

Professor: Kena Fox-Dobbs (*on leave 2021–22*); Michael Valentine, *Chair*

Visiting Assistant Professor: Alexandra Nagurney

About the Department

The Geology Department at Puget Sound consists of five faculty members and roughly 40 majors. Our size enables us to offer a broad spectrum of classes while at the same time maintaining a close-knit and collegial learning environment. All of our courses include a field component and these range from day or weekend trips to semester-long projects that integrate field and laboratory analysis. We also believe strongly in the importance of training our students to use analytical instrumentation and are very well-equipped in this regard. By the time they graduate our majors are scientists, trained to collect and interpret their own data, think creatively, and answer real-world questions.

Geology faculty are actively engaged in research that involves our students. Our research interests span a broad range of topics including the environmental geochemistry of water and sediment from water bodies in the Puget Sound area, paleomagnetic studies of variations in the earth's magnetic field and past plate motions, biogeochemical studies of past and present energy and nutrient cycles, and the magmatic and tectonic evolution of the Pacific Northwest. Many of our projects are based here in the Pacific Northwest, but we have also taken students to more distant research locations including Alaska, the American Southwest, Ascension Island, New Zealand, and Africa.

In both teaching and research we take advantage of outstanding facilities and equipment available in the department. Our resources include:

- A Hitachi 3400 scanning electron microscope equipped with x-ray analysis and cathodoluminescence capabilities.
- An Agilent 5100 ICP-capable of measuring elemental abundances at ppm levels and below in a wide variety of materials including rocks, water, and sediment.
- A Phillips x-ray diffractometer for mineral analysis.
- A Costech elemental analyzer for measuring C-H-N-S in soil, sediment, and organic matter.
- A completely equipped sample prep lab with facilities for cutting, crushing, and pulverizing rocks, making thin sections, and preparing mineral separates.
- Separate, fully equipped labs for preparation and analysis of samples for paleomagnetism, sedimentology, and geochemistry.
- A wide array of field equipment including two boats, water, soil and sediment sampling gear, and GPS units.
- A broad range of geophysical instruments including a gravimeter, magnetometer, electrical resistivity meter, and hammer seismograph.
- Extensive collections of rocks, minerals, fossils, maps and other teaching materials.

Students who major in geology learn to observe and interpret the natural world. To that end, and to supplement our coursework and research opportunities, we take a departmental trip lasting 10-14 days to an exciting location in alternate years. Our Summer 2019 tour was to Hawaii; past trips have been to New Zealand, Tanzania, Ecuador, and Iceland.

Our majors develop the skills to formulate hypotheses, collect and interpret data, synthesize results, and present findings at professional conferences. All Geology majors have the option to complete a senior thesis. Upon graduation our students are ready to apply their knowledge and skills not only to academic topics, but also to important societal issues such as natural disaster planning, waste disposal, climate change, resource utilization, and water policy.

Our graduates have gone on to a wide range of careers, the most popular in recent years being graduate school, environmental consulting, and education. However, we have graduates across the country and around the world, and their occupations include not only Earth Science fields (e.g., natural resource extraction, hydrology, academia) but also other sciences and related professions (e.g., medicine, environmental law).

General Requirements for the Major or Minor

General university degree requirements stipulate that 1) at least four units of the major or three units of the minor be taken in residence at Puget Sound; 2) students earn a GPA of 2.0 in courses taken for the major or the minor; and 3) all courses taken for a major or minor must be taken for graded credit. Any exceptions to these stipulations are indicated in the major and minor degree requirements listed below.

Requirements for the Major

Geology is the application of biology, chemistry, mathematics, and physics to the study of the earth. Students majoring in Geology must understand the principles and techniques of these disciplines as well as the basic skills and concepts of geology. A Geology major consists of the following sequence of related courses:

1. Ten Geology units to include:
 - a. One unit from GEOL 101, 104, 110, or 140;
 - b. GEOL 200, 302, a departmentally approved summer Geology field camp, normally taken between the junior and senior years, and one of the following: GEOL 305, 306, 330, or 340 taken in the junior or senior year;
 - c. Five units from the following: GEOL 206, 301, 303, 304, 305, 306, 307, 310, 315, 320, 324, 330, 340, 492
2. CHEM 110 and 120 or 115 and 230, MATH 180 and 181 (or 160 or CSCI 161), PHYS 111/112 or 121/122;
3. A grade of C or better must be received in all Geology Department courses.

The Geology Department does not accept courses more than 10 years old towards the major.

Requirements for the Minor

The minor consists of at least 6 required courses and must include one unit from GEOL 101, or 104, or 110, or 140 (only one unit counts toward the minor) plus GEOL 200 and any four additional Geology courses.

The Geology Department does not accept courses more than 10 years old towards the minor.

Course Offerings

Unless otherwise specified, each course carries 1 unit of credit and is offered at least once each academic year. Please see "Frequency of Course Offerings" on page 18.

Seminars in Scholarly Inquiry. See *Seminars in Scholarly Inquiry in the Core Curriculum* section of this Bulletin for course descriptions (page 18).

SSI1 125 Geomorphology of Ancient Catastrophes

SSI2 151 The Natural History of Dinosaurs

Other courses offered by Geology Department faculty See

Connections in the Core Curriculum section of this Bulletin for *Connections* course descriptions (page 34).

ENVR 325 Geological and Environmental Catastrophes

Satisfies the Connections core requirement.

Geology (GEOL)

101 Physical Geology Physical geology is a survey of the physical processes operating on and in the earth and the results of these processes through time. Topics covered range in scale from the atomic to the galactic. The formation of the minerals and lavas, types of volcanoes, and the creation of sedimentary and metamorphic rocks make up the first third of the course; this introduces the materials of the earth. The course next covers large-scale topics such as the age of the earth, earthquakes and their resultant damage, how continents and seafloors are created, a brief history of the world, and an outline of the great unifying theory of geology, plate tectonics. The last third of the course discusses how surface processes such as streams, wind, waves and changes in the environment affect the deserts, glaciers, shorelines, and groundwater, and how these changes affect our way of life. Includes a laboratory. *Prerequisite: Credit for GEOL 101 will not be given to students who have received credit for GEOL 104. Satisfies the Natural Scientific core requirement. Offered every semester.*

104 Physical Geology of North America This course examines the range of natural environments of North America and the geologic, climatic, and biogeographic basis for this diversity. Focusing on the major physiographic divisions of the United States and Canada, the course looks at the relationship between these fundamental factors, the unequal distribution of natural resources, and the geography and history of human response to them. Includes laboratory. *Prerequisite: Credit for GEOL 104 will not be granted to students who have received credit for GEOL 101. Satisfies the Natural Scientific core requirement. Offered occasionally.*

105 Oceanography Earth is largely a “water planet”—the only planet we know of that has liquid water on its surface. Oceanography has developed from early mythological explanations of the present use of high technology to study their features and workings. The oceans played an integral role in the exploration of Earth and the spread of humankind across the planet, as well as being a continuing source of food and other resources. In the Puget Sound region, we feel the effects of the nearby ocean daily, from the weather we have to food we eat. This course investigates the origins and nature of Earth’s oceans. It looks at processes acting within the oceans (tides, currents, waves), interaction of the oceans, atmosphere, and continents, and the effects of these processes on life on Earth, including humans in the northwestern U.S. These facets are studied in the “big picture” context of the Earth as an integrated system in which each process affects the others. A portion of the lab time is devoted to measurement of the properties of oceanic and crustal material, some of which are collected locally from Puget Sound. Other labs are used to familiarize students with maps, charts, and other information sources. Emphasis is placed on making inferences about Earth systems from data gleaned from students’ own measurements and other sources. *Satisfies the Natural Scientific core requirement. Offered every year.*

110 Regional Field Geology This course focuses on one of several geologic provinces in North America in the most direct manner possible - in the field. After an initial lecture orientation, the class explores the rocks, land forms, structures, and fossils first hand. Students learn to make their own observations and interpretations along the way. Each student becomes an expert in the geology of a selected area and makes in-field presentations to the rest of the class, as well as compiling a field notebook of the features that the class examines. Trips include the Colorado Plateau, the Death Valley region, and the Pacific Northwest. *Satisfies the Natural Scientific core requirement. Cannot be taken Credit/No Credit. Offered occasionally.*

140 Climate Change This course examines the wide variety of geologic, physical, chemical, and biologic evidence for the nature, duration, timing, and causes of climate change throughout the long history of our planet. In general, the course proceeds chronologically through geologic time. As the course approaches the modern world, students examine the paleoclimate record in progressively greater detail, and consider increasingly complex explanations for the patterns seen. This course also examines the complex interactions between the development of modern human societies and global climate, and considers some projections of climate change and its effects on our planet in the next few decades. *Satisfies the Natural Scientific Approaches core requirement.*

200 Introduction to Mineralogy and Petrology This course introduces the methods used to identify minerals and rocks and provides an overview of the processes by which they form. Topics covered include chemical and physical properties of minerals, mineral associations, and the classification, genesis, and interpretation of igneous, sedimentary, and metamorphic rocks. Labs emphasize the identification of samples in hand specimen and by x-ray diffraction. *Prerequisite: GEOL 101, 104, 110, or 140. May be taken concurrently. Offered every year.*

206 Introduction to Geophysics This course investigates the shape, composition, and formation of the major internal and external features of the Earth: ocean basins, continents, mountain ranges, the core, the mantle, and the lithosphere. A large portion of time is spent obtaining and interpreting quantitative geophysical measurements of Earth properties. This includes collecting and analyzing seismic, gravity, and magnetic and paleomagnetic data, measuring the gravitational constant, and determining Earth’s size and mass, the thickness of the crust, and the distance to earthquake epicenters. Emphasis is placed on geophysical methods used by scientists in the measurement of basic Earth properties. *Prerequisite: GEOL 101, 104, 110, or 140, or permission of the instructor. Offered every other year.*

301 Sedimentary Geology The origin, texture, composition, classification, and interpretation of sediments and sedimentary rocks. The various methods for studying these materials in the field and laboratory are emphasized. A portion of the course is devoted to the main groups of microscopic fossils that occur as components of many sedimentary rocks. *Prerequisite: GEOL 200. Offered every other year.*

302 Structural Geology and Tectonics Study of earth’s architecture, major tectonic features and processes, and folding and fracturing in rocks; lab and field projects included. *Prerequisite: GEOL 200. Offered every other year.*

303 Geomorphology Detailed study of agents, processes, and products involved in landscape development and water movement at the Earth’s surface. Special emphasis is on the effect of the Pleistocene (Ice Age) climate on landforms. *Prerequisite: GEOL 200. Offered occasionally.*

304 Igneous Petrology/Volcanology This course covers igneous rocks and the processes by which they form. Specific topics include magma formation and evolution, characteristics of igneous rocks in different tectonic settings, and the causes, styles, and impacts of volcanic eruptions. Students learn and utilize a variety of field and lab techniques including ICP analysis and thin section microscopy. *Prerequisite: GEOL 200. Offered every other year.*

305 Earth History The principles, methods, and materials of stratigraphy and paleontology used to interpret the physical and biological history of the Earth. Emphasizes the classification, correlation, interrelationships, and interpretation of rock strata and of the various types of

fossils that occur in these rocks. *Prerequisite: GEOL 200. Offered every other year.*

306 The Fossil Record This course investigates how life on earth has changed through time as recorded in the fossil record. It includes a survey of major invertebrate and vertebrate fossil groups, with emphasis on paleoecological pattern and process, and reconstruction of paleoenvironments. *Prerequisite: Any one of the following: GEOL 101, 104, 110, 140; BIOL 111, 112. Offered every other year.*

307 Introduction to Geologic Field Methods and GIS In this course students learn a variety of techniques that are used to locate, describe, and document geologic features in the field. Specific topics include navigating with topographic maps and GPS, sketching geologic features, using a Brunton compass, recognizing and interpreting geomorphic features on topographic maps, aerial photos and lidar images, and working with ArcGIS to produce a variety of different types of maps. Three all-day field trips on Saturdays and/or Sundays are required. *Prerequisite: GEOL 200. Offered every other year.*

310 Water Resources This course examines the physical, chemical, and geologic processes that determine the distribution, movement, and nature of freshwater resources (rivers, lakes, wetlands, and groundwater). The course pays particular attention to issues of water supply and quality in North America. Lab and field exercises introduce the fundamentals of measuring and modeling river and groundwater flow; field trips to several dams and reservoirs in Washington illustrate some of the ways that surface water resources are utilized. *Prerequisite: Any one of BIOL 111, 112, CHEM 110, 115, 120, 230, GEOL 101, 104, 110, 140. Offered every other year.*

315 Energy Resources This course surveys the wide range of modern energy sources, and considers the prospects for their future supply and availability. Each energy source is explored from a wide range of perspectives, including: its origin, geographic distribution, energy density, energy "type" (gravity, chemical, radioactive, solar), processing, refining, or transformation from one form of mass or energy to another, transport (both pre- and post- processing/transformation), environmental costs (upstream and downstream- lifecycle considerations), and economic costs (cost/unit of energy produced). As ongoing events dictate, energy topics in the news are also considered, including economic, political, and environmental issues of the day. *Cross-listed as ENVR/GEOL 315. Prerequisite: One course in the Natural Scientific Approaches core and ENVR 200 or permission of the instructor. Offered occasionally.*

316 Mineral Resources and the Environment This course provides an introduction to the study of a variety of the Earth's natural resources, and the environmental impacts of their extraction and use. The course focuses on the origin of different types of resources including metallic and non-metallic mineral deposits, and building stone. A discussion/lab session is scheduled for in-class activities, labs and field trips. Course readings center around case studies from the primary scientific literature. *Cross-listed as ENVR/GEOL 316. Prerequisite: One course in the Natural Scientific Approaches core and ENVR 200 or permission of the instructor.*

320 Environmental Geochemistry This course provides an introduction to the ways in which chemical principles are used to study geological and environmental processes. The emphasis is on low-temperature processes that influence the chemistry of water, sediment, and soil. Specific topics include aqueous solutions, thermodynamics, mineral-water equilibria, oxidation-reduction reactions, adsorption-desorption processes, and applications of radiogenic and stable isotopes. The labora-

tory component of the course is field-based and involves sampling and analysis of water and sediment from around Tacoma. *Prerequisite: GEOL 101, 104, 110, or 140, and CHEM 110, or permission of the instructor. Offered every other year.*

324 Biogeochemical Approaches to Environmental Science A broad review of quantitative and qualitative biogeochemical methods used in the study of environmental science. The course will focus on isotopic and elemental analyses of geological and biological materials with applications to a range of questions. Examples include; energy flow, nutrient cycling, animal migration, and paleoceanographic conditions. The course readings will draw heavily upon case studies from the primary scientific literature. *Cross-listed as ENVR/GEOL 324. Cross-listed as ENVR/GEOL 324. Prerequisite: Any one of BIOL 111, 112, CHEM 110, 115, 120, 230, GEOL 101, 104, 110, 140. Offered every other year.*

330 Regional Field Geology See description for GEOL 110. *Prerequisite: Permission of the instructor and GEOL 200. Cannot be taken Credit/No Credit. Offered occasionally.*

340 Climate Change This course examines the wide variety of geologic, physical, chemical, and biologic evidence for the nature, duration, timing, and causes of climate change throughout the long history of our planet. In general, the course proceeds chronologically through geologic time. As the course approaches the modern world, students examine the paleoclimate record in progressively greater detail, and consider increasingly complex explanations for the patterns seen. Because of the great breadth (interdisciplinary range) and great depth (wide range of time periods) of the topics considered, students use a wide range of sources, including semi-popular articles, textbooks, and primary literature. The lab focuses on examining a variety of primary sources of paleoclimatic information and techniques of data analysis, such as tree rings, pollen, and stable isotopes. *Cross-listed as ENVR/GEOL 340. Prerequisite: One course in the Natural Scientific Approaches core. Offered occasionally.*

390 Directed Research This course provides a laboratory or field research experience for juniors or seniors under the direction of a faculty mentor. Students may initiate a project or join a research project in the mentor's lab. Students must complete an agreement listing research activity to be completed, references, and a progress plan that will result in a written report and a presentation. *May be repeated for credit. Offered occasionally.*

490 Seminar 0.25 units. In this course, students explore a variety of current topics in the geosciences. The choice of topics varies from year to year, but are primarily based on current or proposed research topics being conducted by faculty and students in the department. Each student is responsible for preparing for and leading one class session; all students are responsible for thoroughly preparing for and participating in all class sessions. *Prerequisite: GEOL 101, 104, 110, or 140, GEOL 200, and one upper division Geology course. May be repeated for credit. Offered spring semester.*

492 Senior Thesis Research and preparation of a senior thesis under the supervision of a faculty member. Public presentation of research results is required. *May be repeated for credit. Cannot be taken Credit/No Credit.*

495/496 Independent Study Variable credit up to 1.00 unit. Independent study is available to those students who wish to continue their learning in an area after completing the regularly offered courses in that area. *May be repeated for credit up to 4.00 units. Cannot be audited. Cannot be taken Credit/No Credit.*

498 Internship Seminar Variable credit up to 1.00 unit. This scheduled weekly interdisciplinary seminar provides the context to reflect on concrete experiences at an off-campus internship site and to link these experiences to academic study relating to the political, psychological, social, economic and intellectual forces that shape our views on work and its meaning. The aim is to integrate study in the liberal arts with issues and themes surrounding the pursuit of a creative, productive, and satisfying professional life. Students receive 1.0 unit of academic credit for the academic work that augments their concurrent internship fieldwork. This course is not applicable to the Upper-Division Graduation Requirement. Only 1.0 unit may be assigned to an individual internship and no more than 2.0 units of internship credit, or internship credit in combination with co-operative education credit, may be applied to an und *May be repeated for credit up to 2.00 units. Cannot be audited. Cannot be taken Credit/No Credit.*