Graduate Courses 2021-2022

Fall 2021

Course	Course Title	Units	Instructor	Breadth area
GEL 206	Stratigraphic Analysis	3	Sumner	2 or 4
GEL 240	Foundations of Geophysics	3	Rudolph	6
GEL 250	Advanced Geochemistry Seminar	3	Cooper	4
GEL 290	Seminar	1	TBD	N/A
GEL 294	Structure & Tectonics forum	1	Roeske	N/A
GEL 390	Methods of Teaching Geology	2	Billen	N/A

Winter 2022

Course	Course Title	Units	Instructor	Breadth area
GEL 216	Tectonics	3	Cowgill	3
GEL 253	Current Topics in Igneous Petrology	3	Ratschbacher	4
GEL 260	Paleontology	3	Vermeij	1
GEL 298	Microbial Photosynthesis	3	Sumner & Grettenberger	1
GEL 290	Seminar	1	TBD	N/A

Spring 2022

Course	Course Title	Units	Instructor	Breadth area
GEL 219	Fracture & Flow of Rocks	3	Billen	3 or 6
GEL 230	Geomorphology & River Management	3	Pinter	5
GEL 290	Seminar	1	TBD	N/A
GEL 294	Structure & Tectonics forum	1	Roeske	N/A

Course Descriptions

Fall, 2021

GEL 206: Stratigraphic Analysis (Sumner)

Graduate course breadth area: #2 or 4

This course will provide students the opportunity to learn and apply sedimentary geology, regional stratigraphy, and sedimentary basin analysis to tectonically active basins. It will be divided into three components: 1) specific techniques (tailored to student prior experience level); 2) a 3-day field trip (likely to the Ridge Basin, Southern California) and application of analysis techniques to those data; and 3) small group projects on topics of interest. Small group projects can focus on Martian stratigraphy for students interested in planetary science.

GEL 240: Foundations of Geophysics (Rudolph)

Graduate course breadth area: #6

This course presents foundational concepts in geophysics at a level accessible to all graduate students in the EPS department. Topics to be covered include the geophysical

constraints on the large-scale structure and dynamics of Earth and planetary interiors such as seismology, gravity, heat flow, magnetic field, and geodesy. We will explore the physics of the processes that shape planetary surfaces and interiors including impact events, differentiation, mantle convection, and tectonics. The course will include a computer laboratory with hands-on programming activities in Python that reinforce the concepts covered in lecture.

Format: Lectures, weekly problem sets/labs, midterm, final

Note: This course is one of several regular 'core classes' being developed to strengthen our graduate curriculum.

GEL 250: Advanced Geochemistry (Cooper)

Graduate course breadth area: #4

U-series dating of geologic processes. Quantifying time is critical for understanding Earth history and for quantifying rates of geologic processes. In particular, dating recent geologic events (i.e., the past few hundred thousand years) is difficult, but it can be critical for understanding processes that occur on human time scales (e.g., climate change, volcanic processes). This seminar will explore the application of uranium-series disequilibria to understanding the timescales of recent geologic processes. The course will have three parts: U-series systematics and techniques for dating igneous processes and carbonates, applications to igneous processes, and applications to tectonic and paleoclimate research. The specific topics explored within these rather broad applications will be tailored to the interests of the students enrolled, for example, timescales of melt generation and transport, dating of crystals in volcanic rocks to constrain rates of magmatic processes, dating speleothems to reconstruct records of climate changes in the Quaternary, or dating carbonates to constrain rates of fault motions.

The course will consist of lectures to introduce the techniques and to provide the background required for meaningful discussion of research papers, and reading and discussion of literature. Discussion meetings will be led by students, and students will write short papers summarizing recent research on a topic of their choice. There may also be a few problem sets during the quarter designed to give students hands-on experience with using U-series data.

GEL 294: Structure-Tectonics-Geophysics seminar (Roeske)

1-unit

This on-going discussion group meets once/week to discuss a paper selected by participants in the group. The theme of the articles varies each quarter; the seminar's goal is to emphasize breadth and we read and discuss a range of articles that cover the diverse interests of members of the group. As an example, we have recently read articles on subduction zone processes, ranging from UHP metamorphism and exhumation, to response of the upper plate to degree of coupling in the subduction zone. If schedules allow, we plan a multi-day field trip to examine rocks that may show some of the processes of interest to the group and focus the reading around the field trip.

Winter, 2022

GEL 216: Tectonics (Cowgill)

Graduate course breadth area: #3

Tectonic processes provide the fundamental mechanisms by which the exosphere (atmosphere, hydrosphere, and biosphere) and the deep interior of Earth interact. This course seeks to understand tectonic systems by examining processes of mass and energy flux at modern and ancient plate boundaries. Our approach will be fundamentally geological in nature, in the sense that we will strive to link the rock record of processes with observations from modern settings. The course will involve readings/lectures based on *Global Tectonics* (Keary, Klepeis, Vine) and the primary literature, problem sets, and a research project and presentation.

Planned topics: 1. Basics of Plate Motion on Sphere; 2. Basics of Isostacy & Flexure; 3. Divergent Boundaries & Passive Margins (e.g., Red Sea, Atlantic); 4. Transform Boundaries (e.g., San Andreas, Alpine, North Anatolian faults); 5. Convergent Boundaries (e.g., Andes); 6. Collision & Orogeny (e.g., Alpine-Himalayan Belt & Demise of NeoTethys); 7. Tectonics, Climate & Ocean Chemistry; 8. Tectonics and Life. Simultaneous enrollment in GEL253 is strongly encouraged.

GEL 253: Petrology seminar (Ratschbacher)

Graduate course breadth area: #4

This course will focus on the formation of continental crust in subduction zone settings. Topics about magma generation, ascent, and mechanisms of differentiation will be discussed using scientific journal articles. Further topics can be decided depending on the interest of participating students. The course will comprise weekly student-lead discussion of scientific journal articles as well as short lectures by the instructor.

GEL 260: Paleontology (Vermeij)

Graduate course breadth area: #1

This course will explore a broad topic of interest (still to be decided). We will read and discuss relevant papers and there will be a short final presentation and paper.

GEL 298: Microbial Photosynthesis (Grettenberger)

Graduate course breadth area: #1

Photosynthesis is one of the most important evolutionary innovations in Earth's history. It permanently changed Earth's surface geochemistry, fundamentally reshaping the cycling of key elements and altered the evolutionary path of life by allowing widespread aerobic respiration. This course will explore the importance of oxygenic photosynthesis in biogeochemical cycling, its evolutionary history, and the history of it in the fossil record. The course will include classroom, field, and laboratory components. Students will participate in a quarter long hands-on project during which they will 1) collect samples from a nearby field site, 2) extract DNA and sequence it using a MinION sequencer, 3) analyze the data using common bioinformatic pipelines, and 4) present their findings in a 10 minute talk format.

Spring, 2022

GEL 219: Fracture and Flow of Rocks (Billen)

Graduate course breadth area: #3 or 6

This revised course is designed to provide students with diverse undergraduate backgrounds with a strong foundation in brittle, ductile and viscous behavior of rocks. Compared to how the class was taught previously there is a shift to more time spent on brittle/ductile behavior of the lithosphere, including the rheologies used to model earthquake rupture, and less time spent on the viscous behavior of the mantle (but this is still covered). For each topic, I will present the experimental data, the equations used to describe the behavior and a discussion of the microscopic origin of the observed behavior. Targeted paper discussions will occur at key junctures in the course to help synthesize the topics and learn how to critically read papers establishing or applying rheological concepts. Each student will also complete a literature review-based term project on a specific type of rheology of relevance to their own research. Please also see detailed syllabus.

GEL 230: Geomorphology and River Management (Pinter)

Graduate course breadth area: #5

The course is a multidisciplinary study of the ecology, geomorphology and management of rivers of the US West, and one river (TBD) in particular. The field of watershed science, including the study of rivers and streams, is inherently multidisciplinary, involving a broad array of physical, biological, and social sciences. Traditional education programs emphasize in-depth study within a specific discipline, whereas most careers in water-related science and management rarely are limited to a single discipline. The ability to work collaboratively with professionals from different backgrounds is fundamental to success in watershed science and management, and indeed in most applied-science fields. Comprised of upper division undergraduate students and first-year graduate students, this course will bring together students from a range of biological and physical sciences to address the geology, ecology, and management of a targeted river and watershed. The course will be followed by an optional, private rafting and research expedition on the study river. Trip participants will be expected to help organize logistics for the field trip, including food, gear, transportation and field itineraries.

GEL 294: Structure-Tectonics-Geophysics seminar (Roeske)
1-unit

This on-going discussion group meets once/week to discuss a paper selected by participants in the group. The theme of the articles varies each quarter; the seminar's goal is to emphasize breadth and we read and discuss a range of articles that cover the diverse interests of members of the group. As an example, we have recently read articles on subduction zone processes, ranging from UHP metamorphism and exhumation, to response of the upper plate to degree of coupling in the subduction zone. If schedules allow, we plan a multi-day field trip to examine rocks that may show some of the processes of interest to the group and focus the reading around the field trip.