learning outcomes, assessment plan, assessment tools (methods, rubrics, curriculum map, or key assignment etc.), and/or the university baccalaureate learning goals?

a. If so, what are those changes? How did you implement those changes?
b. How do you know if these changes have achieved the desired results?
c. If no, why not?

In 2011-2012, we looked primarily at two learning outcomes:

A. Students will master a set of fundamental geologic concepts essential to understanding and solving geologic problems

Every year we administer a Student Knowledge Inventory (SKI) in one junior-level and one senior-level course. The structure of the assessment remains the same each year; the questions are chosen from a bank of questions compiled by the faculty. We identified areas in which students did not do as well as we hoped, and four problem areas emerged: classification of igneous rocks, geologic time, geologic structures, and basic chemical concepts. We dealt with some of these issues with changes to the assessment, and clarified questions on the SKI. Other areas of weakness were addressed with changes to our program (see answer to question #2 below).

We identified two potential problems with the geologic structure questions on the assessment (SKI). A multiple-choice question was ambiguous, and had two possible correct answers. This question was corrected for future versions of the test. The faculty also examined the constructed response question (Draw a simple geologic map using strike and dip symbols for an anticline plunging to the east), and we realized that this might be an unrealistic expectation for our juniors, who may have had very little practice with this skill in their Physical Geology lab course. Since many of our majors are transfer students (often more than half), we have limited control over what they learn on community college campuses. We do expect that the students should have

seen geologic maps in their introductory courses, even if they have not drawn them. To rectify this problem we chose to change the question from drawing a map, to recognizing the structure in a map provided to the students.

The problem with classifying igneous rocks has been persistent over several years, so we decided to investigate how students are doing with other kinds of rock classification systems by adding a question about metamorphic rocks to the assessment.

Since we were concerned with students' performance on basic chemistry concepts, we decided to add another item on the assessment that explores student knowledge about ions and isotopes.

In the past students have done fairly well on a question that asks them to label plate tectonic features. This year we chose to investigate their understanding of tectonic processes using questions from a validated research instrument, the Geoscience Concept Inventory (http://geoscienceconceptinventory.wikispaces.com/).

The revised assessment (administered in Fall 2012) is attached to this report as Appendix A. The results of the 2012-2013 SKI (Appendix B) and a longitudinal analysis of from 2009-2013 (Appendix C) are presented below in our answers to questions #3-6.

B. Students will be proficient in solving geologic problems.

In 2011-12 we did a fairly cursory examination of student work on geologic problems more as proof of concept than as a deep examination for program assessment. Our goal for 2012-2013 was to take this examination and make it more systematized by selecting specific projects from Geology 188 (Advanced Geologic Mapping) and compiling the scores on grading rubrics for all students into a spreadsheet to examine patterns of performance. The results of this effort are described below.

2. As a result of last year's assessment effort, have you implemented any other changes at the department, the college or the university, including advising, co-curriculum, budgeting and planning?

a. If so, what are those changes? How did you implement those changes?
b. How do you know if these changes have achieved the desired results?
c. If no, why not?

The results from last year's SKI sparked several changes in our curriculum. We introduced a rock review unit in our Historical Geology lecture and lab course (Geology 12 and 12L). This rock review is a positive step, but it does not completely solve the problem that we have identified with igneous rock classification, because many of our students take these introductory courses in community colleges. We decided as a faculty to look for places to insert more interaction with rocks throughout the curriculum, instead of just in the rock (petrology) courses (Geology 102 and Geology 103). An identified student weakness in chemistry was addressed by introducing more review of basic chemical concepts into Geology 12 and Geology 100. Both of these classes have units that deal with atoms, ions and isotopes, and these concepts will be

strengthened for future cohorts. Students were also weak at identifying geologic structures on geologic maps. Our initial plan was to shelve discussion of how to improve students' understanding of geological structures until we finished the hiring process for our new structural geologist. As it happened, we actually did revisit the structural geology issue due to an unpleasant surprise as we were preparing the data for our Fall 2012 assessment retreat (see below).

3. What PROGRAM (not course) learning outcome(s) have you assessed this academic year?
4. What method(s)/measure(s) have you used to collect the data?
5. What are the criteria and/or standards of performance for the program learning outcome?
6. What data have you collected? What are the results and findings, including the percentage of students who meet each standard?
a. In what areas are students doing well and achieving the expectations?
b. In what areas do students need improvement?

In 2012-2013, the Geology Department assessed these two programmatic learning outcomes:

A. Students will master a set of fundamental geologic concepts essential to understanding and solving geologic problems
B. Students will be proficient in solving geologic problems.

For this assessment report, we will discuss each of these learning outcomes separately

A. Students will master a set of fundamental geologic concepts essential to understanding and solving geologic problems.

As in past years, we administered a Student Knowledge Inventory to our juniors and seniors. This instrument is intended to measure the students' mastery of fundamental geology concepts as they enter the upper division courses. As noted above, our assessment efforts in 2011-2012 guided the revision of this instrument (Appendix A). This assessment is administered to the students in one junior level class and one senior level class during the first two weeks of the semester. The goal is to measure how well our students have mastered fundamental concepts as they move into their upper division work as juniors, and if they are retaining or building on those fundamental concepts as seniors. The result of this year's assessment is detailed in Appendix B. We would like to see 80% of the students scoring correct on each question, but we are satisfied with 70%. To improve our programmatic learning outcomes, we want to target first the areas in which we see the worst performance.

This year we saw the same patterns as in past years: students did poorly on geologic structure problems and identification of igneous rocks. We were encouraged to see that the seniors did better on almost every measure than the juniors, indicating that most of the deficiencies the juniors had as transfer students were being addressed in their upper division courses. We also identified several other results of note:

- All students did much better with questions that involve ions and isotopes, leading us to believe that reviewing these concepts in Mineralogy (Geology 100) has helped.
- The seniors did well with metamorphic rock identification, leading us to ask if the persistent problem we see in naming igneous rocks is a product of the question being asked instead of a deficiency in their knowledge. We will revise the SKI in Fall 2013 to investigate this possibility.
- Students are still struggling with geologic structures. We revised our assessment to see if students could recognize geologic structures on a map, rather than draw the map. However, the juniors still did very poorly on recognizing and sketching the structure. We suspect this is making their introductory field course (Geology 111) more challenging that we had realized. The seniors did somewhat better. The assessment was given in the first two weeks of our Structural Geology course (Geology 110) so the seniors are a bit below where we would expect them to be starting that course.
- We are fighting an on-going battle to have students remember the geologic time scale. Students on our Historical Geology class (Geology 12) are required to take multiple quizzes on the time scale, and that may be having some impact, but not enough. It was discouraging to note that the juniors who had just taken our Historical Geology class (Geology 12) and the seniors who had just taken Paleontology (Geology 105), all of whom took multiple quizzes on the time scale the semester before this assessment was given, actually scored worse on the time scale question than other students.

This year we also had enough years of data to do a longitudinal analysis of SKI scores for the past four years. Those results are detailed in Appendix C. The most important limitation in interpreting these results is that we have a limited number of students in each cohort. This means that the results for any given year can be heavily swayed by a class with an unusual number of high or low achieving students. In this assessment report we only looked for general trends in the longitudinal results because of this issue with the statistics of low numbers.

The most striking result is one that we did not intend to examine: The percentage of Geology majors who started with us in introductory Physical Geology has risen dramatically– from 38% in 2010-2011 to 63% in 2012-13. This is a short-term trend, but it looks like our efforts to recruit more Geology majors from our General Education courses seem to be working. Relatively few undergraduate students enter college intending to major in Geology, so this is excellent news for us. It also means that any changes we make to our introductory level courses – Geology 5, Geology 8, Geology 10 and Geology 12 – can have a larger impact than we anticipated on our major as a whole, since most of our students are now coming through those classes rather than the community college equivalents.

We can also see steady increases in some areas of student performance: chemical concepts, and geologic time. Performance in other areas has fluctuated, and still needs work: identification of igneous rocks, and recognition of geologic structures. As mentioned above,

we are revising the assessment for Fall 2013 to see if there is a problem with the way we are measuring knowledge of igneous rocks. We discuss more about our geologic structure problem below.

B. Students will be proficient in solving geologic problems.

2012-2013 was to have been the first year we systematically used the field report from our capstone summer field course (Geology 188) to assess students' ability to solve geologic problems. Only BS students take Geology 188, so this assessment component most directly measures progress in the BS program. However, the skills that are measured in Geology 188 are developed through at least four other courses that are also part of our BA program. In this sense we are using the results from Geology 188 as a first approximation of how this learning outcome is playing out in the BA program as well. If the BS students are not doing well, then we should also be concerned about our BA students.

Our primary goal this year was to test our programmatic assessment method. To do this, we explored whether the existing grading mechanism for the Geology 188 field course – a set of rubrics for each project in the course – would tell us what we needed to know about students' ability to solve geologic problems, or whether we need to develop a different metric for use in program assessment. We chose two projects from the Geology 188 course, extracted the grading rubrics that were present in each student's course binder, and compiled the data in a spreadsheet for analysis.

In the course of compiling data from Geology 188, a disturbing pattern emerged in one particular area: construction and interpretation of geologic cross-sections. A cross-section is an excellent measure of a student's ability to interpret geologic data and reconstruct the structure of the rocks of a region, and requires projecting features in three-dimensions underground. It is an essential skill for the practicing geologist to produce accurate cross-sections. The cross-sections drawn by the students in the 2012 field class had a disturbing unevenness in quality, with almost half of the cross-sections bearing little relationship to the interpretation we would expect to see. The problem seemed urgent enough to drop our other plans for analyzing the summer field reports, and to concentrate on the cross-section problem, as described below. We will return to the analysis of summer field reports next year.

The skill of drawing cross-sections is addressed at different levels of sophistication in four courses: Geology 10L (Physical Geology Lab); Geology 12L (Historical Geology Lab); Geology 111A & B (Field Geology), and Geology 110 A&B (Structural Geology). Drawing cross-sections involves a range of skills. Some of these skills are technical in nature: how to correctly draw a topographic profile and how to estimate angles for rock layers. Other skills are conceptual: how to build a mental model of relationships in the subsurface, and how those three-dimensional structures interact with surface topography.

We had originally planned to delay discussion of students' understanding of geologic structures until our new structural geologist was hired in Fall 2013. We discovered this fundamental problem with cross-sections in Fall 2012, the semester that Structural Geology (Geology 110 A&B) is taught to our seniors. Because of the severity of the

problem, the faculty moved to address it in the current class, before the seniors moved on the Geology 188 (Advanced Field Mapping) the next summer.

Instead of following our original plan and examining the scoring rubrics for two projects from the summer field course, the faculty decided to focus on the cross-sections, talk about how this problem developed and look for potential solutions. Cross-sections from the 2012 field class were evaluated at a faculty meeting in Fall 2012. We did not use a formal rubric to evaluate the cross-sections – a simple visual comparison of the 14 cross-sections from the Geology 188 class was enough to convince us that we needed to act.

In the course of this discussion, several issues emerged that may have contributed to the problem:

- We realized that we do not completely control the content of our introductory courses, and do not always know what students are doing with cross-sections in our introductory courses, which are largely taught by part-time faculty. We could not say with certainty to what degree students are getting practice with either interpreting or drawing cross-sections at the introductory level.
- We also realized that students have not been receiving sufficient feedback on their cross-sections. When students do projects in the field, there is always a concern that some students may simply borrow a field report, map or cross-section from a student who took the course the previous year, and not actually produce their own results from their fieldwork. This was a special concern of the previous Structural Geology instructor. As a result, this instructor did not return field reports, maps or cross-sections to the students – only the grading sheet. Thus the feedback that students were receiving on their work was extremely limited.
- We went to the literature that discusses student learning and cross-sections, and discussed a recent paper from a geoscience education journal. This paper looked at the differences between the way novice and expert mappers approach the task of mapping and drawing cross-sections. The authors found that expert mappers always construct a mental model of the geologic structures – they "see" through the rocks and visualize the structure projecting into the ground. Their maps and cross-sections were representations of that mental model. The novice mappers rarely had such a mental model. Instead, the novices went straight to the technical aspects of drawing the geologic structures without a mental model of the structure. The result is that novice mappers can end up with cross-sections and maps that are not consistent with each other, or with any reasonable interpretation of the actual geologic structures. We discussed strategies to help students explicitly develop mental models before attempting representation of those models.
- When we have solved the programmatic problems that this year's assessment process have identified, we will revisit the issue of maps and cross-sections and think about common rubrics that could be used across all the courses where students produce this work.

7. As a result of this year's assessment effort, do you anticipate or propose any changes for your program (e.g. structures, content, or learning outcomes)?
a. If so, what changes do you anticipate? How do you plan to implement those changes?
b. How do you know if these changes have achieved the desired results?
c. If no, why not?

A. Students will master a set of fundamental geologic concepts essential to understanding and solving geologic problems.

The analysis of the 2012-13 SKI and the longitudinal analysis suggested some programmatic responses as well as the changes in assessment outlined above.

First, we are adopting a strategy from our colleagues at Hamilton College. They give every student a pamphlet that outlines the fundamentals of geology that every student should know. We are adapting this pamphlet and staring this Fall will give one to every student in Mineralogy (Geology 100), our gateway to the upper division geology classes. We hope to help the students better assess their own knowledge by making it explicit to students what they should already know.

We are also considering incorporating boxes of sample rocks and minerals into our instructional curriculum. Every incoming geology student would be required to purchase a rock box. If every geology major is required to purchase this box, then the samples can be used in many classes to provide more practice with naming and recognizing rocks and minerals. This concept is still in a formative stage, and has not been implemented.

We are also tackling the geologic time scale problem. In 2012-2013, we started requiring students in Historical Geology to reproduce the time scale in multiple formats (paper-sized charts, poster-sized charts, and a song) as an experiment to see if learning the time scale through multiple modalities helps this problem. We are also looking for places to insert the time scale in other courses to continually reinforce this material.

We are also looking for novel ways to encourage students to review the basics of geology. Because we have a relatively small number of majors and they take many field trips together, our students are tightly bonded and do a lot of socializing together, including Geology Club functions. We will talk with the Club officers in the Fall about injecting geology games into Club functions – Geology Jeopardy, or Geology Quiz Night.

B. Students will be proficient in solving geologic problems.

We are taking several steps to solve the cross-section problem. First, the instructors of field courses have already agreed that student work will be returned with feedback so that students can learn from each assignment. This will probably mean increasing the number of field sites we use. Finding field sites in California is difficult for a variety of reasons. Some locations are too complicated for students to decipher; others are on private land (and are therefore inaccessible), and other potential field sites are too far from Sacramento. Instructors in our field classes recognize these challenges and are committed to enlarging

our inventory of field sites.

We are also looking at places to inject more work with cross-sections into our courses, and to make sure we have a developmental range of student experiences to improve their ability to draw and interpret cross-sections. Over the years we have become fairly casual about coordinating the introductory courses. We will return to a more formal system of course coordinators, and make sure that the course coordinators and the Department Chair clearly communicate our expectations to part-time faculty. We are also looking for places in our upper division courses to inject more work with spatial analysis of rocks.

Finally, we have agreed that it is time to revisit the process of curriculum mapping across our BA and BS programs. We last went through this process when we developed our first assessment plan over a decade ago. Since that time, the program has been revised, courses have been reorganized, several faculty members have retired or FERPed, and two new faculty members have joined us. We are currently in the process of curriculum mapping for our new MS/MA program, and the Faculty agree that we need to repeat this process for our BA and BS in Geology.

We have a faculty retreat every Fall where we consider the year's assessment activities. This Fall we will begin this new curriculum map. We expect to revise our assessment plan as a result of this process.

ADDENDUM: Other Geology Programs

BA in Earth Science, Minor in Geology: The feedback on last year's assessment report noted that we lack assessment plans for these programs. We have to agree. The challenge for us in developing assessment plans for these programs is that both programs involve a lot of student choice. We see that as a virtue of the programs, since it allows them to be tailored to student needs. For example, we have Geology minors who are Anthropology majors, and they usually take a different set of upper division courses than Environmental Studies majors who are Geology minors. We probably need some help in thinking about how to embed assessment for these programs. Both programs have the additional challenge in that they have low enrollments. At any given time there are perhaps a half-dozen Earth Science majors and a dozen Geology minors. We expect we would have insufficient data in any particular year to do meaningful assessment. We have asked for assistance with this issue, and were told that Academic Affairs is aware of this issue across a number of programs and is working on a solution. We hope to have guidance on this aspect of our assessment plan in the near future.

MS in Geology: The first steps toward assessing our graduate program were completed in June 2013. We just submitted learning outcomes and metrics to the Office of Graduate Studies, and expect this to be the basis of an assessment plan for the Geology M.S. degree. There is some confusion in the process beyond this point. We have questions about whether Office of Graduate Studies or the Office of Academic Program Assessment oversees

the development of the graduate assessment plan from here. Our Graduate Program committee is aware that they need to develop a full-fledged plan, and they will continue with that effort as the new MS/MA program is developed through CCE.

Our graduate program is also undergoing revision, and this makes assessment difficult. Enrollment in our State-side degree program has been suspended indefinitely, and our current M.S. program is offered through CCE. Our CCE program is undergoing extensive revision and is reduced in scope as we "teach out" the current cohort of graduate students. As was noted in our assessment feedback from last year, we do not have an assessment plan for either program. The positive news is that curriculum revisions in our CCE-based M.S. program have resulted in a complete evaluation of skills and outcomes in the degree program, and this will form the basis of a strong assessment program when admissions resume.

APPENDIX A

Student Knowledge Inventory Name _____
Fall 2012

1. The periods of the Mesozoic include (mark all that apply)
   A. Triassic
   B. Permian
   C. Silurian
   D. Paleogene
   E. Oligocene

2. _____ of an element are atoms containing **different** numbers of neutrons but the **same** number of protons.
   A. ions
   B. classes
   C. particles
   D. isotopes
   E. varieties

3. Reverse or thrust faults occur where
   A. there is horizontal shortening
   B. there is horizontal tension
   C. the hanging wall moves down
   D. the footwall moves up
   E. the hanging wall moves sideways

4. Which of the following statements about the age of rocks is most likely true?

   A. Rocks found in the ocean are about the same age as rocks found on continents
   B. Rocks found on continents are generally older than rocks found in the ocean
   C. Rocks found in the ocean are generally older than rocks found on continents
   D. None of the above; we cannot figure out the age of rocks precisely enough to figure out which rocks are older

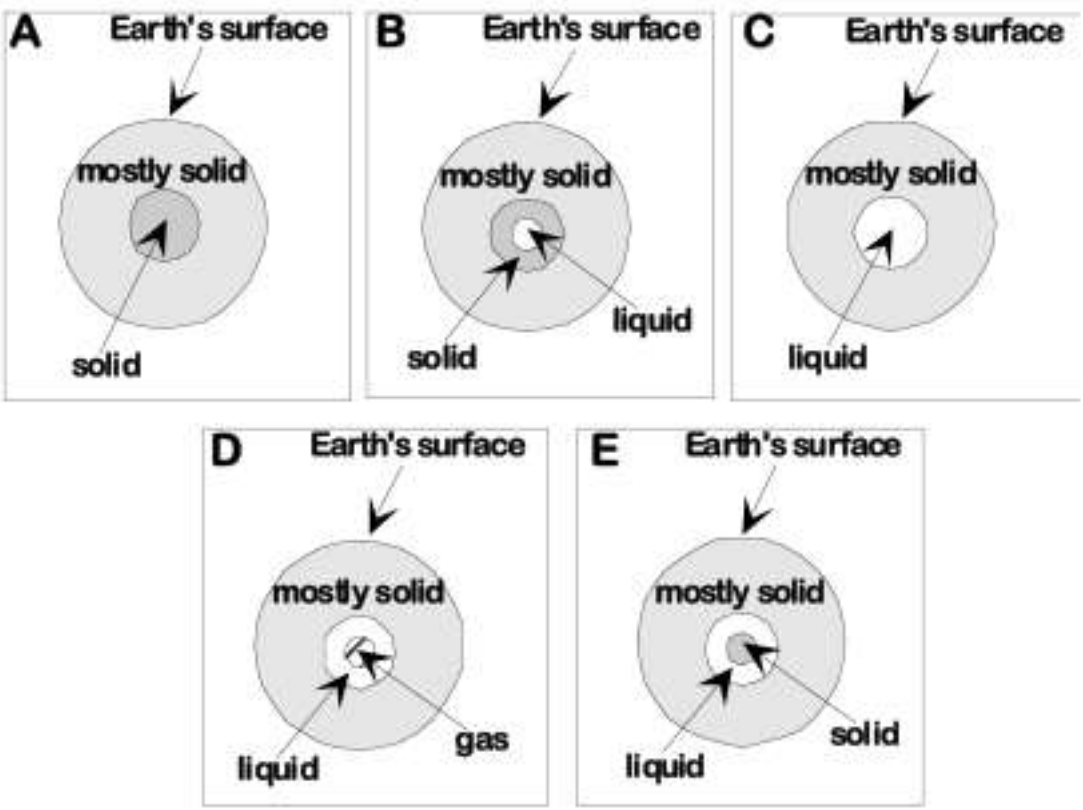
5. The difference between ionic and covalent bonding is
   A. in ionic bonding, atoms can share or lose electrons.
   B. ionic bonds are always stronger
   C. covalent bonding only occurs in salts
   D. in covalent bonding, atoms share electrons
   E. covalent bonds can only occur when metals bond.

6. Which of the following responses best summarizes the relationship between volcanoes, large earthquakes, and tectonic plates?
   A. Volcanoes are typically found on islands and earthquakes typically occur in continents. Both volcanoes and large earthquakes occur near tectonic plates.
   B. Volcanoes and large earthquakes both typically occur along the edges of tectonic plates.
   C. Volcanoes mostly occur in the center of tectonic plates and large earthquakes typically occur along the edges of tectonic plates.
   D. Volcanoes and large earthquakes both typically occur in warm climates near tectonic plates.

E. Volcanoes, large earthquakes, and tectonic plates are not related, and each can occur in different places.

7. Which of the following figures do you believe is most closely related to what you might see if you could cut the Earth in half?

Circle one: **A** **B** **C** **D** **E**



8. Match each metamorphic rock with at least one parent rock that it might have been before metamorphism (there might be more than one possibility for each parent rock or metamorphic rock). Put the letter or letters of the appropriate parent rock(s) in the blank after the name of the metamorphic rock.

Gneiss _____	a. Sandstone
Slate _____	b. Limestone
Quartzite _____	c. Shale
Greenstone _____	d. Granite
Marble _____	e. Basalt

Schist _____ f. Chert

9. Fill in the chart below with the appropriate igneous rock names:

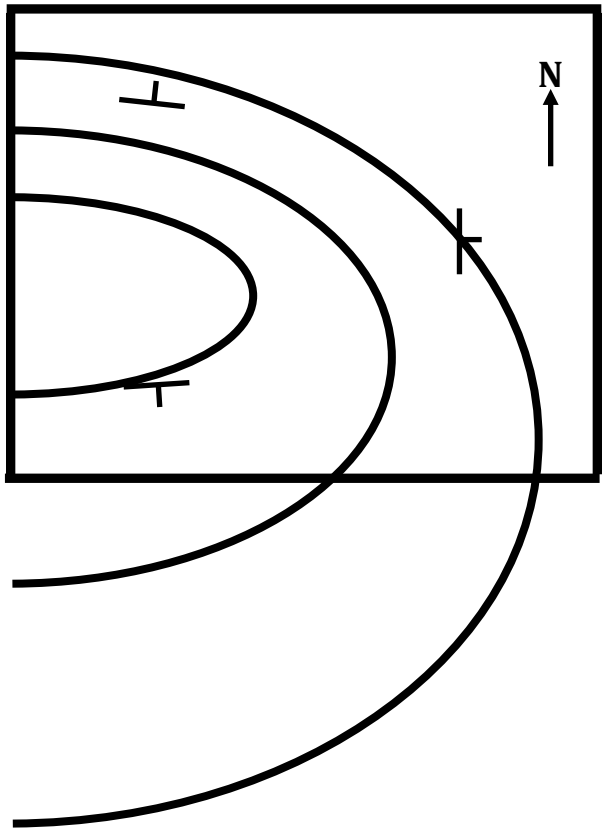
	Felsic	Intermediate	Mafic
Coarse-grained			
Fine-grained			

10. Identify each of the following materials as either an element (E), a mineral (M) or a rock (R)

arkose____ phyllite____ iron____ peridotite____

augite____ calcium____ mica____ amphibolite____

11. Look at the map below.



a. What geologic structure is shown on the map?

b. Put an **O** where you would expect to see the youngest rock in this area.

c. In the box below, draw a cross-section of this structure on the eastern edge of the map. (a sketch will do).

APPENDIX B

Student Knowledge Inventory 2012-2013 report:

Geology 100 students (29 juniors) did well (above 80%) on:

- Recognizing elements (iron 100%, calcium 97%) and minerals (augite 90%, mica 86%)
- Defining isotopes (86%)
- Simple plate tectonics (where volcanoes and earthquakes are - 86%)

They did less well (70-80%) on:

- Bonding (76%)
- Sorting rocks, minerals and elements in general (71%)

They did poorly (50-70%) on:

- Matching metamorphic products and parents (50%)
- More complex plate tectonics (age of ocean floor – 66%)
- Layers of the earth (69%)

They did abysmally (below 50%) on:

- Geologic time (48%)
- Geologic structures (faults – 45%; anticline 35%)
- Igneous rocks (26%)

Geology 110 students (29 seniors) did well (above 80%) on:

- Defining isotopes (97%)
- Simple plate tectonics (93%)
- Layers of the Earth (93%)
- Metamorphic rocks (84%)
- Sorting minerals, rocks and elements (89%)
- Age of ocean floor (83%)

They did less well (70-80%) on:

- Bonding (79%)
- Anticline (76%)

They did poorly (50-70%) on:

- Faults (62%)
- Geologic time (59%)
- Igneous rocks (59%)

APPENDIX C

Longitudinal Results SKI

Classes tested & number of students at each level:
2009-2010 (administered in Spring): GEOL 111A (11 juniors), GEOL 102A (34 seniors)
2010-2011 (administered in Fall): GEOL 100 (20 juniors), GEOL 110A (23 seniors)
2011-2012 (administered in Fall): GEOL 100 (28 juniors), GEOL 110A (21 seniors)
2012-2013 (administered in Fall): GEOL 100 (29 juniors), GEOL 110A (29 seniors)

Percentage of students who completed Physical/Historical Geology at Sac State

Class/Year	2009-10	2010-11	2011-12	2012-13
Juniors	No data	38% / 52%	44% / 44% + 12% concurrent in G12	63% / 63% + 19% concurrent in G12
Seniors	No data	26% / 61%	41% / 55%	42% / 50%

I. Igneous Rocks: out of possible 6

Class/Year	2009-10	2010-11	2011-12	2012-13
Juniors	3.1 / 52%	2.45 / 40.8%	2 / 33%	1.6 / 26%
Seniors	2 / 33%	3.38 / 56%	3.9 / 65%	3.5 / 59%

Variables: in 2009, the seniors were just starting Geology 102. From 2010 on, the seniors had already taken Geology 102.

The 2009-10 junior class was very small – 11 students, half of whom were high achieving students. Later years saw larger junior classes with a more typical distribution of student performance.

II. Chemical concepts: percent correct isotopes / bonding

Class/Year	2009-10	2010-11	2011-12	2012-13
Juniors	91% / NA	NA / 69%	96% / 86%	86% / 76%
Seniors	88% / NA	NA / 50%	62% / 52%	97% / 79%

Note: The scores for GEOL 100 are problematic, because the students may have reviewed these concepts right before the assessment was given (true for 2012).

The bonding assessments are not directly comparable from year to year; in 2012 it was a multiple-choice question, and in previous years it was a constructed response.

In 2009 there was only one chemistry question about isotopes; in 2010 there was only one chemistry question about bonding.

III. Geologic Time

Class/Year	2009-10	2010-11	2011-12	2012-13
Juniors	NA	25%	29%	48%
Seniors	NA	33%	38%	59%

There was no question on Geologic Time in 2009.

The question was identical in 2010-11 and 2011-12 (periods of Paleozoic); it changed in 2012-13 (periods of Mesozoic) so the results may not be directly comparable.

Six of the 2012-13 seniors took GEOL 105 the previous semester, where they were required to learn the timescale. 50% of those students got the question right.

Fourteen of the GEOL 100 students were required to learn the timescale in either GEOL 12 or GEOL 105 the previous semester; 43% of those students got the question right.

IV. Geologic Structure: faults

Class/Year	2009-10	2010-11	2011-12	2012-13
Juniors	36% / NA	50%	50%	45%
Seniors	68% / NA	71%	71%	62%

Assessments before 2012-13 all used the same problem (normal faults) with an error in 2010-11 that made both answers b and d correct.

2012-13 question asked about reverse (thrust) faults.

Anticline problem for 2010-11, 2011-12 (Draw a map of a plunging anticline):

	Completely correct	¾ correct	¾ correct	¼ correct	Nothing correct or did not attempt
2010-11: Juniors - seniors	5% - 42%	35% - 29%	5% - 8%	25% - 17%	30% - 4%
2011-12: Juniors - seniors	0% - 33%	10% - 43%	29% - 24%	21% - 0%	39% - 0%

Anticline for 2012-13 (students given map of plunging anticline with S&D symbols):

	What geologic structure is shown on the map?	In the box below, draw a cross-section of this structure on the eastern edge of the map. (a sketch will do).
G100	41% anticline or dome 13% syncline 10% fold 19% something else 16% did not attempt	20% anticline 20% syncline 27% something else 33% did not attempt
G110	83% anticline or dome 3% syncline 3% hill 10% did not attempt	62% anticline 14% syncline (only one student had IDed as syncline) 10% something else 14% did not attempt

V. Plate Tectonics

We cannot do a direct longitudinal analysis of plate tectonics because the questions have varied in type from year to year. Here are the statistics anyway.

Class/Year	2009-10	2010-11	2011-12	2012-13
Juniors	81% / 89%	80% / 82%	86% / 92%	66% / 86% / 69%
Seniors	88% / 85%	71% / 83%	86% / 88%	83% / 93% / 93%

- Questions on assessments before 2012-2013 included one question about features of subduction zones, and one question that required labeling of plate boundaries and other features.
- The questions on the 2012 assessment were drawn from the Geoscience Concept Inventory, an assessment specifically designed to probe common misconceptions. The questions included the age of the ocean floor, the location of earthquakes and volcanoes, and the layers of the Earth.