Department of Earth and Environmental Sciences
California State University, East Bay

# ASSESSMENT REPORT 2016-17

# GEOLOGY M.S.

17 September
2017

Department of Earth and Environmental Sciences
California State University, East Bay

**Assessment Results 2016-17**
**Geology M.S.**

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Department of Earth and Environmental Sciences
California State University, East Bay

**Geology M.S. Program ILO Alignment Matrix**

The table below shows which Institutional Learning Outcomes (ILOs) are addressed by each of the Program Learning Outcomes (PLOs) listed above.

| | MS PLO 1 Geologic Materials | MS PLO 2 Data Analysis | MS PLO 3 Communication | MS PLO 4 Research | MS PLO 5 Geologic Time |
|---|---|---|---|---|---|
| ILO 1: Thinking & Reasoning | X | X | X | X | X |
| ILO 2: Communication | | | X | X | |
| ILO 3: Diversity | | | | | |

**Curriculum Map for Program Student Learning Outcomes**
**CSU East Bay, Dept. of Earth & Environmental Sciences**
**Degree Program: M.S. in Geology**

| | | | Program Learning Outcomes | | | | |
|---|---|---|---|---|---|---|---|
| **Field** | **Course** | **Title** | **1. Geologic Materials** | **2. Data Analysis** | **3. Communi-cation** | **4. Research** | **5. Geol. Time** |
| GEOL | 6020 | Seismic Exploration | P | M | | | |
| GEOL | 6040 | Near Surface Geophysics | P | M | | | |
| GEOL | 6310 | Isotope Geochemistry | I | P | P | | M |
| GEOL | 6320 | Groundwater | I | M | P | | P |
| GEOL | 6411 | Engineering Geology | M | M | | | |
| GEOL | 6414 | Earthquake Geology | P | | M | | M |
| GEOL | 6430 | Tectonic Geomorphology | I | | P | | M |
| GEOL | 6811 | Graduate Seminar | | | M | | |
| GEOL | 6899 | Project | | P | P | M | |
| GEOL | 6910 | University Thesis | | M | M | M | |

Proficiency Levels: I = Introduced; P = Practiced; M = Mastered

Quantitative Literacy (QL) is competency and comfort in working with numerical data. Individuals with strong QL skills possess the ability to reason and solve quantitative problems from a wide array of contexts and situations.

This rubric may be applied to student assignments that involve all or parts of any of the department's Program Learning Outcomes (PLOs).

| | Capstone | Milestone 2 | Milestone 1 | Milestone 0 |
|---|---|---|---|---|

## M.S. Geology Program

## Assessment Summaries, 2016-2017

## Overview

We evaluated student work from selected courses in the Geology MS Program 2016-2017 to assess how well Program Learning Outcomes (PLOs) were met. PLOs evaluated during this period are 4) Research and 5) Geologic Time and Processes.

**GEOL 6910 University Thesis - Fall 2016, Winter 2017:** Research

Thesis and Project Research The department requires students on the thesis and project tracks to carry out

{ Marcelino Vialpando: CSU WRPI Conference, Fresno, CA, April, 2015, American Geophysical Union Annual Meeting, San Francisco, CA December, 2015, Groundwater Resources Association Biennial Meeting, Sacramento, CA October, 2015.

{ Elizabeth Peters: American Geophysical Union Annual Meeting, San Francisco, CA December, 2015, Groundwater Resources Association Biennial Meeting, Sacramento, CA October, 2015.

{ Faithe Lovelace: Groundwater Resources Association Biennial Meeting, Sacramento, CA October, 2015.

{ Nathan Veale: Groundwater Resources Association Annual Meeting, Concord, CA September, 2016 (winner of student poster competition); American Geophysical Union Annual Meeting, San Francisco, CA December, 2016; European Geophysical Union Annual Meeting, Vienna, Austria, April, 2017.

{ Joanne Chan: American Geophysical Union Annual Meeting, San Francisco, CA December, 2015

{ Adrian Mcevilly: American Geophysical Union Annual Meeting, San Francisco, CA December, 2015; Seismological Society of America Annual Meeting, Reno, NV, April, 2016; Seismological Society of America Annual Meeting, Denver, CO, April, 2017

{ Ayoola Abimbola: American Geophysical Union Annual Meeting, San Francisco, CA December, 2015; Seismological Society of America Annual Meeting, Reno, NV, April, 2016.

{ Jennifer Galvin: American Geophysical Union Annual Meeting, San Francisco, CA December, 2015

{ Seth Shuler: American Geophysical Union Annual Meeting, San Francisco, CA December, 2015; Society of Exploration Geophysics, Denver, CO, March, 2016

{ Ian Richardson: American Geophysical Union Annual Meeting, San Francisco, CA December, 2016; Seismological Society of America Annual Meeting, Denver, CO, April, 2017

**Assignment – Geologic Time**

GEOL 6310 Isotope Geochemistry HOMEWORK 2 due Oct 17

4. isotope dilution method of determining a precise elemental concentration

Concentration of Rb = 49.428/0.35 = 141.2 ppm

5. Atomic weight of spike Sr:

AtWtSr = 0.10x87.9056 + 0.025x86.9089 + 0.08749x85.9092 + 0.0001x 83.9134

| Isotope | abundance | mass (amu) | mass x abundance |
|---|---|---|---|
| $^{88}$Sr (S) | 10.00% | 87.9056 | 8.7905600 |
| $^{87}$Sr (S) | 2.50% | 86.9089 | 2.1727225 |
| $^{86}$Sr (S) | 87.49% | 85.9092 | 75.1619591 |
| $^{84}$Sr (S) | 0.01% | 83.9134 | 0.0083913 |
| | | | 86.1336329 |

sum 1.76 atomic weight $W_S$=

$$^{87}Sr/^{88}Sr = {}^{87}Sr/^{86}Sr \times {}^{86}Sr/^{88}Sr = 5.30 \times 0.1194 = 0.63$$

Rb-Sr isochron date:

The initial $^{87}Sr/^{86}Sr$ ratio is 0.7377, which is high compared to the 0.7040 used to calculate individual mineral ages, and may indicate that the Sr was homogenized at this higher value during metamorphism. Or, the minerals may have crystallized from a magma that contained Sr having an elevated $^{87}Sr/^{86}Sr$ because it formed by remelting of old continental rocks. So, the Rb-Sr date is recording the time since the minerals

9. mineral and whole rock isochrons

Minerals of rock 5 plus whole-rock

The rocks of the Baltimore Gneiss crystallized at 1011 Ma, likely during the Grenville orogeny. The $^{87}Sr/^{86}Sr$ of the protolith (intercept for whole rock isochron) is 0.70538, suggesting a prior crustal history (e.g., volcanic or sedimentary). The Baltimore Gneiss was metamorphosed at about 287 Ma (Early Permian) during the Appalachian orogeny. The isotopic composition of Sr in the minerals was homogenized at this time such that the $^{87}Sr/^{86}Sr$ of the minerals took on the same value as the rocks in which they occurred. Thus, mineral and whole-rock Rb-Sr systems may respond differently to metamorphic events. $^{87}Sr$ generated by Rb decay occupies unstable lattice sites in Rb-rich minerals and tends to migrate out of the crystal if subjected to a thermal pulse, even of a magnitude below the melting temperature. However, Sr released from Rb-rich minerals such as mica and K-feldspar will tend to be taken up by the nearest Sr sink such as plagioclase or apatite. Hence, the whole-rock system may remain closed, even though mineral systems are open.

2.

T = 52.0 Ma, which is also early Eocene. The K-Ar date of the hornblende is older than that of the coexisting biotite because hornblende has a higher blocking temperature than biotite. One can estimate a cooling history of this monzonite, given that the blocking temp. of biotite is 373C and that of hornblende is 685C (as given in text). So the cooling rate is (685-373)C/(52.0-48.8)Ma = 97.5°C/million yrs

Ch 7: 1

which is Devonian

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10-17-2016

Geology 6310: Isotope Geochemistry

HW2 Essay

A Comparative Review of $^{40}K/^{40}Ar$ and $^{40}Ar/^{39}Ar$ Dating

Potassium naturally exists in 3 isotopic states, potassium-39, potassium-40, and potassium-41, and potassium-39 is the most prevalent with an abundance that is over 90%. Of these isotopes potassium-40 is unstable, has a half-life of 1.251 billion years, and 10.5 percent of potassium-40 decays by electron capture or emission of a positron to form argon-40. 89.5% of potassium-40 decays by beta emission forming calcium-40; $^{40}K/^{40}Ca$ dating is less effective than $^{40}K/^{40}Ar$ dating because calcium-40 has a high natural abundance because it commonly incorporates into crystal lattice of many minerals. Argon-40, on the other hand, has low abundance and is chemically inert meaning any argon trapped in minerals should be expected to be radiogenic. $^{40}K/^{40}Ar$ dating uses the ratios of radioactive potassium-40 and radiogenic argon-40 to calculate ages of rocks (Faure and Mensing, 2005).

Unfortunately not all radiogenic argon-40 within minerals is necessarily generated internally within minerals. Due to the unreactive nature of noble gases, argon-40 will not form chemical bonds inside minerals and will readily diffuse out of rocks even at low temperatures, making rocks date younger. This excess gas also gets incorporated into other minerals within the same rock, making it date older. $^{40}Ar/^{39}Ar$ dating corrects for these errors that arise from argon diffusion. Argon-39 is an unnatural unstable isotope with a half-life of 269 years and decays to potassium-39 by beta emission. Potassium-39 is transformed to argon-39 by bombarding a sample by neutrons in a nuclear reactor (Faure and Mensing, 2005). The argon-39 generated can be used as a proxy to derive the amount of potassium-40 present in a sample (Lee, 2013).

$^{40}K/^{40}Ar$ dating can be performed on any potassium bearing rock or mineral. Potassium feldspar tends to not be a good choice as argon diffuses more readily. Any metamorphism can greatly affect argon concentrations in rocks; for example, the Idaho springs gneiss experienced a complete loss of argon in all minerals within 3 m of the contacted of the Eldora stock. $^{40}K/^{40}Ar$ dating is most effective on biotite, muscovite, and hornblende; however, because of the low melting temperatures of micas; increasing temperatures cause the weakening of the crystal structure allowing argon to diffuse at a higher rate. Whole rock dating can be done on fine grained igneous rocks if there are not foreign inclusions present; however, since potassium is not extracted from the same location on a sample, rocks that are very fine grained or glassy may give erroneous dates because the rock is not chemically homogeneous. Some $^{40}K/^{40}Ar$ dating has also been done on metasedimentary rocks (Faure and Mensing, 2005).

$^{40}Ar/^{39}Ar$ dating works for any rock in which potassium-argon dating can be used. $^{40}Ar/^{39}Ar$ dating can also be used in rocks composed of low potassium bearing minerals, such as amphibole, pyroxenes, plagioclase, and magnetite. Also fine grained rocks do not need to be homogenous as one sample tests for both argon-40 and argon-39 at the same time (Faure and Mensing, 2005).

In order to date rocks using the $^{40}K/^{40}Ar$ method, the concentration of potassium must be found by first dissolving a powdered rock sample in hydrofluoric acid. The isotopicd 0 11.04 60-4.6(s)--((v)10.9(i)9/-((v)10.9s)-2.3(i -

Department of Earth and Environmental Sciences, CSCI

# ASSESSMENT PLAN: M.S. in Geology

Updated Winter 2015 by Jean Moran, Luther Strayer, and Mitchell Craig

## PROGRAM MISSION

CSUEB Missions, Commitments, and ILOs, 2012 version

### CSUEB Geolo gy M.S. Program Description

To serve graduate students who are employed during the day, all graduate courses in the Department of Earth and Environmental Sciences are offered in the evenings and on weekends. In addition to regular catalog courses, recent graduate seminars and advanced topics courses have dealt with such subjects as sediment transport and modern depositional environments,0.002 a. re f BT 0 [illegible]

| Year 1: 2013-2014 | |
|---|---|
| 1. Which PLO(s) to assess | PLO 3 (Communication), PLO 4 (Research) |

## Year 4: 2016-2017

| | |
|---|---|
| 1. Which PLO(s) to assess | PLO 4 (Research), PLO 5 (Geologic Time). |
| 2. Assessment indicators | Course assignments and projects, precis & oral presentations of topical journal articles in the field, MS prospectus, MS project, MS Thesis. Department rubrics will be used. |
| 3. Sample (courses/# of students) | GEOL6040/15, GEOL6414/15, GEOL6811/12, GEOL6899/5, GEOL6910/3. |
| 4. Time (which quarter(s)) | Fall 2016, Winter 2017, Spring 2017. |
| 5. Responsible person(s) | Mitchell Craig, Luther Strayer, and affiliated faculty. |
| 6. Ways of reporting (how, to who) | Reports first to the Chair and then to the entire faculty for comment & discussion. An end-of-year meeting will be devoted to evaluating assessment results and "closing the loop." |
| 7. Ways of closing the loop | We will assess progress made since 2015-2016, adjust strategies. Revise program requirements concurrently with quarter-to-semester conversion. |

## Year 5: 2017-2018

| | |
|---|---|
| 1. Which PLO(s) to assess | PLO 1 (Geologic Materials), PLO 2 (Data & Analysis) |
| 2. Assessment indicators | Course assignments and projects, precis & oral presentations of topical journal articles in the field, MS prospectus, MS project, MS Thesis. Department rubrics will be used. |
| 3. Sample (courses/# of students) | GEOL6020/15, GEOL6414/15, GEOL6899/6, GEOL6910/3. |
| 4. Time (which quarter(s)) | Fall 2017, Winter 2018, Spring 2018. |
| | |