Geology Department

Five-Year Review, Self-Study Document
2019 to 2020

Prepared by the
Geology Faculty

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I. Geology Department Program Overview

a. Department of Geology Mission Statement: *To engage students through lecture-, field- and laboratory-based courses, and to train them to identify and interpret the materials, structures, processes and history of the Earth. To provide our graduates with the skills needed to pursue careers in education, government, research, and industry, particularly within California. To provide our faculty with opportunities to create and apply knowledge in the earth sciences and to communicate scientific understanding to students, peers, and the communities we serve.* – Mission statement proposed and passed unanimously by Geology Faculty in 2008.

b. SSU Mission Statement: The mission of Sonoma State University is to prepare students to be learned persons who:

- have a foundation for life-long learning
- have a broad cultural perspective
- have a keen appreciation of intellectual and aesthetic achievements
- will be active citizens and leaders in society
- are capable of pursuing fulfilling careers in a changing world
- are concerned with contributing to the health and well-being of the world at large.

The Geology Department facilitates these goals by cultivating opportunities for our students to engage with the academic content through their coursework and through independent research, scholarship, and/or creative activities related to the discipline, and project-based learning. More specifically these goals are achieved by:

- engaging students in critical thinking, system-based thinking, and meaningful problem solving in order to encourage life-long learning.
- applying practical skills and scientific methodologies to address questions about the individual, society, and connections to the community and the larger, interconnected global system.
- teaching students to synthesize geological data from the literature and compile that information into a working understanding of a specific topic within the Earth Sciences or a specific field area.
- building a community of creative and critical thinkers, with local to global perspectives, that understand some of the most pressing global crises of this century, e.g., climate change, water availability, wild fires, earthquakes, and other natural disasters. Our society needs citizens/voters and leaders that truly understand these topics in order to drive appropriate and life-saving policies.
- facilitating students to be able to apply technological knowledge, skills, attitudes, and flexibility needed to succeed in a rapidly changing environment and job market.
- enabling students to understand and engage with the concepts and practices of global interdependence. Our students learn how human activities impact the environment.

c) Ways in which the Geology Department serves regional and state needs.

A large proposition of our graduates work within our local community at the North Coast Regional Water Quality Control Board (probably the biggest single employer of

our alumni) and various geotechnical firms around the greater Bay Area. These institutions make sure that our structures (e.g., buildings, bridges, dams, etc.) have adequate foundations such that they do not pose a danger to local residents, as well as making sure that our water quality is maintained, protected, and even enhanced. Our alums investigate and assess construction sites, conduct lab tests, create designs for structures, supervise construction, and write and present reports. They work on such projects as designing tunnels, roadways, retaining walls, and earth dams, as well as helping to create strategies for the clean-up and management of contaminated sites.

d) Geology Department Goals and Student Learning Outcomes

The Geology Department provides the base education needed to become a licensed Professional Geologist (PG), apply to graduate school in Geoscience related fields, or become a secondary educator in the Earth Sciences.

We have a successful record when it comes to our alumni passing the PG qualifying exams, and the level of success will be explored in great detail in the Assessment section later in this report. This National Association of State Boards of Geology (ASBOG) Fundamentals of Geology (FG) and Practice of Geology (PG) Examination Knowledge Base consists of eight domains which collectively encompass the scientific and practical knowledge needed to become a licensed Professional Geologist (PG). Our average student score on the FG and PG exams are significantly above the national average with 71% of our students over the past 30 years passing the exam. The pass rate for the topics covered in our core disciplines are even higher with

average passage rate scores of 74.25% for Mineralogy and Petrology, 72.25% for Structural Geology and Tectonics, and 69.5% for Sedimentology/Paleontology.

We also have a very successful record of getting our majors into graduate programs in the Geologic Sciences. Last year, one of our majors was accepted to nearly all the top-tier graduate programs in the nation, and ultimately decided to attend Princeton University.

The Geology Department is in frequent contact with Laurie Racca, P.G., who is the Examination Committee Chairperson for the National Association of State Boards of Geology (ASBOG). We have had Ms. Racca come to campus multiple times to talk to our majors about the PG accreditation process, and are currently working on scheduling a Zoom meeting with Ms. Racca for our majors. This is particularly important in the era-of-Covid, because some of the state requirements with regards to field courses and field camps are temporarily changing in response to the pandemic.

Goals for the Department of Geology

The goal of the department of geology is to give students professional competence in the Earth Sciences. Common knowledge of the field of geology and the feedback we receive from graduates and prospective employers continually tell us to focus on three areas: 1) Fieldwork, 2) Student Research, and 3) a wide ranging curriculum.

The instructional faculty's philosophy is that the outdoors is an extension of the classroom; it is a laboratory without walls. By going into the field we bring geology back to the classroom. The field is really our outdoor classroom, and we utilize this important resource as often as we can, both locally, regionally, and internationally. Field learning

is active learning with a high level of student engagement. This concept has made our program one of the most field-intensive programs in the CSU system and beyond. Mapping projects and written reports which accompany all field courses hone our students' interpretive and communication skills, preparing them for careers in education, government, research and private industry. Approximately 1/3 of our graduates immediately pursue graduate degrees, and all obtain positions using their degrees if they choose to do so. Sonoma State University's service area requires a steady supply of new geoscientists to address needs in the areas of education, land use and development, water supply and quality, environmental assessment and remediation, paleontology investigation and review, geologic hazards assessment, geothermal energy research, air quality assessment (toxic mineral dust), plus new challenges associated with climate change (changes in the hydrologic cycle, sea-level rise effects on the Pacific coast and San Francisco Bay and Delta system, plus its levee systems), and a resurgence of interest in mineral and energy resource exploration. These employers need graduates who are ready and able to assume practitioner roles in their disciplines, and to be able to convey effectively their work to other professionals and to laypersons.

The SSU Geology Department continues to receive regular solicitations for our students to apply for jobs from employers within our service area and beyond. Oftentimes these solicitations come from department alumni who have progressed into management positions in their organizations. We provide a broad education with our core courses and multiple options for electives. We also provide service to the campus by teaching several large-lecture GE courses.

Student Learning Outcomes for the BS in Geology and the BA in Earth Science:

Students who complete the Bachelor of Science in Geology or the Bachelor of Arts in Earth Science degrees at Sonoma State University are required to demonstrate: 1) The understanding of geologic terms, concepts, and theories, 2) The ability to collect geologic data through laboratory and field studies, and to formulate logical interpretations and conclusions from those data, 3) The ability to compare, contrast and demonstrate appreciation of competing views within geology, involving both historical and current controversies, 4) A solid understanding of geologic conditions specific to California and the unique global geological context of California, 5) The ability to identify common rocks and minerals found in any country located anywhere on Earth, and 6) how to collect primary scientific data as well as to aggregate data from disparate sources, including books, videos, and the internet. Additionally, students are also expected to acquire the following general skills: 7) Competence in scientific inquiry, 8) critical thinking abilities, 9) written and oral communication proficiency, and 10) quantitative reasoning skills.

Dissemination of Learning Goals to Students

The following chart (Table 1) documents a wide breadth of learning objectives we strive to teach throughout our curriculum as well as the course that covers that topic. Our course offerings are built to give the student professional competence in geology.

Table 1. Course Offerings, Special Designations and Desired Professional Skills. Light Blue = Introduce Skill; Medium Blue = Further Develop Skill; Dark Blue = Develop Mastery of Skill

Finalized skills list	Introduction to Geology (102)	Dinos (105)	Natural Disasters (110)	Mineralogy (205)	Regional Geology (120)	Hawaii (301)	Climate Change (302)	Advanced Principles (303)	Field mapping, Report Writing (304)	Computer Applications (309)	Igneous/Metamorph	Sedimentology (311/312)	Paleontology (313/314)	Structure (317/318)	Hydrology (323)	Geophysics (310)	Basins (415)	Economic (435)	Senior Field (420)	Summer Field	Senior Thesis (426)	Ind. Study (428)
Core requirement (C), General Ed (G), Elective (E)	G	G	G	C		G E	G E	G C	C	C	C	C	C	C	E	E	E	E	C	C	E	E
Define, classify, and identify basic principles and fundamentals of geology																						
Implement techniques used for geological field and laboratory investigations (optics, strike and dip measurements, stream velocity, topographic profiling)																						
Collect and Record Geological & Hydrologic Quantitative and Qualitative Observations																						
Analyze and plot geologic/hydrologic data in map view and cross section																						
Analyze, interpret, and evaluate geologic and hydrologic data in report or scientific paper format																						
Improve oral presentation skills																						
Improve written and multimedia communication skills																						
Develop cooperative learning and leadership skills																						
Engage with external community members																						
Synthesize, evaluate, and interpret geologic and hydrologic concepts																						
Access and reference public data sets and peer-reviewed literature																						

e) Geology Department History/Overview

The Geology Department consisted of five permanent tenured and tenure-track faculty from 1972-2002. To this day, we consider the ideal size of our department to be five, full-time, tenure-track faculty. During the 30-year period from 1972-2002, only one faculty position turned over (in 1986 with the death of a faculty member). Since then, all of the original faculty members of the department have retired, and we have had several faculty members be hired into the department, namely (in order of hire): Dan Karner (hired 2003; retired in 2011), Matty Mookerjee (hire 2006), Mike Smith (hired 2007; left 2014), Owen Anfinson (hired 2015), Laura Waters (hired 2017; left 2019), Robin Glas (hired 2018; left 2020), and our most recent hire Marissa Mnich (hired 2020).

The relative rapid turnover in faculty in the recent years has made us reflect on faculty retention as well as faculty diversity. While it is important to explore local factors for our difficulty in retaining our most recent hires (namely Dr. Waters and Dr. Glas), during exit interviews with both of these faculty, they both expressed that the Geology Department was not the reason for their departure, and in fact, they were very saddened to have to leave our department. Primarily, each of the faculty had financial reasons for leaving. Both of these faculty members had spouses that needed jobs in our local area in order for them to stay. Former faculty member Michael Smith also cited this as one of the reasons for his departure. Matty Mookerjee also nearly left SSU because of the university's unwillingness to find any reasonable solution to his "two-body problem." Particularly given the cost of living in our area, the university needs to come up with a plan to deal with this significant problem for departments, otherwise, we will continue to loose valuable faculty at no little expense to the University.

It is the Geology Department's belief that we can best serve our students and the core mission of the department by hiring new tenure track faculty that better reflect the demographic of the student body. We have adopted a holistic hiring philosophy that takes into account the candidate as a whole and their potential impact on the department, not just their professional and scholastic achievements. In 2017 we hired the first female tenure track faculty member in SSU Geology Department's history, and in 2018, we hired our second female tenure track faculty member. Unfortunately, both of these candidates have since left the department for other positions, which has hindered our goal of reflecting the diversity of our student body. We were able to hire another excellent candidate in 2020 and currently have a 3:1 Male-Female tenure track faculty ratio. We hope to replace our hydrology position taking into account our holistic hiring philosophy, but with Covid and the resulting economic downturn and hiring freeze, we did not get this position back. Our hope would be that once the hiring freeze is lifted, we can go back to being a five-person, tenure track faculty department as well as make strides towards having our faculty composition better reflect the demographic of our student body.

In addition to our tenure track faculty, we also hired an educational support technician (Phil Mooney), whose has been instrumental in all aspects of the department, from organizing our field trips, to curricular development and teaching large-lecture courses. Our pool of talented and reliable temporary lecturers teach many of the introductory courses as well as upper division GE courses. With the addition of new tenure-track faculty and the retiring of some lecturer faculty, our lecture pool has shrunk to two main lecturers (Nicole Myers and Martha Murphy). Both of these faculty members

are incredibly hardworking and dedicated to our department. Martha Murphy is currently working on developing a new course on the Geology of our National Parks, and she also teaches our upper division Climate Change course. Nicole Myers routinely teaches our Geology 303 course, which is the “gateway to the major” as it is a prerequisite to most of our other upper division major courses.

II. Outcome of the Previous Program Review

List the recommendations made at the conclusion of the previous review:

1) “Replace Dr. Smith’s tenure-track position. The department should place as a hiring priority a geologist who has a strong desire to mentor student research and continue the emphasis on geological field studies.”
2) “Based on Dr. Mookerjee’s research and current national trends, Sonoma State has an opportunity to be on the cutting-edge of data-based, computation geology. Dr. Mookerjee has already had success with NSF and should be encouraged to develop additional external funding.”
3) “Utilize the part-time lecturers and staff in more diverse roles.”
4) “The faculty members need to continue to evaluate the curriculum.”
5) The department needs to develop a successful strategy for maintaining a department with so few faculty members in regards to governance and university service.
6) The department needs to strengthen its ties to the private sector and bring in new collaborations.

Department's Response to External Reviewer's Recommendations:

1) We were able to replace the sedimentology tenure track position by hiring Owen Anfinson in 2015. As mentioned above, we were also able to hire an Igneous and Metamorphic Petrologist (twice, in fact; once with Laura Waters in 2017, and then after she left, again in 2020 with Marissa Mnich). Additionally, we hired a hydrologist in 2018. Therefore, we feel like we have made significant strides in the direction that our external reviewer suggested, and if we are able to replace our hydrologist, who left in 2020, we will have fulfilled his original goal.
2) As the external reviewer suggested, Dr. Mookerjee has made several attempts to get NSF funding. While not all of these attempts have been successful, he has been able to acquire three additional NSF grants. The first one in 2016, funded hosting an international meeting at SSU, the 2016 Structural Geology and Tectonics Forum. This forum included 7 oral sessions, 6 poster sessions, 8 field trips, and 5 short courses, and did a lot to increase the visibility of SSU in the field of the geosciences. Secondly, Dr. Mookerjee was able to secure a second cyberinfrastructure-based NSF grant that facilitated his research collaborations with both computer scientists (developing image analysis algorithms for photomicrographs using machine learning), and mathematicians (developing forward and inverse models of crystallographic textures in deformed fault rocks). Lastly, as the lead PI, Mookerjee was able to acquire funding for a new Scanning Electron Microscope (SEM) with Electron Backscatter Diffraction (EBSD), Cathodoluminescence (CL), and Energy Dispersive X-Ray Spectroscopy (EDS) detectors, and electron beam lithography package and sample preparation

equipment. This specifically designed microanalysis system has the ability to push forward the research agendas of several faculty members in the School of Science and Technology (not to mention the Anthropological Studies Center and the Geography, Environment, & Planning Department). Specifically in the Geology Department, Mookerjee needs the EBSD detector to facilitate his field research, Anfinson needs the CL detector in order to facilitate his detrital zircon analyses, and our newest hire, Mnich, will used the EDS to accomplish her geochemical analyses.

3) We have taken on the suggestion to use our faculty and staff in more diverse roles. Our department technician, Phil Mooney, had his position changed to become a SSPIII shortly after this review. This enabled him to become more involved in curricular development, running the department seminar, and stepping in to teach courses when needed in addition to facilitating department field trips. Our two remaining lecturer faculty have taken on more significant roles in the Geology Department too. Both Nicole Myers and Martha Murphy were helpful during this past year's GE revision and recertification. Martha Murphy was instrumental in converting her climate change course into an upper division GE course. Additionally, Ms. Murphy is currently proposing a new upper division GE course on the Geology of National Parks in order to fulfill a dearth of UDGE B courses/seats being offered by in the School of Science and Technology.
4) While we agree that it is always a good idea to evaluate the need for curricular revisions, for the most part we are happy with the overall structure of our curriculum. It has been difficult to make major and substantive changes to the

curriculum while the makeup of our faculty is in flux. Once the department has stabilized, we can revisit the idea of major curricular revisions. We have made two changes to the curriculum, however: 1) we have added a seminar series to our list of courses; this course was first added to the schedule in the Fall of 2020, and 2) and we added a laboratory component to our Hydrology course, which was taught for the first time in the Spring of 2020. We also changed the timing of our Computer Applications in Geology (GEOL 309) and Mineralogy (GEOL 205) course in order to facilitate a more logical progression of skills through the major. We also had discussions about teaching a Tectonics course and/or an Economic Geology course, but have been unable to staff such electives given our limited faculty.

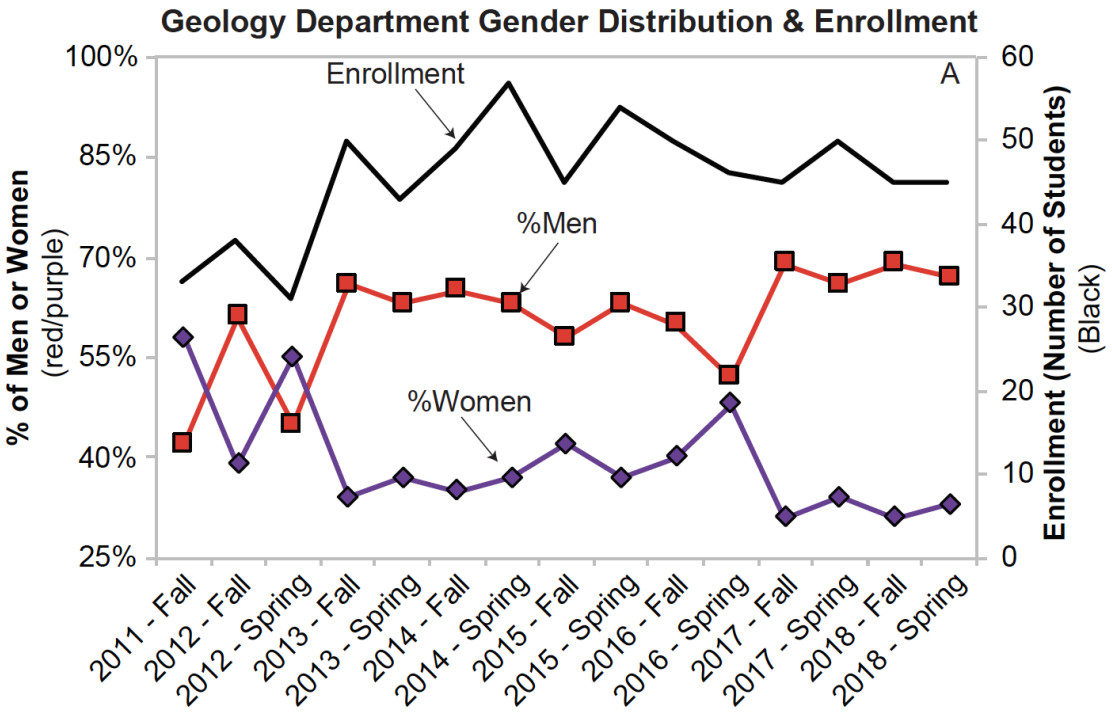
5) This comment is certainly true, but it will always be difficult to balance university service in a small department like ours, particularly if we do not want to lose our representation and voice in university issues. Ultimately, we can only do the best that we can do here.
6) With obtaining the new SEM, our ability to make create and maintain new industry collaboration and partners will be vastly improved. Additionally, we have an informal relationship with Biomarker Technologies Inc in Rohnert Park that we continue to foster and develop. We also host an active seminar series that helps us to maintain ties with local geoscientists and helps to foster collaborations between other institutions and SSU.

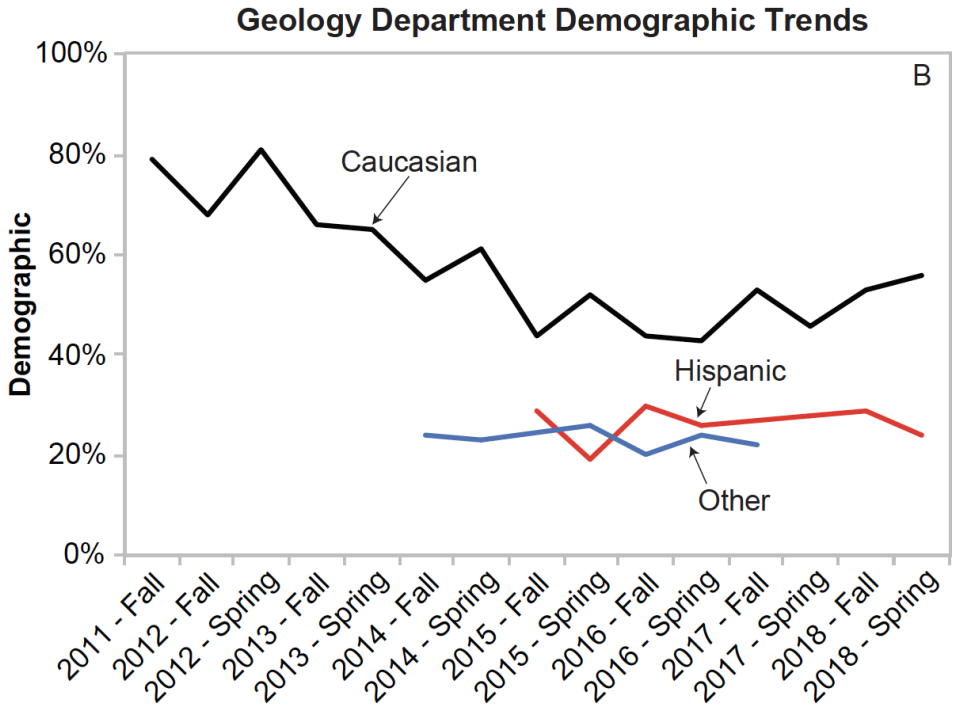
Changes in the Program since the Last Program Review

As mentioned above, we have only made significant two curricular changes to our program since our last review, namely: we have added a seminar series to our list of courses; this course was first added to the schedule in the Fall of 2020, and 2) and we added a laboratory component to our Hydrology course, which was taught for the first time in the Spring of 2020. The seminar series will serve as an opportunity for our students to become familiar with scientific literature, how to summarize results of a professional paper and present those results in a brief technical document. This course will prepare our students for the requirements of investigation and report writing in future jobs, as well as introduce students to local and non-local professional geologists in a wide variety of careers (and pathways towards careers). We additionally believe that this course will bolster our students' performances on the WEPT requirement for SSU graduation. The addition of the Hydrology lab section helps in preparing our students to join the workforce, and makes our curriculum consist with other Universities in the California State University system and nationally. More will be said about the importance of the Hydrology course for our department, for our majors, and for the California workforce below. An additional and relatively minor change to our curriculum is the conversion of our Sedimentary Geology (GEOL 311) course to serve as a met-in-major GE course in the category Upper-Division Area B (UDB). Most of our majors have no problem getting their UDB, but for those few individuals who get started in the major early, and therefore take our GEOL 303 course (which fulfills the UDB requirement) before reaching junior status, this provides another avenue for them to meet this requirement.

III. Student Profile

As you can see in the figures below, the Geology Department student body skews male-heavy, particularly when compared to the SSU average M:F ratio, although it does fluctuate quite a bit with time. While the School of Science and Technology, and the sciences in general, have a higher M:F ratio than the rest of the university, we feel like we have room for improvement when it comes to equally recruiting from both sexes. Our hope is that by making our department faculty makeup more reflective of our student body, we can start to address this discrepancy with diversifying our faculty hires. After only weeks in our department, our newest faculty hire, Marissa Mnich, noticed this ratio and started brainstorming with the department on ideas to help correct this. She will likely be starting a new “Women in the Geosciences” group that would be open to “female geology students, as well as non-binary, transgender, or anyone else who wants to join!” The Geology Department is fully in support of this endeavor and will support Dr. Mnich in anyway it can to make this a success.





As seen illustrated in the figure above, the Geology department student body has a majority of students who identify as Caucasian, however the trend is decreasing with time as the demographic of the whole university is changing. Ethnic diversity has been a

significant hurdle in the geosciences, in particular (as is illustrated in the New York Times article in 2019 “Earth Science has a Whiteness Problem”). From the article “The Earth Sciences are White AF” by Yessenia Funes in 2018, it was reported that, “about 86 percent of geoscience Ph.D.s awarded in the U.S. from 1973 to 2015 went to white people.” Ms. Funes also noted that, “in 2016, just six percent of geosciences doctorates went to people of color even though they make up 31 percent of the U.S. population. That makes the geosciences the whitest STEM (Science, Technology, Engineering, and Math) field of them all.”

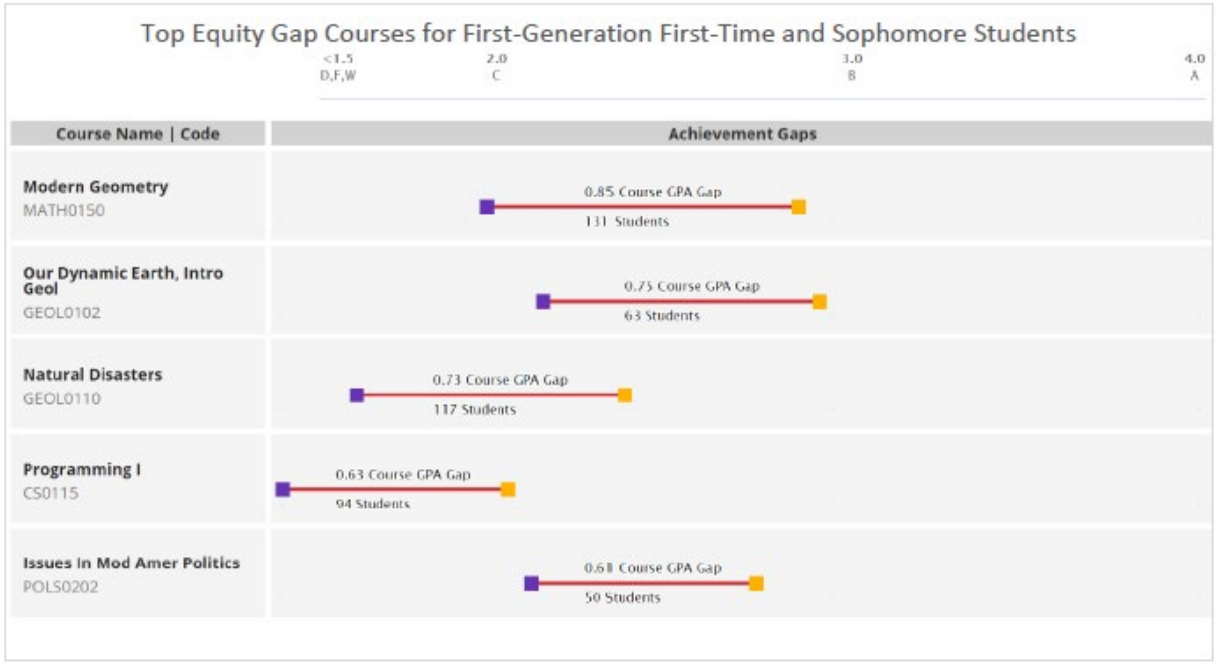
We have a real opportunity to make significant and long-lasting changes by recruiting more diverse students into our department. By taking advantage of programs like the McNair Scholars faculty mentoring program and the Koret Scholars awards, we can have significant impacts on students who initially “never dreamed of going to grad school” (student response from exit survey). In the Geology Department, we have the ability make impactful research opportunities accessible to a diverse spectrum of students and combat the “whiteness problem” in the geosciences. In the last few years, we have been very successful at getting students to participate in the McNair program and eventually get students accepted to top-tier graduate programs. These successes need to be advertised more broadly to the current students (particularly our first and second years) so that these opportunities seem more accessible to our majors.

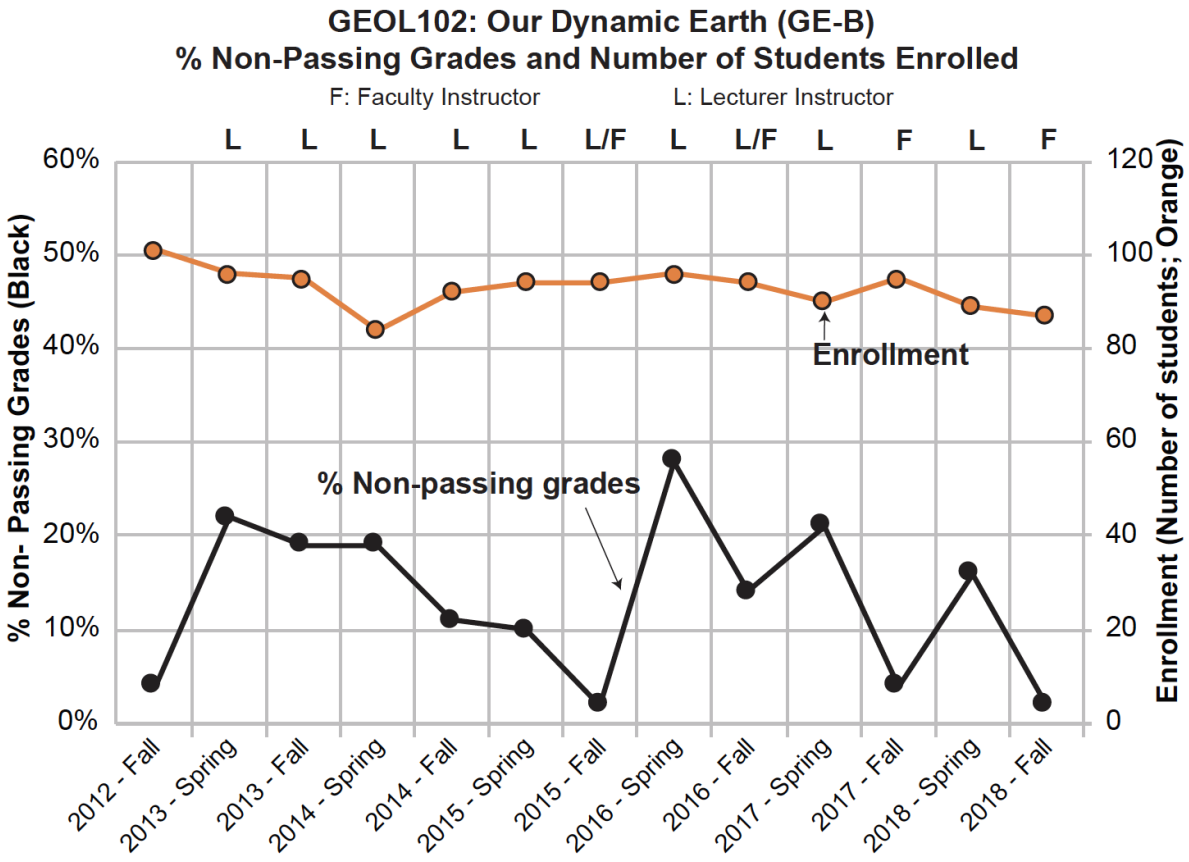
Additionally, two of our lower division courses have been identified as having significant equity gaps (GEOL 102: Our Dynamic Earth and GEOL 110: Natural Disasters) as is illustrated in the figure below from the 2019 Campus Equity Report. These two courses are often taught by lecturer faculty in large lecture settings, and we

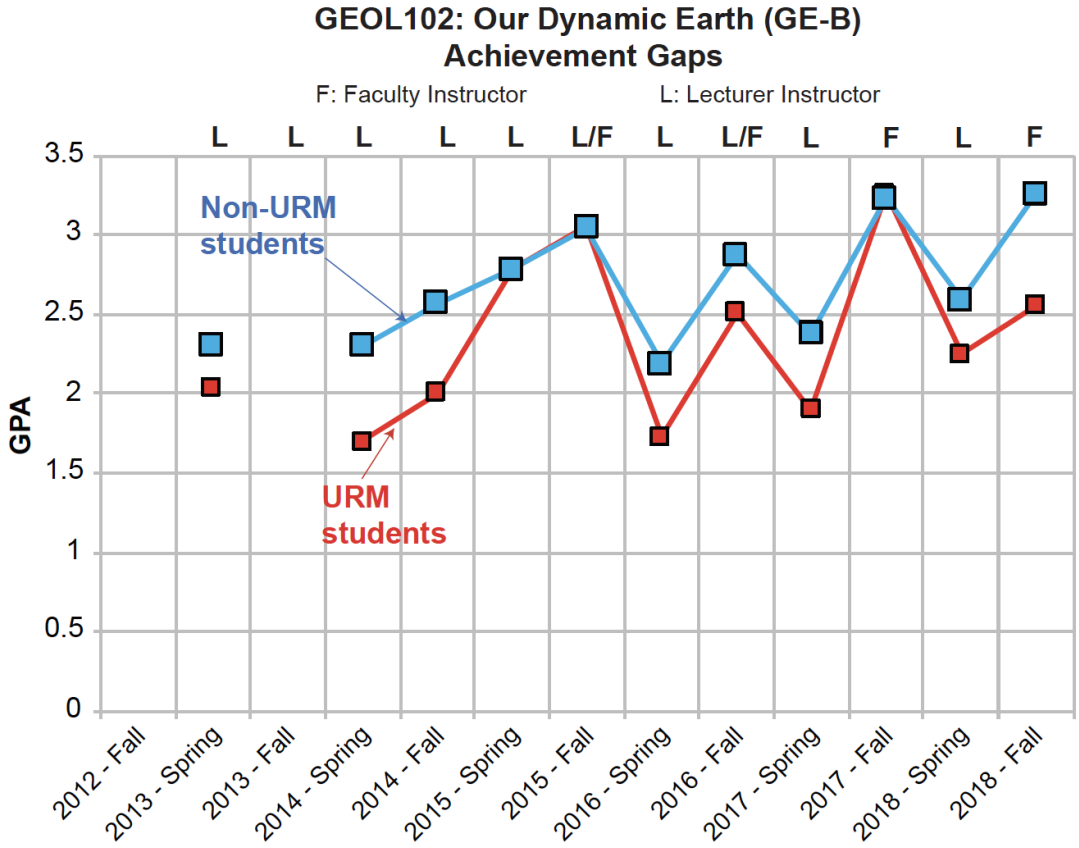
have noticed that a lot of the diversity training on this campus seems to focus on the tenure-track faculty. In the data from our GEOL 102 course, we can see that there is a distinct difference in the passage rate of a class and whether that class is being taught by a lecture faculty member or a tenure-track faculty member. These more severe failure rates seem to have some correlations with the equity gap in this course. Clearly, we need to create opportunities for all of our faculty, not just our tenure-track faculty, to engage with these important topics. To this end, the Geology Department will be participating in the recently funded National Science Foundation grant under the Improving Undergraduate STEM Education: Hispanic Serving Institutions (HIS) Program: “Transformative Inclusion in Postsecondary STEM: Towards Justice: (TIPS Towards Justice)” with lead-PI Brigitte Lahme from SSU’s Math and Statistics Department. As participants in this project we have committed to the following:

- Encourage faculty in the department to participate in professional development and research activities provided through the grant and implement knowledge gained, as practicable, in the classroom.
- Encourage faculty in the department to attend campus-based and community-based workshops and activities to increase familiarity with the Latinx culture.
- Encourage faculty in the department to participate in the evaluation of the project, as needed.
- Encourage faculty to collaborate with other SSU faculty and staff to identify institutional practices and determine which need to be changed, leveraged, or eliminated to increase STEM student participation and success and participate, as appropriate, to help implement designated changes.

Top Equity Gap Courses for First-Generation First-Time and Sophomore Students




GEOL102: Our Dynamic Earth (GE-B)
% Non-Passing Grades and Number of Students Enrolled
F: Faculty Instructor
L: Lecturer Instructor
L L L L L L/F L L/F L F L F
% Non- Passing Grades (Black)
Enrollment (Number of students; Orange)
60%
50%
40%
30%
20%
10%
0%
120
100
80
60
40
20
0
Enrollment
% Non-passing grades
2012 - Fall
2013 - Spring
2013 - Fall
2014 - Spring
2014 - Fall
2015 - Spring
2015 - Fall
2016 - Spring
2016 - Fall
2017 - Spring
2017 - Fall
2018 - Spring
2018 - Fall


GEOL102: Our Dynamic Earth (GE-B)
Achievement Gaps
F: Faculty Instructor
L: Lecturer Instructor
L L L L L L/F L L/F L F L F
GPA
3.5
3
2.5
2
1.5
1
0.5
0
Non-URM students
URM students
2012 - Fall
2013 - Spring
2013 - Fall
2014 - Spring
2014 - Fall
2015 - Spring
2015 - Fall
2016 - Spring
2016 - Fall
2017 - Spring
2017 - Fall
2018 - Spring
2018 - Fall

Enrollment

Going into the 2019-2020 academic year, we were fairly pleased with our enrollment numbers. Now, in the Covid-era and in the midst of an economic downturn, we feel like we need to be proactive with regards to boosting the enrollment and graduation numbers in our Department. Our recruiting activities will include and are not limited to: attending (either virtually or in person, depending) multiple student orientations during the summer, connecting with local community colleges and onboarding transfer students, rotating introductory courses so that a tenure track faculty member is always teaching a large introduction to geology class, reaching out to undeclared undergraduates, building our social media presence and advertising geology. Another potential add in our recruitment efforts is to change the name of our Bachelors in Arts degree from “Earth Science” to “Earth and Environmental Science.” This small change has had relatively drastic effects in enrollments at other institutions, and we feel like this name change also does a better job of fully describing our program.

IV. Tenure Track Faculty Profiles

Owen Anfinson

Dr. Anfinson primarily considers himself a tectonic sedimentologist, meaning that most of his research focuses on utilizing tools such as detrital geochronology and thermochronology to understand tectonic problems. His research spans a wide range of field areas from the Channeled Scablands of Washington to the Canadian and Russian Arctic. Locally, his current research focuses on sedimentologic and tectonic problems associated with strata of the Franciscan Complex and the Sur Series. Globally, Dr.

Anfinson still remain closely tied to Arctic Tectonics and has a small number of active projects in the Swiss and Italian Alps. Unrelated to his main research focus, he is also a UAS (drone) pilot and collects aerial imagery to help create 3D models and 3D prints to better understand regional geologic outcrops.

Matthew James

Dr. James started the Faculty Early Retirement Program in 2019, and is currently on a Fall only teaching schedule, where he continues to teach GEOL 313: Paleontology, GEOL 314: Paleontology Field, GEOL 301: Natural History of the Hawaiian Islands, and GEOL 304: Geologic Mapping and Report Writing. Additionally, Matt completed his book “Collecting Evolution: The Galapagos Expedition that Vindicated Darwin” where he recounts the journey of eight men from the California Academy of Sciences that set sail from San Francisco for a scientific collection expedition in the Galapagos Islands, and by the time they were finished in 1906, they had completed one of the most important expeditions in the history of both evolutionary and conservation science. Matt James is a current Fellow of the California Academy of Sciences, and he uses his access to unpublished writings and photographs to provide unprecedented insight into the history behind the science of evolution.

Marissa Mnich

Dr. Mnich’s research interests lie in the areas of volcanology and igneous petrology, primarily on basaltic systems. She became interested in volcanology while spending a semester studying in Hawaii and has been fascinated with basalts ever

since. Her research spans a variety of volcanic systems, from the monogenetic Springerville Volcanic Field in Arizona to studying volatiles in Icelandic lavas. Dr. Mnich is particularly interested in integrating field data with geochemical and mineral data to gain understanding of the petrogenesis of basalts, from their mantle source through eruption.

Matty Mookerjee

Matty Mookerjee is a structural geologist with particular interests in quantifying three-dimensional kinematics of fault/shear zones. He often use three-dimensional grain shape analysis combined with crystallographic texture analysis using Electron Backscatter Diffraction (EBSD) to characterize the behavior within these deformation zones. He liaises between the geoscience and cyberinfrastructure communities and facilitates the inclusion of field data into the appropriate data repositories such that it can be used and re-used to answer questions about earth history.

Dr. Mookerjee has field areas along the San Andreas Fault (CA), the Denali Fault (AK), in the Himalayas (India), the Bitterroot Detachment Lobe (MT), the Rosy Finch Shear Zone (CA), polygonal faults in Egypt, as well as analog modeling of fault asperity kinematics, and developing cyberinfrastructure (CI) tools for crystallographic, microstructural, and image analyses.

Hydrology Position

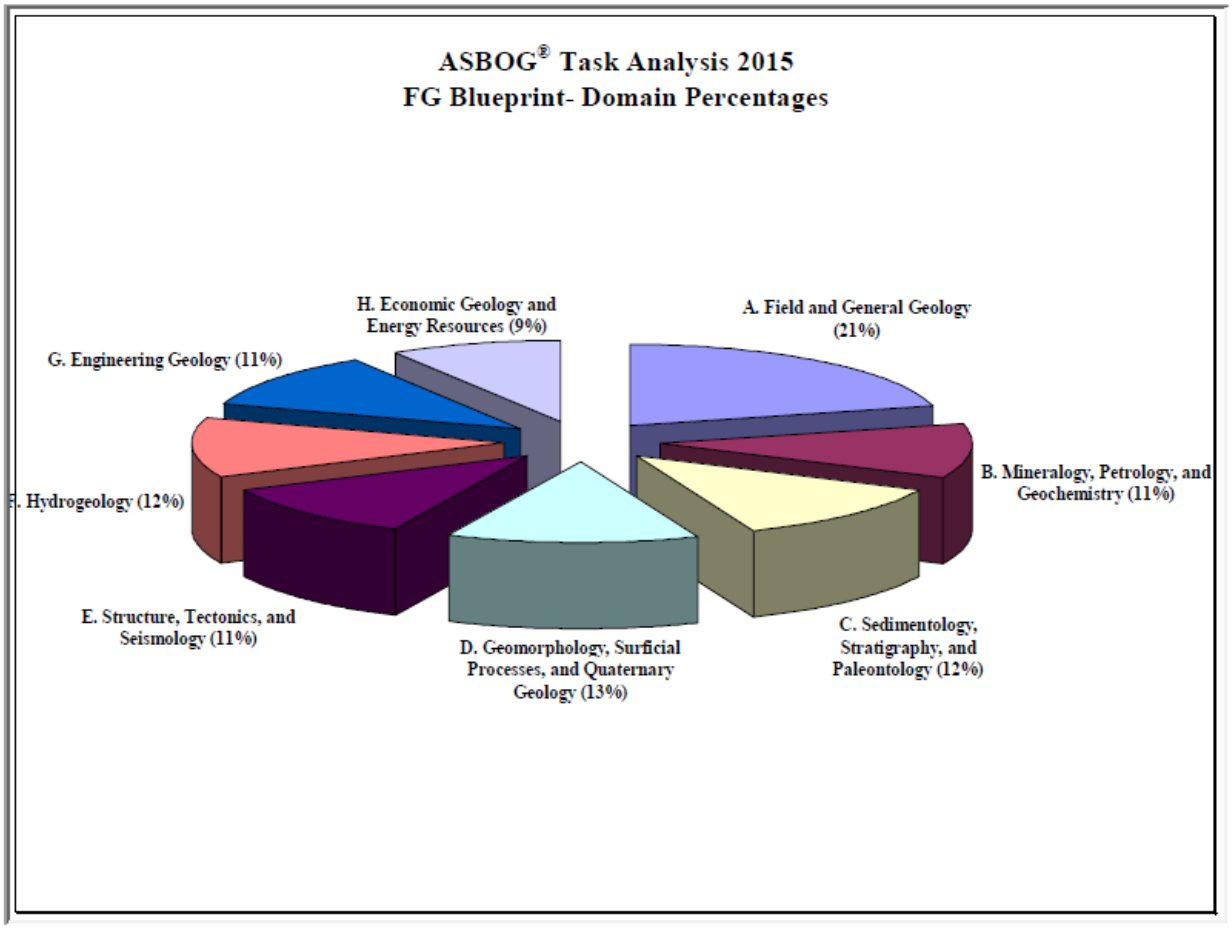
It cannot be overstated that it is imperative that we replace our tenure-track position in hydrology/hydrogeology both for the academic reasons listed below in the Assessment Section, but also to help the Geology Department reach our diversity goals.

V. Assessment, Program Quality, and Integrity

In terms of assessment, we have two main sources of data: the performance results of our alumni on the National Association of State Boards of Geology (ASBOG) exams, and the results from our voluntary exit survey.

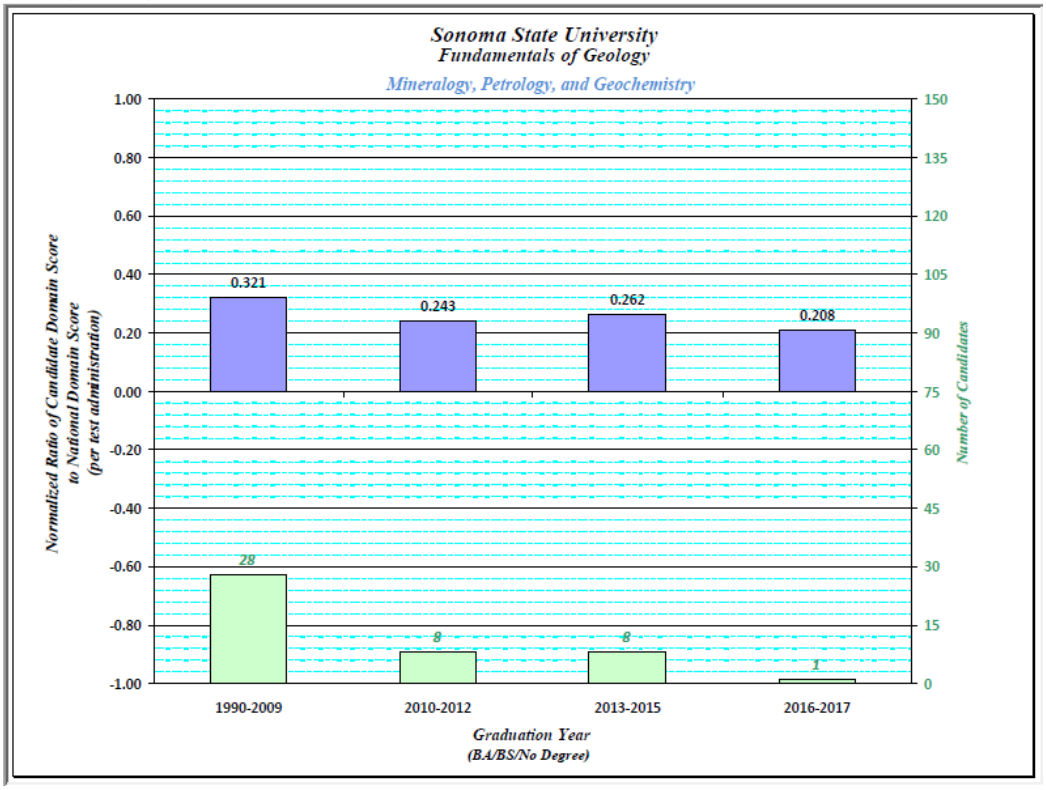
ASBOG

This ASBOG® Fundamentals of Geology (FG) and Practice of Geology (PG) Examination Knowledge Base consists of eight domains which collectively encompass the scientific and practical knowledge needed to become a licensed professional geologist. The diagram below illustrates the relative percentages of each of these eight domains on the Fundamentals of Geology Exam. The percentages do not change substantially for the Professional Geology Exam. Students are qualified to take the FG exam once they graduated with a BS in Geology, and they would typically take it once they were employed by a geotechnical company. After working for six years under a licensed Professional Geologist, they are qualified to sit the PG exam.

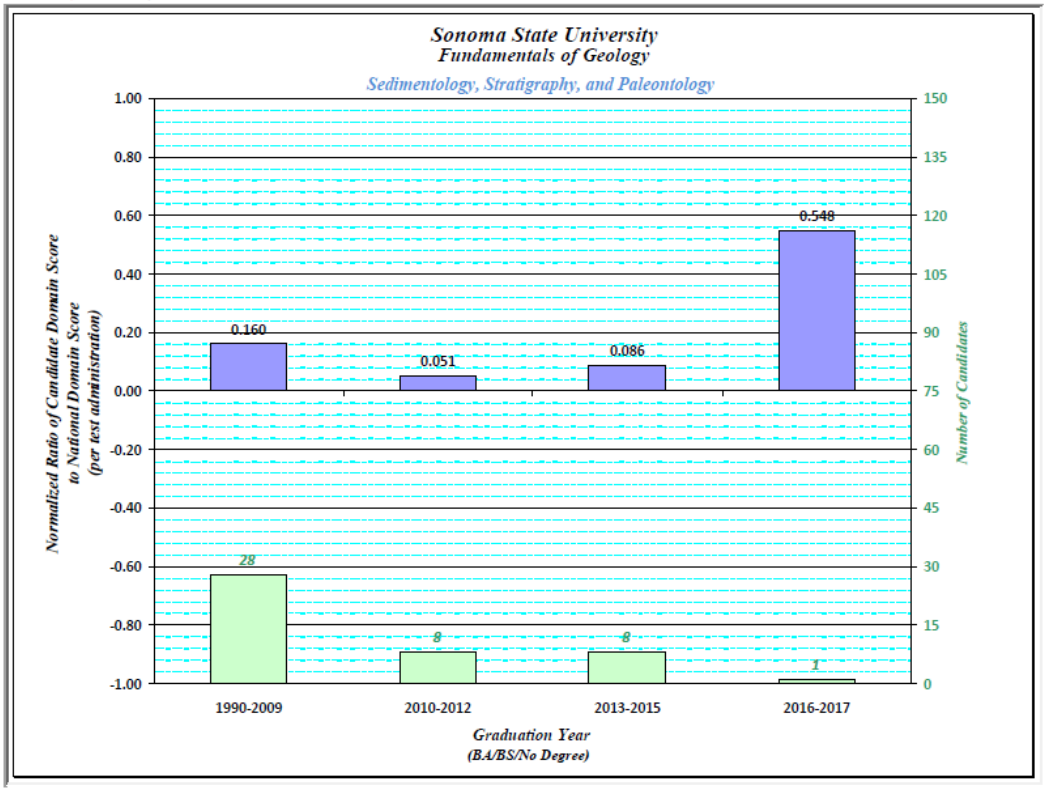


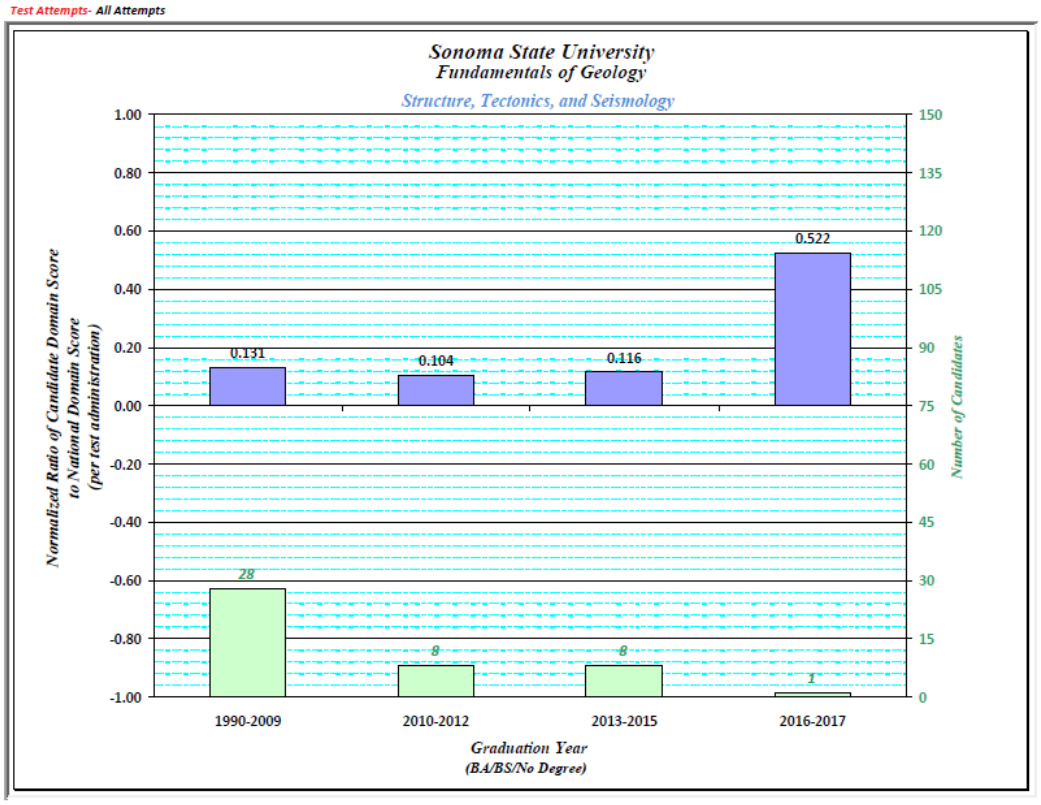
Gratifyingly, our majors who sit the ASBOG exam consistently score higher than the national mean. The graphs below show our major's proformance on this exam in the content areas that our curriculum specifically focuses on, namely: Minearlogy, Petrology, Sedimentary Geology, Structural Geology, and Paleontology.

Test Attempts- All Attempts



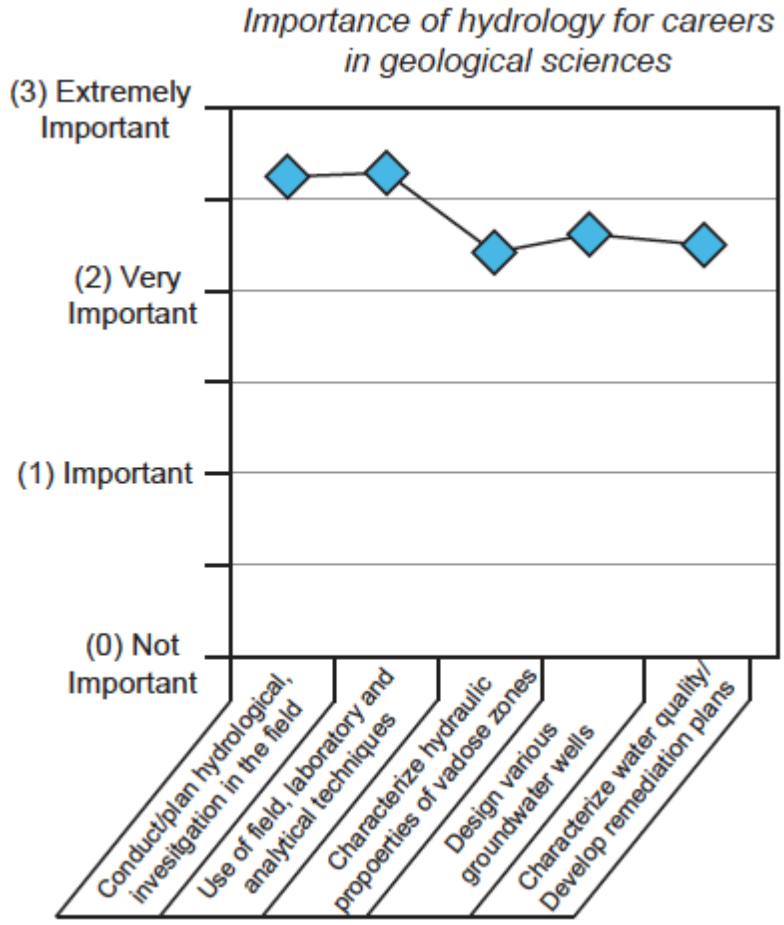
Test Attempts- All Attempts



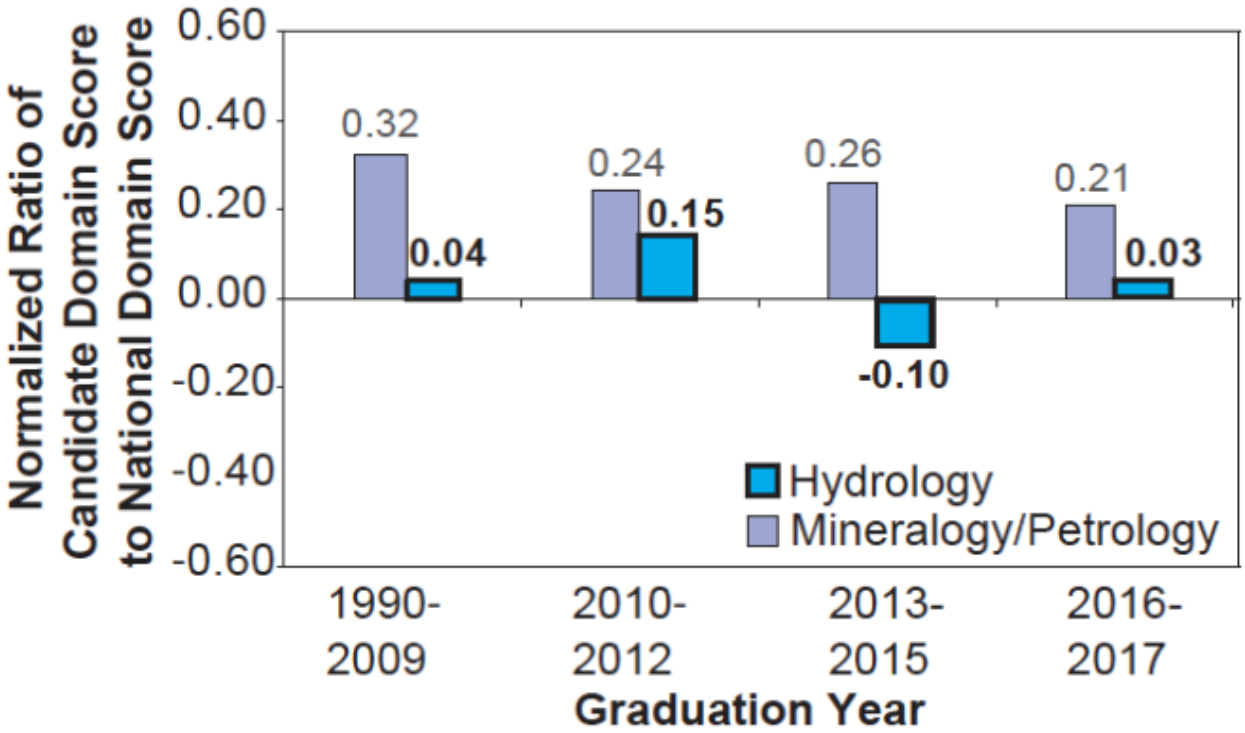


One content area of the ASBOG exam that our majors historically have not performed as well is in the area of Hydrogeology. We attempted to rectify this by hiring a Hydrologist into our tenure-track faculty and revise the curriculum to include a laboratory section, consistent with both the CSU and national trends. Unfortunately, Dr. Glas was "headhunted" away from us; her partner, an Anthropologist, could not find employment locally or at SSU, and they have a new-born, so she took the job much to the detriment of the department and SSU. It bears repeating again that SSU should find ways to stop losing these talented faculty members by instituting a more aggressive spousal-hiring initiative. Once the hiring-freeze is lifted, it is imperative that we are able to fill this curricular hole in our program.

In 2018, the National Association of State Boards of Geology conducted a survey amongst practicing and academic geologists to determine which skills (within the discipline) they deem as essential for their jobs. The skills were ranked on a scale of not important to extremely important. Skills related to hydrology were consistently ranked between very and extremely important on the basis of the survey (n=2322 geologists) (see figure below). Moreover, the ASBOG survey compared their findings in 2018 with those collected in 2010, which also ranked skills related to hydrology between very and extremely important- suggesting that there is a historic demand in the work force for these skills.



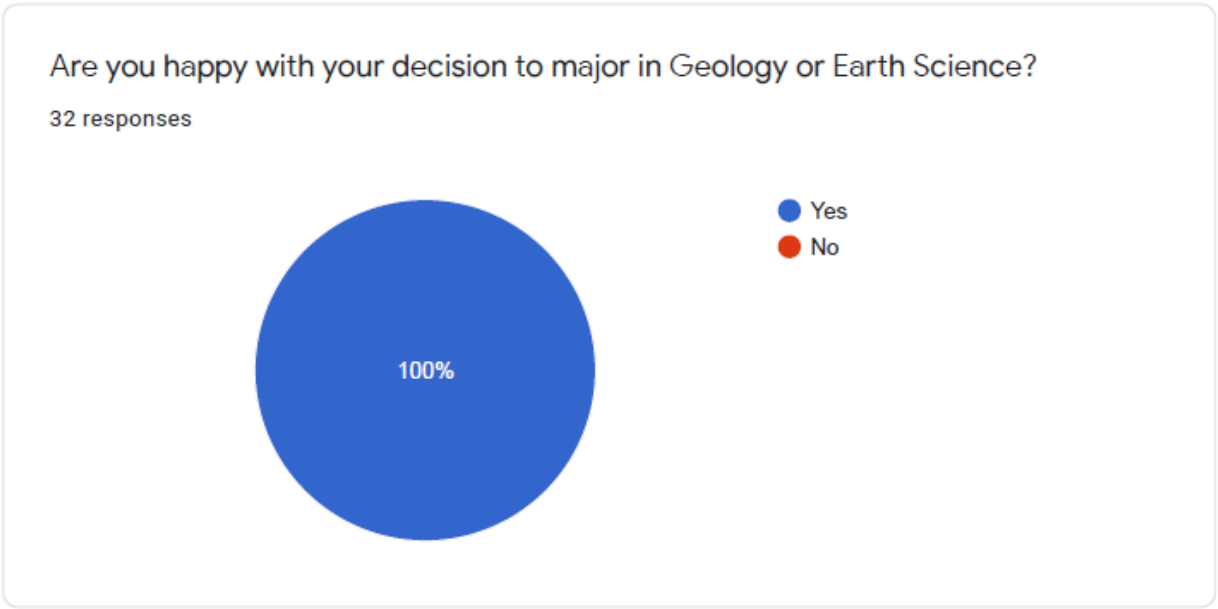
As reported in the ASBOG dataset, our students are systematically doing worse on hydrology components of the professional licensure exam. See figure below where we compare our geology alumni rate of correct responses on hydrology questions with those related to mineralogy and petrology. The results are normalized to the national average scores. For questions related to hydrology, our students typically perform with the national average or slightly worse. We attribute this to the absence of a lab component associated with our hydrology class (which we have now rectified), and the lack of a dedicated Hydrology tenure-track faculty member. Within the CSU, only two of the 23 campuses do not offer a hydrology/hydrogeology course: Cal. State Maritime and San Marcos. In order to keep our students competitive in today's job market, we need to hire a hydrologist faculty member in our department.



Exit Survey

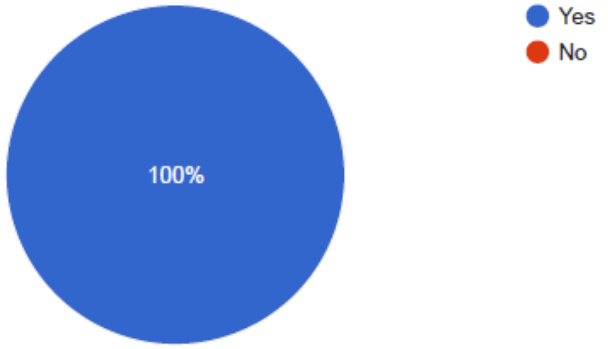
After our last 5-year review, we instituted an exit survey to our graduating seniors. This survey was administered in the spring semesters of 2017, 2018, 2019, and 2020. We have had difficulty in getting high response rates with these surveys. In 2017 and 2018, we received a total of 13 responses. In 2019 and 2020, we got an additional 19 responses. While we certainly wish that our response rates were higher, an approximately 50% response rate is considered reasonable for most surveys. We are considering giving away small gift cards to random survey participants, as soon as we figure out a mechanism to pay for those prizes (i.e., it is unclear that we could pay for these using the departments OE funds). We will also provide time in class during our Senior Field course, a course taken by all BS majors but not BA majors, for students to complete the survey. There is no equivalent capstone course for the BA major.

There are several questions from our exit survey that produced very gratifying responses, for instance:



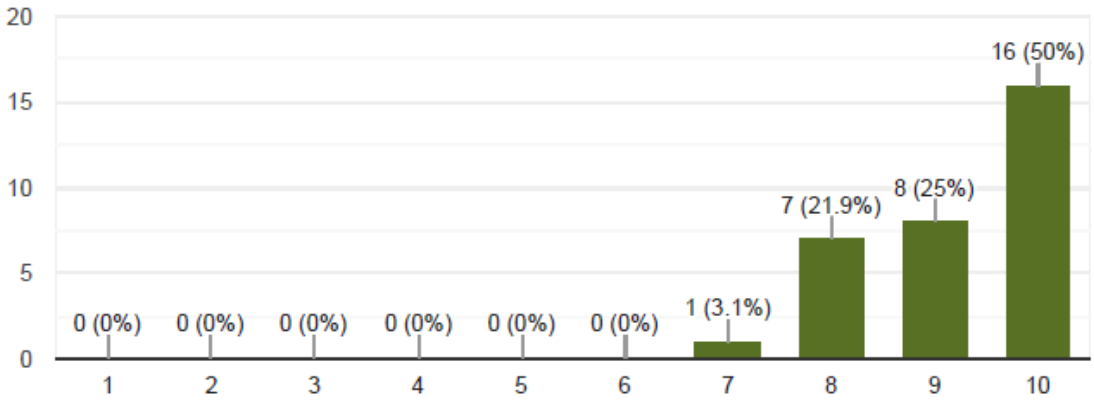
Did you feel like participating in student research was an available option for you, if you wanted it?

32 responses



On a scale of 1-10, with 10 being the best, how would your rate the level of instruction that you received within the Geology Department?

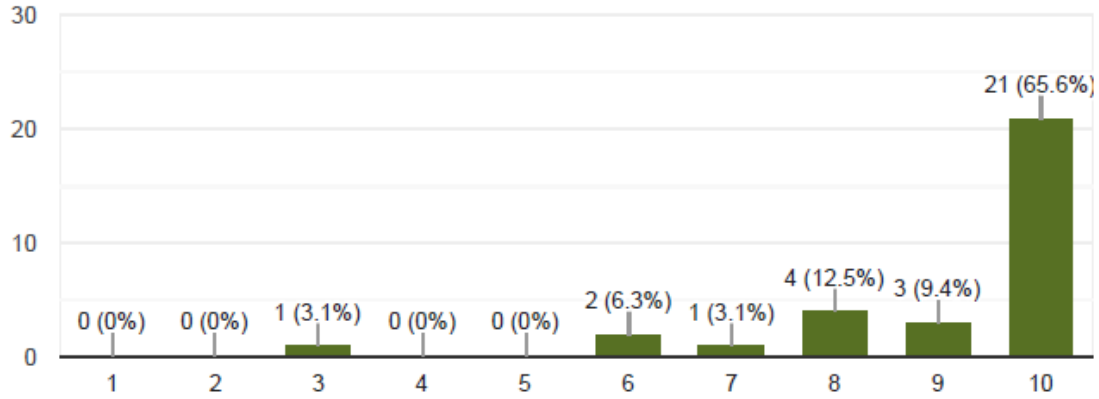
32 responses



Mean: 9.22

I am confident that the skills I learned in the geology department are transferable to the work force and/or graduate school

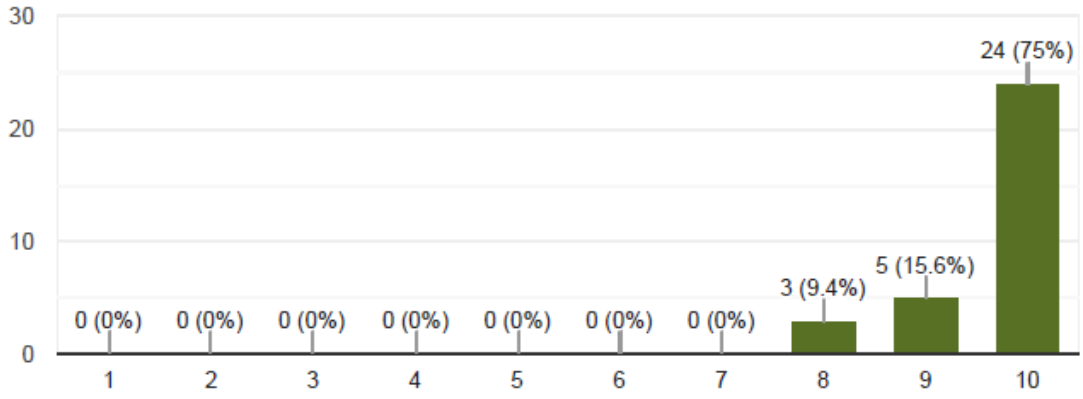
32 responses



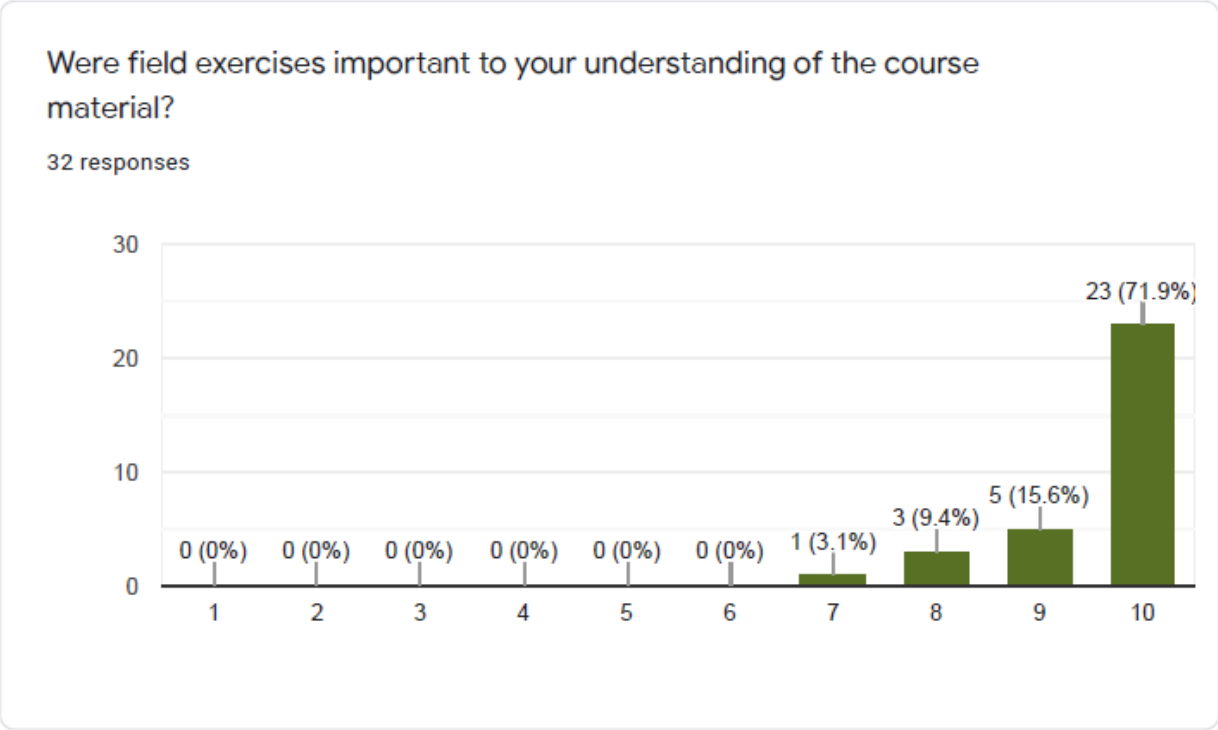
Mean: 9.09

Did the courses offered increase your understanding of Geology?

32 responses



Mean: 9.66



Mean: 9.56

We take particular pride in giving all of the students who desire it the opportunity to explore independent research (100% of survey participants felt that these opportunities were available). This is particularly gratifying because of how small our department is (we went down to only two tenure-track faculty at one point after Michael Smith left; those were challenging times). Our newest faculty have made sure that providing opportunities for our students both inside and outside of the classroom environment is a huge priority for our department. We have multiple students getting involved in world-class research projects, and presenting the results at national meetings, such as the Geological Society of America and the American Geophysical Union every year.

We are also happy to see that our students find the field trips and field courses to be incredibly relevant to their studies, as well as being well-integrated with the

classroom material. This is the main point of pride for our department, and we are gladdened to hear feedback from our alumni that they agree with us with how important these field course are to our program and to their education. In the Covid-era, when all of our field trips were cancelled for the Fall of 2020, we quite forcefully reminded how important fieldwork is to our program. We will be applying for exceptions for our fieldtrips to run in the Spring of 2021 in order to salvage a somewhat disastrous year. Being force to shut down our field program for a semester has made us appreciate it all the more and feel grateful for the support we get from the administration in helping us maintaining and innovate within our well-regarded field program.

In addition to the quantitative feedback, there were also some notable "additional" comments to the department:

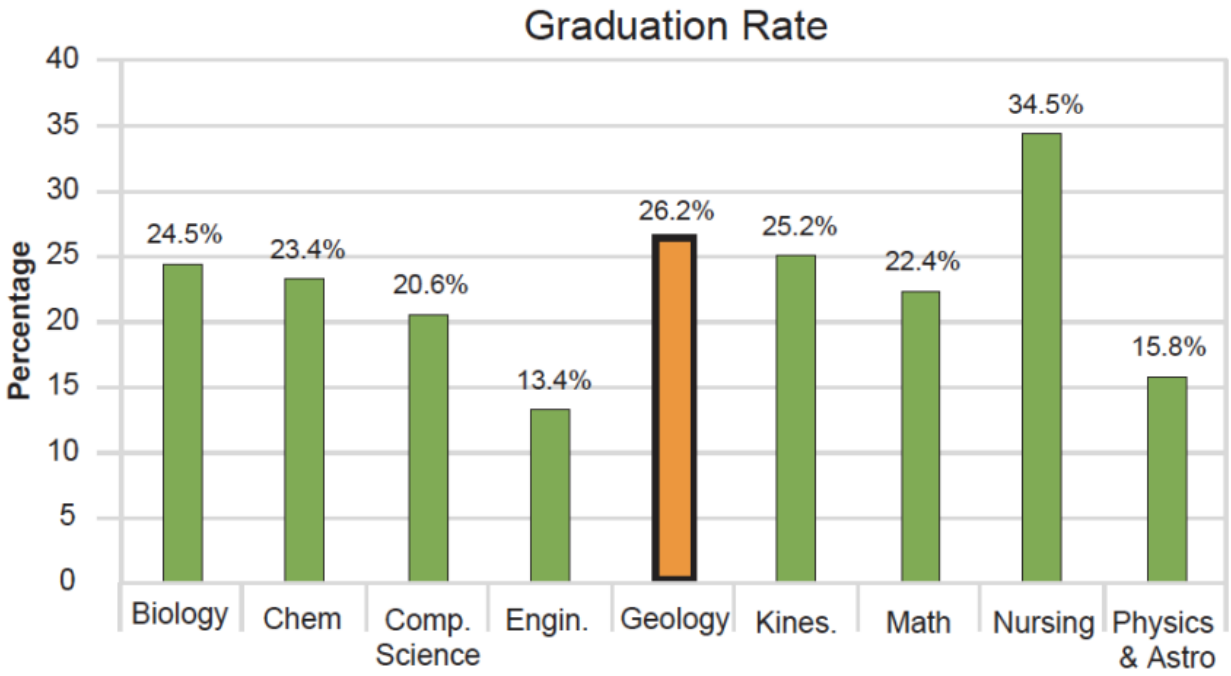
- "Overall my experience has been wonderful, I met life long friends and learned a huge amount in what feels like a short time. The faculty are engaged in their subjects and easily approached with questions."
- "The field courses were some of the highlights of my college career, I wish I could have taken more now that I look back on it but I will never forget them. All of the professors were always willing to help whether it was in classes or advising which was very helpful for me."
- "Couldn't be happier in any other major at SSU. The faculty within the Geology Department have been the best teachers I've ever had. The combined experience and enthusiasm to teach is really inspiring to the students."

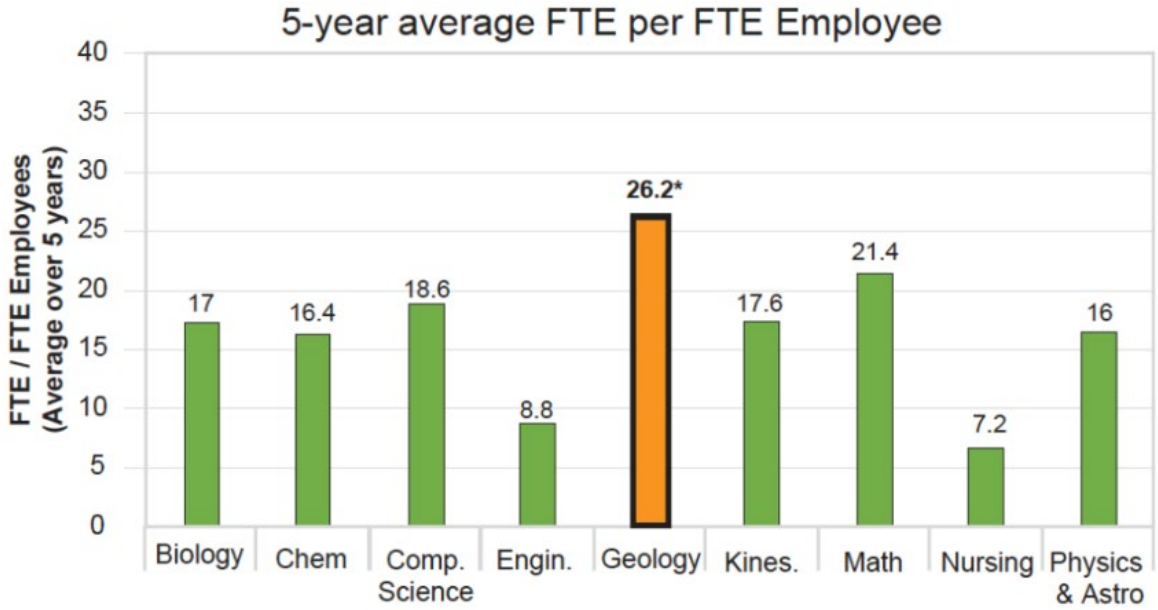
Moreover, almost unanimously, the survey participants highlighted field work in their comments to what the “Geology Department (is) doing well with respect to undergraduate education.”

Of course, one cannot only focus on the positive feedback. Our survey also asked for input on areas our alumni feel we need to improve. The most common response was to have a great variety of elective courses. Obviously, we can only do this if we maintain our tenure-track density. Three more areas mentioned where the Geology Department could improve are: 1) advising, 2) more feedback on report writing, and 3) introduction of computer applications earlier in the curriculum. We will address advising in section VII below. In terms of additional feedback with regards to writing, we can establish a multiple draft protocol for at least one of the writing exercises in all of our field courses. Lastly, we recently moved our GEOL 309: Computer Applications in Geology course to the Fall in order to make it one of the first courses our students take in the major sequence.

Additional Metrics

In terms of additional metrics for our department, we have one of the highest four-year graduation rates in all of the School of Science and Technology (second only to Nursing). We have managed to accomplish this while having the highest Full-Time-Equivalent Student (FTES) to Full-Time-Equivalent Faculty ratio in SST (see figures below).





***These numbers do not reflect the teaching commitment and number of students in Science 120, a primary duty of one of our faculty members**

Our significantly above average scores on the independent and external ASBOG Fundamentals of Geology exam are a testament to the quality and integrity of the education received at SSU. We consistently produce graduates who exceed the state and national standards to become practicing geologists. Moreover, our exit survey data and anecdotal evidence demonstrate our high-level of student satisfaction within our program, our success at transitioning students into top tier graduate programs, and high employment rates after graduation.

VI. Instruction, Advising, and Resources in the Program

Instruction: Bachelor's of Science in Geology

The Bachelor's of Science offered by the Geology department is built on foundational courses taught within the department combined with specific support courses in the Physics, Chemistry and Mathematics Departments. This degree pathway is specifically designed to prepare our students to become either licensed professional geologists or prepare them for further graduate studies. The core courses provide students with a broad exposure to a wide range of disciplines in geology. Our lower level courses are designed to recruit students into the major and to provide students with those specific GE requirements. Prior to enrolling in upper division courses students must complete Advanced Principles of Geology (GEOL303) and its associated field course, Geologic mapping and report writing (GEOL304). This course and field course pairing provides students with a foundational set of field-based skills (map reading, navigation, report writing) and sense of the technical standard expected in upper level geology courses. The remaining upper-level, core courses provide students

with both breadth and technical skills related to that specific area of geology. The course pairings are designed with lecture and lab “classroom” courses (always the lower number in the pairing), where topics are discussed and investigated in the laboratory using maps and hand samples from the geology collection. The field courses bring students to nature where they are able to apply techniques and theories learned in the classroom to interpret and map challenging outcrops. The students in the Geology major are required to take a culminating senior capstone experience, Integrative Field Experience (GEOL420), where they utilize and apply all skills learned in the major. Prior to obtaining their degrees, students must complete a formal field camp, Advanced Field Geology (GEOL427), where they have the opportunity to apply more of their mapping techniques and expand their networks. While GEOL427 is in our course catalog, it is typically not offered at Sonoma State and students must take this course through other universities, which enables them to make connections with other advisors. Our small department views as advantageous for possible graduate careers and/or job opportunities.

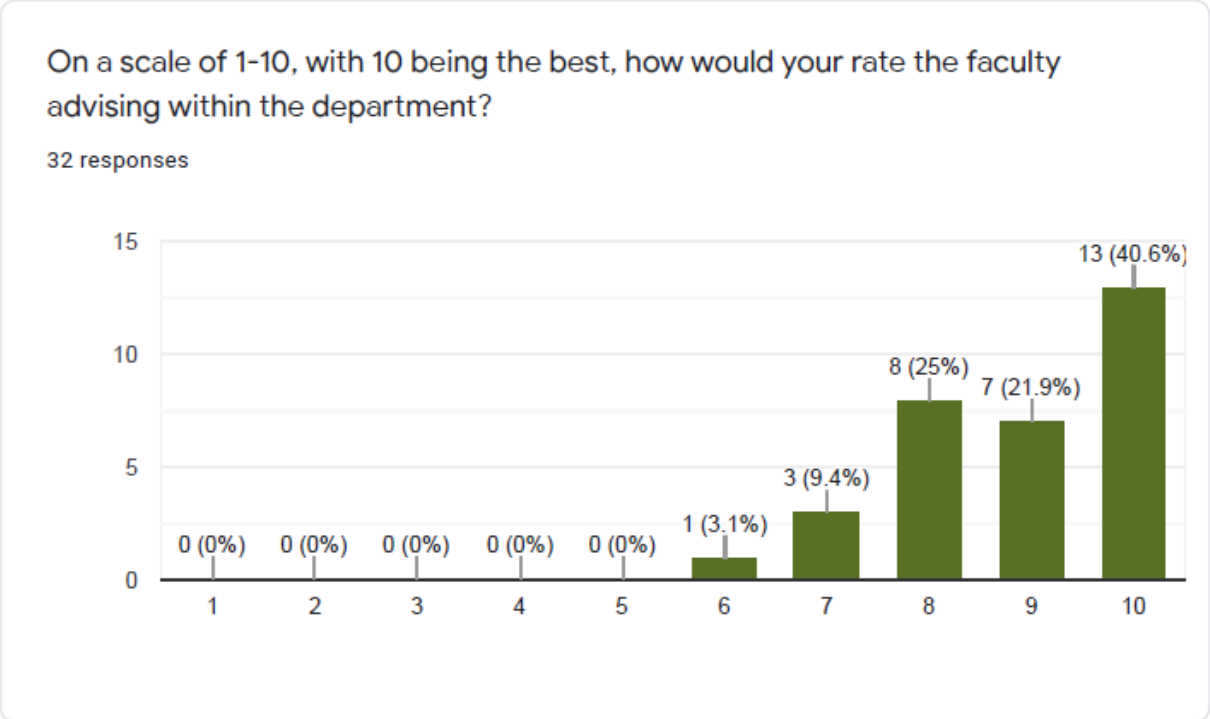
Instruction: Bachelor’s of Arts in Earth Science

The Bachelors of Arts in Earth Science is a dynamic degree and suitable for student interested in careers in the educational realm, including national park interpreters and secondary school educators. This degree grants the student a considerable amount of flexibility in designing their own curriculum to fit their specific needs. BA in Earth Sciences includes 33 elective units where a student can take courses from a large list of approved courses across campus that relate to the Earth

Sciences. Additionally, this degree addresses the intersection of surface processes (the hydrosphere, atmosphere, biosphere and humans) and geologic processes and formations. The Bachelors of Arts lends itself to those interested in a degree that provides students with a quantitative skillset they can use to describe environmental, human and geologic processes.

Advising

While some students in our exit survey mentioned that advising was an area that our department needed some improvement, our mean score for advising was an 8.88 (see figure below). This suggests to us that, while there is room for improvement, we have a solid foundation to build off of (i.e., “we shouldn’t through the baby out with the bathwater”).



Currently, department chair, Matty Mookerjee, takes the lead on academic advising within the department. He meets with each student individually to plot out their academic schedules. Additionally, twice a year the faculty has an advising lunch (just prior to registration), complete with pizza to attract a greater number of students, where we discuss advising for the upcoming semester. The advising for an individual student who wants to talk about “next steps” (e.g., graduate school or finding a job in the geotechnical industry) is generally accomplished one-on-one with whichever professor(s) the students is the most comfortable with. However, we do routinely have an advising meeting in the Fall around the topic of applying to graduate school (we just had our first socially-distanced grad. school advising meeting via Zoom in the middle of September, 2020).

In addition to some comments in our exit survey, Covid has highlighted some gaps that exist in our advising strategy. Because our advising strategy relies so heavily on the relationships and the one-on-one interactions that we have with our majors, our advising took a real hit when we had to rapidly transition into a distanced-learning environment. It was pointed out to us that last semester (Spring 2020) we were scrambling so hard to get our courses functioning and making sure that there were even suitable field camp alternatives available for our students, that some of the logistics for transferring credits in order to be graduated by the end of the summer got lost. We are currently working with Megan D’Errico, SST’s Academic Advisor, on revising our advising documents for our BS degree such that that process is made clearer. Also, again with Dr. D’Errico’s help, we are adding specific advising notes to our web page so that there are multiple avenues that this information can reach our students.

Resources

We are lucky at SSU to have access to a wide range of scientific equipment and resources with which to engage our students both in the classroom as well as during independent research opportunities. A summary of those resources is provided below:

Facilities, Equipment and other Resources within the School of Science and Technology at Sonoma State University (SSU)

- Machine shop: this facility has been used to create sample holders for the SEM as well as equipment used for EBSD sample preparations.
- Personnel: SST has a technician that runs the machine shop as well as being a more general instrument technician for all departments in SST.

KECK MICROANALYSIS LABORATORY

- Hitachi S-3000N Scanning Electron Microscope (purchased 2003)
- Oxford INCAx-sight EDS Detector (attached to SEM)
- Pacific Nanotechnology Atomic Force Microscope (AFM) (purchased 2003)
- Ocean Optics Laser Induced Breakdown Spectrometer (LIBS) (purchased 2005)
- Perkin Elmer Fourier Transform Infrared Spectrometer (FTIR) (purchased 2006)
- Olympus Confocal Microscope (purchased 2003)
- Rigaku Powder X-ray diffractometer
- Pelco sputter coater 91000 Model 3 (purchased 1985)
- Varian VE-10 thermal evaporator (purchased 1971)
- PHI Auger Electron Spectrometer (AES)

GEOLOGY DEPARTMENT

- Personnel: The Geology Department has a full time technician that, in conjunction with the SST technician, maintains all of our instruments.

Geology Computer Laboratory

- 15, Dell Precision Workstation T3620 Mini Towers (purchased 2018)
- 42-inch HP Color Designjet 500 Plotter: for presenting data at conferences
- ArcGIS 10.2, Adobe Creative Suites 6, Mathematica 10.3, Microsoft Office Suite 2013, etc.

Other Laboratory Facilities

Mineral Separation (particularly zircon) Facilities (:

- Camel 24 Pro Water Wheel (purchased 2015): for mineral (particularly zircon) separation
- Frantz Barrier Magnetic Separator Model LB-1 (purchased 2016)
- Bico Rock Pulverizer Type UA (purchased 2015)
- Ro-tap shakers and complement of sieves
- Geochemical “Wet” laboratory with fume hood

EBSD and Sample Preparation Facilities:

- Oxford Nordlys II EBSD Detector (attached to SEM) (purchased 2012)
- Buehler ECOMET250/AUTOMET250 automated grinder and polisher (purchased 2012)
- Buehler VIBROMET 2 Vibratory Polisher (for EBSD sample preparation) (purchased 2012)
- Buehler CAST N VAC vacuum chamber system for sample impregnation (purchased 2012)
- Rock coring drill press
- 2 Highland Park diamond rock saws and one MK diamond tile saw
- Thin section preparation laboratory

Fossil Preparation Facilities:

- SWAM Blaster (purchased 2006)

Cathodoluminescence Facilities:

- Reliotron III Cathodoluminescence Instrument (purchased 2007)
- 50s’ era Zeiss Microscope

Field Equipment

- Mavic 2 Pro Drone (Purchased 2018)
- Mavic Pro Drone (Purchased 2017)
- 3DR Solo Drone (Purchased 2015)
- ASC Scientific Pomeroy EZ Core Drill
- 5 Trimble Junos
- 9 Garmin GPSMap60 GPS receivers
- 14 iPads/iPencils with FieldMove
- 1 iPad Pro/iPencil with FieldMove
- 1 Panasonic ToughPad with FieldMove
- 1Nexus 10 with FieldMove
- 28 standard Brunton compasses
- 14 Freiberger compasses + 5 Brunton dip compasses

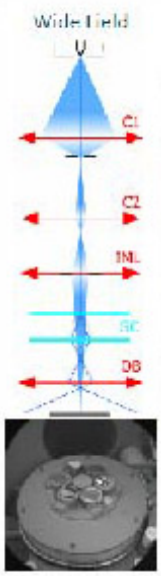
Near Surface Geophysical Field Equipment

- DAQLinkIII, High Resolution 24 Channel Seismic Recording System (purchased 2018)
- GEM GSM-19W v7.0 Walking Magnetometer (purchased 2019)
- SuperSting 28 Electrode Electrical Imaging of RES/IP/SP (purchased 2019)
- Tromino Zero Passive Seismograph Recording System (purchased 2019)
- Mala 250 MHz Shielded Ground Penetrating Radar (purchased 2006)
- BGO, RS-23 Gamma ray spectrometer

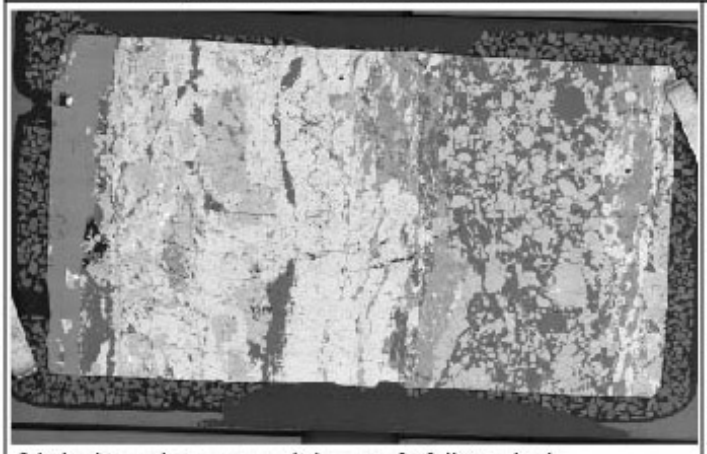
As of the writing of this document, we are currently working on purchasing a new Scanning Electron Microscope with an NSF grant awarded to lead-PI Mookerjee. This new instrument will really help to advance the research agendas of several researchers at SSU. We are purchasing the following instrument: A ***Tescan VEGA3: GMU Variable Pressure SEM*** with a large sample chamber, multiple ports (12+) that are ***ideally oriented for combined EBSD/EDS analysis*** and ***large-area mapping***, motorized compucentric 5-axis stage, Low Vacuum Secondary Electron (SE) detector, and a motorized and retractable BackScattered Electron (BSE) detector. This system includes a variety of safety features such as touch alarms, sample holder profiles which inform the software of the dimensions of the holder to limit the range of movement and avoid collisions (these limits can be overridden by expert users, but not students), “Safe Movement Mode,” and 4 levels of user expertise that define the “rights” of given users. The software allows for live 3D stereoscopic imaging (particularly impressive for large lecture class demos), and ***remote access and control of the SEM***. Tescan microscopes utilize unique, 4-lens optics which provides 5 distinct operating modes (Resolution, Depth, Field, Wide Field, and Channeling). In particular, the Wide Field mode simplifies navigation and will be useful for classroom demonstrations (see images

below). Additionally, the X-Positioner optical stage navigation software allows the operator to use a variety of types of imagery (e.g., optical photomicrograph, x-ray imagery, iPhone photograph, etc.) to navigate around the sample. The ImageSnapper software automatically creates stitched together/panoramic images of large sample areas (see images below).

In addition, the following detectors are included in the proposed SEM system: ***Tescan Panchromatic Cathodoluminescent (CL) Detector*** (fully integrated with the Tescan microscope control software) and the Oxford Instruments ***Symmetry Electron BackScatter Diffraction (EBSD) Detector***, and ***Energy-Dispersive X-ray Spectrometry (EDS) UltimMax 65 Silicon Drift Detector***. Additionally, this microscope will be equipped with Tescan's Electron Beam Lithographic Package in order to be able write patterns into magnetic thin films. Further, we will be purchasing a ***Cressington 208C High Vacuum Turbo Carbon Coater*** for SEM sample preparation in order to diversify the types of projects that this instrument can collect data for.



Tescan's 4-lens optics utilizes 5 distinct modes (Resolution, Depth, Field, Wide Field, and Channeling). The Wide Field mode is particularly useful for classroom demonstration and ease of navigation. Left) demonstrates the impressive Wide Field imaging capabilities and depth of field (image: Mojave Green Snake head), Middle) this diagram illustrates the Wide Field lens configuration, and Right) depicts the stage of the Vega3: XMU (large chamber), which can easily accommodate two standard sized petrographic thin sections where both thin section can be imaged simultaneously; the Wide Field optics can accommodate a zoom-level as low as 1.5x.



Stitched together panoramic image of a full standard petrographic thin section. Image Snapper software acquired this image in less than 15 minutes and consists of 150 images (1024x1024 pixels each). This image was acquired on a Vega3 XMU at the Tescan laboratory in Pleasanton, CA.

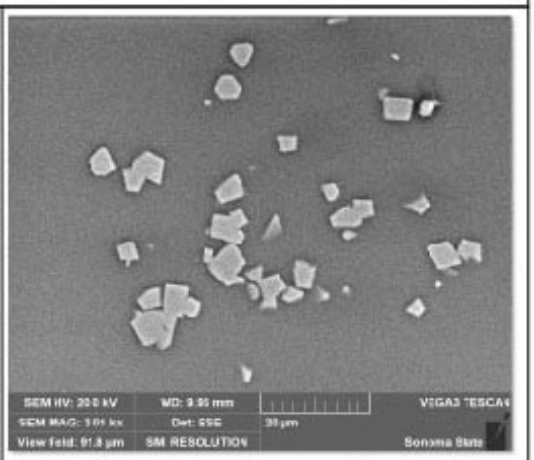


Image of experimentally grown spinnel crystals produced from a basaltic liquid at 1100°C. This image of 1 to 5 micron uncoated crystals was taken in variable pressure mode at 20 Pa using the BackScatter Electron (BSE) detector. This image was acquired on a Vega3 XMU at the Tescan laboratory in Pleasanton, CA.

While we are lucky to have access to some cutting-edge laboratory and field equipment, and have been able to maintain a thriving field-base program for over fifty years, our ability to fund our field program has come into question in the recent years. Former Provost Vollendorf decided to make some significant budget reforms during her short tenure at SSU, include to defund all SSU field programs through the Provost's office. The Provost's opinions was that those funds should come from the Dean and not from her office, despite that being a workable model for many years. This decision affected the Geology and Biology Departments most significantly. While the funds were made available through the Dean's office to fund these two field programs, it still has not been made clear what the current process is with regards to funding these field programs, nor what our budget constraints are for each field season.

As part of the aforementioned budget reforms, we put together an analysis on the cost of our field program, which is below:

Our course fees are used to subsidize the cost of field courses that strengthen the core curriculum of Geology and Earth Science majors. Within California, students can see: the subduction zone volcanoes of the southern Cascades Arc, the processes that form continents in the Sierra-Nevada Mountains and Death Valley, deep time recorded by fossils in lake beds on the edge of the Mojave Desert, and the cryptic processes that happen when two lithospheric plates collide in the neighboring Coast Ranges. These geographic and geologic locations provide the exposures that inform the discipline of geology and transform our collective understanding of the Earth. By bringing students to the field, we give breadth to their education by combining concepts

learned in the classroom with nature. These trips, however, are only possible through support of the School and the University.

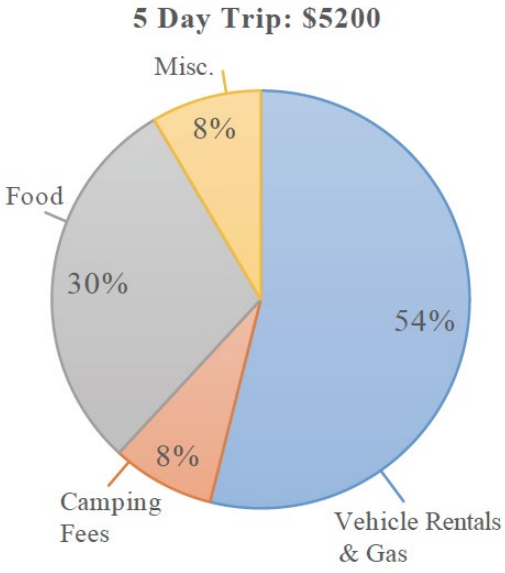
(1) Summary of Geology Course Fees

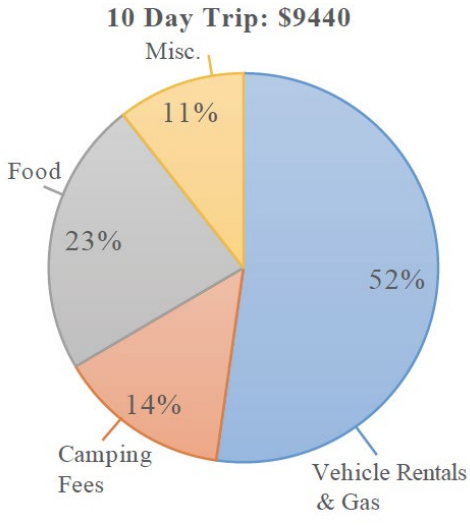
In order to try minimize the effect on the Dean's budget, we considered increasing course fees, which was ultimately denied. Considerations for our proposed course fee adjustment included: date of last fee adjustment, inflation, costs of food (previously not included in fees), and that fees are consistent between courses of similar duration. Records of historical course fees provided by the Department of Administration and Finance show that course fees appear in 1991, increase until 2004, and remain constant with no further increases recorded to date. Records show that Regional Field Geology (GEOL120) had a fee of $130 in 1991 and no adjustments were ever made. Since 2004, the cumulative rate of inflation is 32.6%, based on the consumer price index from the US Department of Labor Bureau, which translates to increases of approximately $40 to $65 for each course fee. Moreover, the course fees do not account for food over the course of the field trip ($12 per person per day) and, as a result, money must be collected from students by Geology Club members and then used to purchase food prior to the trip. Lastly, course fees are inexplicably varied despite comparable durations and historical fee records reveal no explanation for the variations in the magnitudes of the fees. The proposed fees (Table 2) reflect the effects of inflation and the costs of food for the trip; the fees are also adjusted so that trips of equal length have the same or similar costs.

Table 2: Current and Proposed Geology Course Fees

Course Number	Field Course Name	Duration (Days)	Current Fee	Year of Last Fee Adjustment	Fee with Inflation	Food Cost	Proposed New Fee
[1]304	Introduction to Report Writing	5	$175	2004	$232	$60	$310
[1]308	Igneous and Metamorphic Petrology	5	$195	2004	$259	$60	$310
[1]312	Sedimentology	5	$185	2004	$245	$60	$350
[1]314	Paleontology	5	$125	2004	$166	$60	$310
[1]318	Structural Geology	5	$175	2004	$232	$60	$310
[1]420	Senior Field	10	$195	2004	$259	$120	$425
[1]102	Introduction to Geology	5	$12	2004	$15	0	$15
[1]120	Regional Field Geology	10	$130	1991	$239	$120	$425
[1]320	Basin Analysis	1 x 3	0	-	-	0	$40

[1]Prefix GEOL





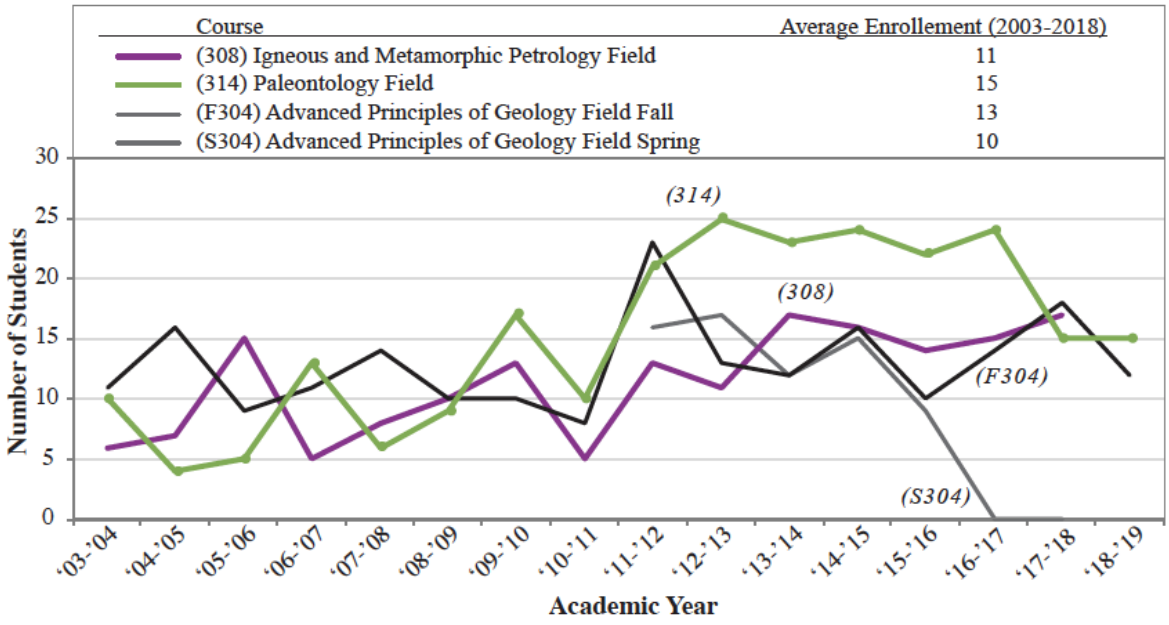
(2) Costs of Field Trips

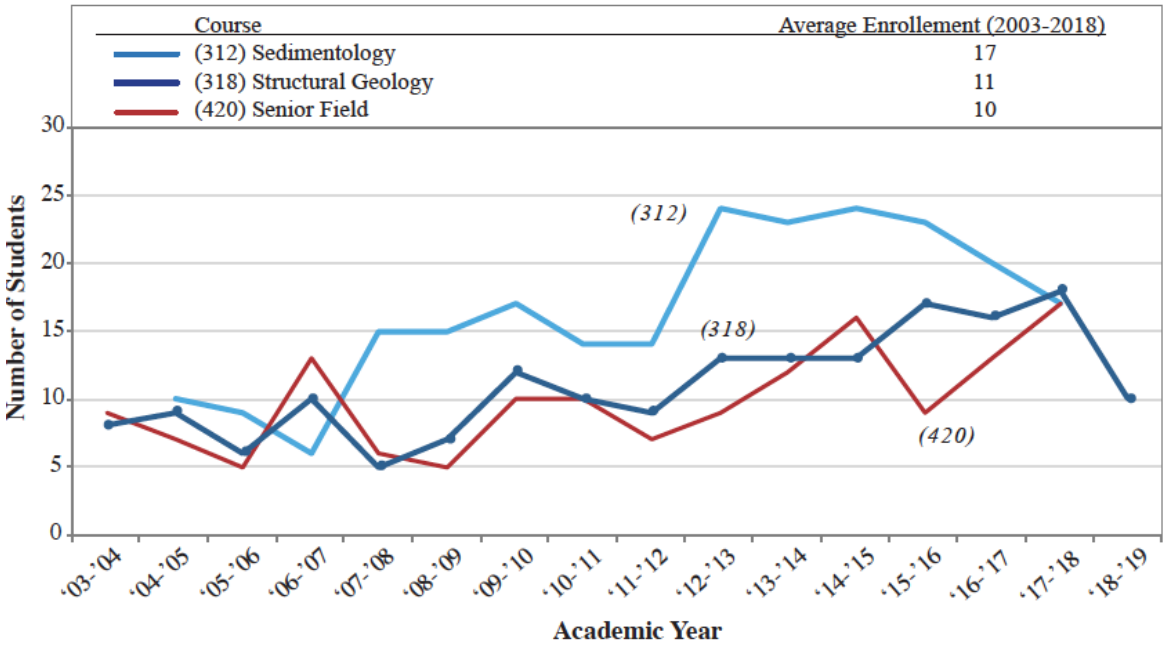
On average, five-day field trips cost ~$5200 and ten-day field trips cost ~$9400 (see figures above for cost breakdown) for 14-17 students. Fuel and vehicle rentals, which include a cargo van (for transportation of gear and camping equipment) and twelve passenger vans for students, constitute the majority of the costs associated with the field trips. The food for the trips makes up 23-30% of the expenses, and, currently, this number is supported by collecting money from the students. Group lodging is generally minimized through camping; however, camp sites for classes of 17-20 students can cost up to $100 per night. A fourth category, miscellaneous includes gear replacement (e.g., coolers and camping equipment), course expenses (e.g., printing field guides or replacing instrumentation), cost of faculty expenses (e.g., food over the duration of the trip), and any park entry fees that may be incured. From a historical perspective, the cost associated with vehicles and travel were offset by using Sonoma State fleet vehicles. However, when the fleet ceased to exist, the overall costs of the field trips increased–by close to 200%– to the current costs today. Important to note is that the cost of these trips is broadly fixed with the exception of the food budget, largely due to the cost of the vehicle rentals.

(3) Historical Course Enrollment

To begin a discussion about the level of assistance our field courses require from the School of Science and Technology, we must assess our average enrollment through time and predict the funds available for each course based on our enrollment. The Office of the Registrar kindly provided our department with current and historical course

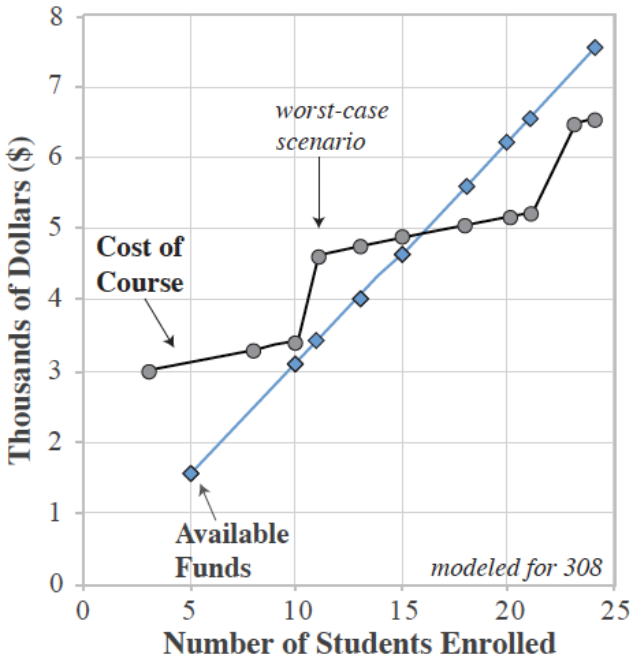
enrollment numbers for the field courses. Collectively, the data show a gradual increase in the number of students enrolled in our major courses (see graphs below). Average enrollments from 2003 (the time of our last course fee increase) to 2018 are listed in the legend of each graph and range from 10-17 over the fifteen-year period. Notably, our enrollments in the past five years are systematically higher than that average.





(4) Requested Augmentation from the School of Science and Technology

The historical averages for the enrollment in our field courses vary dramatically and can create significant complexity for forecasting annual budgets and proposed augmentations from the School of Science and Technology. Enrollment numbers has a huge effect on the budget of any field course. The worst-case scenario is when a class has eleven students, one TA or Phil Mooney, and one faculty member. Those thirteen fieldtrip attendees need to travel in two vehicles instead of only one, but the cost for those two vehicles is only supported by eleven student fee allotments. The impact of student enrollment on the operating cost of a course is shown in in the figure to the right for one of our five-day field courses (GEOL308). Also shown in this figure are the funds that would be available from the proposed course fees. With 11 or fewer students, the course runs a deficit, where the cost of running the field trip is higher than the funds available from the course fees.



The effect of student enrollment on the cost of a five-day field course is shown along with the available funds from course fees to illustrate the formation of a deficit.

The worst-case scenario deficits for the field courses are shown in Table 3 and range from ~$700-$3800 per class. The greatest deficits correspond to the longest trip, which are due to the second van rental and a longer rental period. The average deficit

for five-day trips is ~$1,150, which is the cost of a weekly van rental ($675) and the estimated cost of gas ($467) for a single van (totaling $1,142).

Table 3: Maximum Course Deficits

Course Number	Field Course Name	Duration (Days)	Cost of Trip	Number Enrolled	Updated Course Fee	Available Funds	Deficit
[1]304 Fall	Introduction to Report Writing	5	$4,671	11	$310	$3,410	**$1,261**
[1]304 Spring	Introduction to Report Writing	5	$4,671	11	$310	$3,410	**$1,261**
[1]308	Igneous and Metamorphic Petrology	5	$4,427	11	$310	$3,410	**$1,017**
[1]312	Sedimentology	5	$4,567	11	$310	$3,410	**$1,157**
[1]314	Paleontology	5	$5,175	11	$310	$3,410	**$1,765**
[1]318	Structural Geology	5	$4,227	11	$310	$3,410	**$817**
[1]420	Senior Field	10	$8,343	11	$425	$4,675	**$3,668**
						Total Deficit	**$10,944**

[1]Prefix GEOL

Recent enrollment trends in geology courses suggest that our overall enrollment in courses is higher than 13 students. The average enrollment for the past five years in all field courses is 15 students. The deficits for the field courses with 15 students considered enrolled are shown in Table 4.

Table 4: Deficits Based on 5-Year Average Enrollment (15 students)

Course Number	Field Course Name	Duration (Days)	Cost of Trip	Number Enrolled	Updated Course Fee	Available Funds	Deficit
[1]304 Fall	Introduction to Report Writing	5	$4,991	15	$310	$4,650	$341
[1]304 Spring	Introduction to Report Writing	5	$4,991	15	$310	$4,650	$341
[1]308	Igneous and Metamorphic Petrology	5	$4,747	15	$310	$4,650	$97
[1]312	Sedimentology	5	$4,887	15	$310	$4,650	$237
[1]314	Paleontology	5	$5,495	15	$310	$4,650	$845
[1]318	Structural Geology	5	$4,747	15	$310	$4,650	$97
[1]420	Senior Field	10	$8,983	15	$425	$6,375	$2,608
						Total Deficit	**$4,564**

[1]Prefix GEOL

We ask the Dean's office for an annual supplement to our budget of $7,500 (historically it had been approximately $9K when it came from the Provost's office), a number between our worst-case scenario ($10,944; Table 3) and the deficient derived from the average course enrollment (15 students for all field courses; Table 4) over the past five years. This number provides buffer for when courses are enrolled at below average levels. We asked for these funds to continue over a period of five-years, at which point we would re-evaluate our need for this augmentation.

In summary, with regards to resources, we generally have what we need to engage our students in state-of-the-art laboratory and field research, but what we are lacking is a **consistent field trip budget for our classes (to replace the annual $9K Provost's Augmentation)**, and a **tenure-track Hydrologist position**.

VII. Summary Conclusion

The Department of Geology is a small, congenial, student-centered department that offers highly valued degrees to our majors while simultaneously being productively engaged in dynamic research, successful in obtaining external grants, and serves a critical GE need for the School of Science and Technology and SSU more general. Our strong emphasis on field work and student-involved research has lead our graduates to be recognized favorably by employers and graduate programs. The department receives internal (positive exit survey results) and external (impressive results on ASBOG licensing exam) validation that our graduates receive the training necessary to excel after graduation. All this has been accomplished despite significant turnover in tenure-track faculty and an uncertain financial footing.

Our department has significant challenges to address in the coming years. It is imperative that we retain a strong and stable tenure-track faculty base of 5 that properly represents the diversity of our student body as well as include the domain expertise needed to train our geoscience workforce. This requires re-hiring the hydrology position and preparing to replace Matt James when he fully retires. Field trips are an integral part of an education in geology, and we must have a steady financial footing by figuring out a long-term solution for funding our field trips. Additionally, in the Covid era we need to focus on recruitment. We believe a name change of our B.A. degree to Earth and Environmental Sciences along with a marketing push from within could potentially help with this. Also, we will be revising our advising documents and web resources and our overall advising strategies (in part due to Covid related challenges) that will help with major retention. Further, we will work on the Achievement Gap within our introductory

courses by participating in the NSF funded project, “Transformative Inclusion in Postsecondary STEM (TIPS) Towards Justice” and associated training workshops. Lastly, we plan to make a concerted effort to connect with more of our alumni by reinstituting the department newsletter, hosting alumni events, and keeping better track or our alumni employment

Despite the aforementioned challenges, we believe that the department has a clear and compelling vision for the future. With the proper University support, we predict in 5-years we will be reporting back on a vibrant, engaged, and healthy Department of Geology.