

# Geology

*Chair:* Kevin R. Pogue

Nicholas Bader

Kirsten Nicolaysen

Lyman P. Persico (on Sabbatical, Spring 2020)

Patrick K. Spencer

Lindsay Szramek

Geology integrates physical, chemical, and biological studies of the Earth from its inception to the present day. Courses in Earth Science increase every student's appreciation of the world's natural processes and of how current fluctuations in the magnitudes and frequency of geological events and in the availability of natural resources affect human societies and their integrated ecosystems. Serious students of geology find opportunities in the environmental, energy, mining, teaching, engineering, and geophysics fields, and in resource management, K-12 education, academia, hydrogeology, space science, hazard management, and oceanography.

A student who enters Whitman without any prior college-level preparation in geology will have to complete 49 credits (32 in geology) to fulfill the requirements for the geology major. After a geology or geology combined major is declared, no geology course, except Geology 158, may be taken P-D-F.

**Distribution:** Courses completed in geology apply to the science and quantitative analysis (selected courses) distribution areas.

**Total credits required to complete a Geology major:** A student who enters Whitman College with no prior experience in geology will need to complete 49 credits with 32 credits in Geology.

**Learning Goals:** Upon graduation, a student will be able to:

- Apply geologic concepts to the interpretation of geologic materials and landscapes
- Apply quantitative techniques to geological questions
- Read and interpret geological information, including graphical data, geologic and topographic maps, and scientific literature
- Effectively communicate geologic concepts, including by written communication, oral communication, and mapmaking

**The Geology major:** A minimum of 32 credits in geology, to include either Geology 110 and 111 or 120 and 121, or 125 and 126; Geology 227 and 270; and either Geology 312, 321, or 368; and Geology 350, 358, 405, 420, 470; and a minimum of 3 credits of Geology 480.

In addition, the following courses are required: Mathematics 125, 128, or 247; Chemistry 125, 135; Physics 145 or 155, and a minimum of 6 credits at a catalog number higher than 125 in any of the following departments: mathematics, chemistry, physics, or computer sciences. AP credit may not be used to fulfill the supporting science coursework listed above. Students with AP credit or who have tested out of any of the above courses in mathematics, chemistry, physics, or computer sciences must take the next higher course in the department's sequence.

Seniors completing a geology or geology combined major shall take a comprehensive senior assessment consisting of a four-hour written exam constructed by the geology faculty. In addition, geology majors shall take an oral exam, which may be conducted in the field.

**The Geology minor:** Either Geology 110 and 111, 120 and 121, or 125 and 126, and 227, 301, 312, or 350 plus additional work in geology for a minimum of 16 credits.

**The Astronomy-Geology combined major:** Astronomy 177, 178, 179, two credits of 490, one of the following: 310, 320, 330, 350, 360, 380, and at least two additional credits in courses numbered 310-392; either Geology 110 and 111, 120 and 121, or 125 and 126; and Geology 227, 270, 350, 470 and a minimum of one credit in 358, two credits of 490, and two of the following: 310, 405, or 420; Physics 145 or 155, 156, Mathematics 125, 126, and Chemistry 125, 135 are also required. Computer Science 167; Mathematics 225, 244, Chemistry 126, 136, and Physics 245, 255, are strongly recommended. In the final semester, the student must pass a senior assessment consisting of a two-part comprehensive written examination and an approximately one-hour oral exam conducted jointly by astronomy and geology faculty.

The astronomy-geology combined major requires coursework in astronomy, geology, chemistry, physics, and mathematics. A student who enters Whitman with no prior college-level work in any of these areas would need to

complete 20 credits in astronomy, 27 to 28 credits in geology, four credits in chemistry, eight credits in physics, and six credits in mathematics.

**The Biology-Geology combined major:** Biology 111, 112, 205; four credits each from the Organismal Biology and Ecology/Evolution categories, and at least four additional credits in biology and/or BBMB courses numbered 200 or above; Geology 110 and 111; 120 and 121, or 125 and 126; Geology 227, 270, 350, 470; Geology 312 or 268; Geology 301, 321, or 405; and a minimum of one credit in 358; either three credits of Geology 480, 490, or 498 or three credits of Biology 489, 490, or 498; Chemistry 125, 126, 135, 136 or Chemistry 140; 245; Mathematics 125, 126 or statistics (Mathematics 128 or 247, Economics 227, Psychology 210, Sociology 208). Two semesters of physics and field experience are strongly recommended.

**The Chemistry-Geology combined major:** Either Chemistry 125, 126, 135, 136 (or 140); 310, and at least two of 320, 346, 388; either Geology 110 and 111, 120 and 121, or 125 and 126; and 227, 270, 350, 405, 460, 470, and a minimum of one credit in 358; Mathematics 125, 126, Physics 145, 155. Seniors completing the chemistry-geology major will complete a written exam constructed by the geology faculty, a written exam constructed by the chemistry faculty, and an oral exam conducted jointly by faculty in both departments. Additionally, all students are strongly encouraged to complete a senior research project under the guidance of a faculty member in either of the two disciplines, registering for a minimum of one credit of Chemistry 401 or 402, plus two credits in either Chemistry 490 or 498, or three credits of Geology 490 or 498.

**The Geology-Physics combined major:** Physics 145 or 155, 156, 245, 255, 267, two courses from 325, 339, 347, 357, 385; either Geology 110 and 111, 120 and 121, or 125 and 126; and 227, 270, 310, 405, 420, 470 and a minimum of one credit in 358; Mathematics 225 and 244; Chemistry 125. In the final semester of the senior year, the student must pass a senior assessment consisting of a written exam and a one-hour oral exam.

**The Geology-Environmental Studies combined major:** The requirements are fully described in the *Environmental Studies* listing of the catalog.

## **107 Special Topics in Geology**

### **1-4 credits**

Any current offerings follow.

## **110 The Physical Earth**

### **Spring**

**Bader**

**3 credits**

Physical geology including earth materials, the processes responsible for uplift and erosion, landforms, plate tectonics and the earth's interior. Three lectures per week. Open only to first- and second-year students; others by consent of instructor. Students who have received credit for Geology 120 or 125 may not receive credit for Geology 110. *Corequisite:* Geology 111.

## **111 The Physical Earth Lab**

### **Spring**

**Bader**

**1 credit**

Laboratory exercises to accompany classroom instruction in The Physical Earth. Must be taken concurrently with Geology 110. Topics may include the identification of rocks and minerals, interpretation of topographic and geologic maps, and fluvial processes. One three-hour laboratory per week; field trips. Students who have received credit for Geology 121 or 126 may not receive credit for Geology 111. *Corequisite:* Geology 110. *Lab fee:* maximum \$20.

## **120 Geologic History of the Pacific Northwest**

### **Fall**

**Spencer**

**3 credits**

An examination of the geologic history of the Pacific Northwest, including Washington, Idaho, Oregon, northern California, and southern British Columbia. Fundamental geologic processes that have shaped the Pacific Northwest will be examined through detailed study of different locales in the region. Three lectures per week. Open to first- and second-year students, others by consent of instructor. Students who have received credit for Geology 110 or 125 may not receive credit for Geology 120. *Corequisite:* Geology 121.

## **121 Geologic History of the Pacific Northwest Lab**

### **Fall**

**Spencer**

**1 credit**

Laboratory exercises to accompany classroom instruction in Geologic History of the Pacific Northwest. Must be taken concurrently with Geology 120. Topics may include general geologic skills such as the identification of rocks and minerals, interpretation of topographic and geologic maps, and fluvial processes, with a particular focus on the topics examined in lecture. One three-hour laboratory per week; field trips. Students who have received credit for Geology 111 or 126 may not receive credit for Geology 121. *Corequisite:* Geology 120. *Lab fee:* maximum \$20.

### **125 Environmental Geology**

**Fall, Spring**

**Szramek**

**3 credits**

Natural geologic processes including Holocene deglaciation, landslides, flooding, volcanism, and earthquakes pose risks both to human wellbeing and societal infrastructure. Human decisions for how we choose to interact with the physical environment and its resources (atmosphere, soils, energy sources, minerals) may further imperil societies or may inform global and regional mitigation of Anthropocene climate change, water quality and quantity problems, resource use, and land erosion and mass movement. This introductory course provides exploration and discussion of geologic processes within the paradigm of plate tectonics. Three lecture/discussion periods per week. Students who have received credit for Geology 110, 120, or 210 may not receive credit for Geology 125. Open to first- and second-year students; others by consent of instructor. *Corequisite:* Geology 126.

### **126 Environmental Geology Lab**

**Fall, Spring**

**Szramek**

**1 credit**

Laboratory exercises to accompany classroom instruction in Environmental Geology. Must be taken concurrently with Geology 125. Topics may include general geologic skills such as the identification of rocks and minerals, interpretation of topographic and geologic maps, and fluvial processes, with a particular focus on natural hazards such as floods and mass movement. One three-hour laboratory per week; field trips. Students who have received credit for Geology 111 or 121 may not receive credit for Geology 126. *Corequisite:* Geology 125. *Lab fee:* maximum \$20.

### **130 Weather and Climate**

**Spring**

**Pogue**

**3 credits**

An introductory course in meteorology designed for nonscience majors with an emphasis on the weather patterns and climate of the Pacific Northwest. Topics covered include Earth's heat budget, atmospheric stability, air masses, midlatitude cyclones, global circulation patterns and climates, and the origins of violent weather phenomenon.

### **158 Regional Geology**

**Fall, Spring**

**Fall: Spencer; Spring: Bader**

**1-3 credits**

The geology of part of the United States or elsewhere, with emphasis on geologic history, including petrology, stratigraphy, tectonics, and geomorphology. Lectures on the geology and other aspects of the area will precede field trips, which will take place during vacations and on long weekends. Geologic mapping may be involved. May be repeated for credit for different areas. *Prerequisites:* Geology 110 or 120 or 125 and consent of instructor. Graded credit/no credit. *Fee:* maximum \$75 per semester.

### **227 Sedimentology and Stratigraphy**

**Spring**

**Spencer**

**4 credits**

Fundamental principles of analysis pertaining to sedimentary rocks and rock sequences. Fluid flow, weathering, sediment transport, sedimentary structures, depositional systems. Geologic time and chronostratigraphy. Principles of Lithostratigraphy. Three one-hour lectures and one three-hour lab/week. Field trips. Textbook, professional articles, in-class presentations, research paper. *Prerequisite:* Geology 110 or 120 or 125.

### **229 Geology and Ecology of Soils**

**Fall**

**Bader**

**3 credits**

Soils provide nutrients, water and support for growing plants, host an amazing variety of organisms, and even influence global climate. This class will focus on the dynamic systems in soil and on the interactions between soils and larger ecosystem properties. Course topics will include pedogenic processes, agricultural ecosystems, the

interpretation of paleosols, and the role of soils in the global biogeochemical cycling of organic carbon and nutrients. Lectures, field trip(s).

### **250 Late Cenozoic Geology and Climate Change**

**Not offered 2019-20**

**3 credits**

The geology of the last few million years of Earth history, including glaciology, Pleistocene stratigraphy, glacial and periglacial geomorphology, and changes in flora and fauna. What are the causes of ice ages and the alternating glaciations and interglaciations within them? What are the roles of nature and humans in the current global climate change? Research paper and field trip. *Prerequisites:* Geology 110 or 120 or 125, or Environmental Studies 120 and consent of instructor. Offered in alternate years.

### **258 Geology in the Field**

**1-3 credits**

An exploration of the geology of a region, followed by a field trip to that area. Likely to include geomorphology; structure and tectonics; minerals, rocks, and sediments; fossils and stratigraphy. Classes followed by a field trip at least a week long. Students will make maps and presentations and keep a detailed notebook. *Fee:* variable depending on location, possible scholarships available. May be repeated as location changes. Any current offerings follow.

### **258 VT: Geology in the Field: Risks and Rewards of Volcanic Processes in Andean Landscapes**

**Summer 2020**

**Nicolaysen**

**2 credits**

This course will investigate field exposures of volcanic deposits in the Ecuadoran Andes to interpret generative volcanic processes. Activities will promote discussion of the volcanic resources necessary to contemporary and prehistoric societies and of the management of risks during periodic volcanic unrest. Activities include lectures by local archaeology and volcanology experts, fieldwork and field notes, discussion of peer-reviewed literature and videos in conjunction with field observations, and investigation of maps. *Prerequisite:* Geology 110 or 120 or 125 and acceptance into this Crossroads course (application in September 2019). *Co-requisite:* Geology 410-Spring 2020. Distribution area: none.

### **270 Minerals, Society, and the Environment**

**Spring**

**Szramek**

**4 credits**

This intermediate-level course examines the role of minerals in human societies and Earth systems with particular emphasis on internal structure of minerals, the carbon cycle and carbon sequestration, the nuclear fuel cycle, and the growing concern regarding mining and resource scarcity. Skills include hand sample identification of minerals, analysis of crystal structure by X-Ray Diffraction, analysis of mineral composition by X-Ray Fluorescence or electron microscopy, primary literature searches and science writing. Lectures, discussions, and laboratory exercises. *Prerequisites:* Chemistry 125 and 135, and Geology 110 or 120 or 125. Open to Seniors by consent of instructor only. *Lab fee:* maximum \$20.

### **301 Hydrology**

**Spring**

**Bader**

**4 credits**

A class devoted to understanding water resources, including both surface water and groundwater. We will study the hydrologic cycle and the properties of water, the shape and behavior of streams, the recharge and movement of groundwater, and environmental management of water including wells, dams, irrigation, and water contaminants. Lab topics will include stream gauging and the construction of hydrographs and hyetographs, determining peak discharge, water sampling, flow nets, well tests, and computer modeling of groundwater and contaminant flow. Three lectures and one three-hour lab per week. *Prerequisite:* Geology 110 or 120 or 125. *Recommended prerequisites:* Chemistry 125 and Mathematics 126.

**310 Geophysics**  
**Not offered 2019-20**

**3 credits**

An introductory course in the application of seismic, gravitational, thermal, and magnetic methods for the study of the structure and composition of the interior of the Earth. *Prerequisites:* Geology 110 or 120, or 125 and Mathematics 125.

**312 Earth History**  
**Spring**

**Spencer**

**4 credits**

The physical and biological events during the geologic past. Special consideration given to plate tectonics and fossils in the lectures, and to fossils and geologic maps in the laboratories. Three lectures and one three-hour lab per week; required and optional field trips. *Prerequisite:* Geology 110 or 120 or 125 or consent of instructor.

**321 Sedimentary Basin Analysis**  
**Not offered 2019-20**

**4 credits**

An intermediate-level course that examines the evolution of selected marine and nonmarine sedimentary basins primarily in North America. Consideration of sedimentary features ranging from small-scale sedimentary structures and grain textures and composition to bedform geometry, unit contacts and tectonic significance of depositional features represented. Fossil succession, biostratigraphy and paleoenvironmental indications. Hydrocarbon and other economically significant mineral potential. Geologic map interpretation of important sedimentary basins. Lectures, presentations, and field trips. Professional articles, Internet sources, reference sources. *Prerequisites:* Geology 110 or 120 or 125 and 227. *Recommended prerequisite:* Geology 368. Offered in alternate years.

**338 Pages of Stone: The Literature of Geology**  
**Not offered 2019-20**

**3 credits**

Critical reading of the work of writers on Earth science. Examination of works demonstrating different styles, from scientific to poetry to descriptive prose, and how those writers incorporate Earth into their work. Two lectures per week, papers, in-class presentations, field trip. *Prerequisites:* Geology 110 or 120 or 125, or consent of instructor. Offered in odd-numbered years.

**340 Volcanoes**  
**Not offered 2019-20**

**3 credits**

An investigation of volcanoes, including morphology, composition, eruption processes, periodicity, and impacts on climate and humans. Exploration of the topic will occur through lecture, in-class experiments, computer simulations, discussion of primary literature, and several field trips. *Prerequisite:* Geology 110 or 120 or 125. Offered in alternate years. *Fee:* maximum \$40 unless field trip is outside of the Pacific Northwest.

**350 Geomorphology**  
**Fall**

**Persico**

**4 credits**

Description, origin, development, and classification of landforms. Relationships of soils, surficial materials, and landforms to rocks, structures, climate, processes, and time. Maps and aerial photographs of landscapes produced in tectonic, volcanic, fluvial, glacial, periglacial, coastal, karst, and eolian environments. Exercises on photo-geology. Lectures, discussions, laboratories, and field trips. *Prerequisite:* Geology 110 or 120 or 125; open only to Geology majors and others by consent of instructor.

**358 Field Geology of the Northwest**

**Fall, Spring**

**Fall: Spencer; Spring: Bader**

**1 credit**

The geology of part of the Pacific Northwest, with emphasis on geologic history, including petrology, stratigraphy, tectonics, and mineralogy. Geologic mapping, paleontology, and mineralogy may also be involved. Most field trips will take place on long weekends. Each student will be required to write a report. May be repeated for credit for different areas. Required of all geology and geology combined minors. *Prerequisite:* Geology 110 or 120 or 125 and consent of instructor. *Fee:* maximum \$75 per semester.

**368 Paleobiology**  
**Not offered 2019-20**

**3 credits**

A comprehensive examination of the fossil record through Earth history. Taxonomy and classification of important fossil groups, evolution and extinction, functional anatomy and morphology, ecologic significance of individual taxa and assemblages through time, paleogeographic reconstruction based on the fossil record, time-significance of fossil groups. Two lectures, one three-hour lab/week. Textbook, journal articles, research paper, and weekend field trip.

*Prerequisites:* Geology 110 or 120 or 125 and Geology 227. Offered in alternate years.

**390 Independent Study**  
**Fall, Spring**

**Staff**

**1-3 credits**

A reading or research project in an area of the earth sciences not covered in regular courses and of particular interest to a student. Maximum of six credits. *Prerequisite:* consent of instructor.

**405 Volcanoes and the Solid Earth**  
**Fall**

**Nicolaysen**

**4 credits**

The geologic history of the Pacific Northwest provides excellent examples of an active tectonic margin including accretion of oceanic crust and arc terranes and current arc volcanism. We examine magma generation and differentiation, volcano morphology, and physio-chemical processes of volcanoes from Earth's mantle to the surface through interpretation of rock suites from the Stillwater Complex, the Cascade and Alaska-Aleutian arcs, and the Columbia River basalt group. Lab activities include reading the primary literature, hand sample identification, use of petrographic microscopes, interpretation of thermodynamic phase diagrams, an introduction to computer modeling of magmas (e.g., MELTS), and field trips including one overnight field trip. *Prerequisites:* Chemistry 125, 135, and Geology 270 (formerly 343). *Lab fee:* maximum \$30.

**410 Problems in Earth Science**  
**1-4 credits**

Specific problems in the geological sciences will be considered. Textbook and/or professional articles, discussions, paper, possible field trips. May be repeated for credit with different topics. *Prerequisite:* consent of instructor. Any current offerings follow.

**410 ST: Volcanology in Global Contexts**  
**Spring**

**Nicolaysen**

**2 credits**

Geoscientists from many nations study cycles of dormancy and unrest arising at volcanoes. This course emphasizes advancing understanding of global volcanic processes, within the context of plate tectonic theory, by exploration of case studies, in-class experiments, computer simulations, and discussion of primary literature written by scientists from different cultural backgrounds. *Prerequisite:* Geology 110 or 120, or 125. Distribution area: none.

**415 Terroir**  
**Fall**

**Pogue**

**3 credits**

*Terroir* is a French word that refers to the idea that agricultural products derive unique sensory characteristics from the physical and cultural environment in which they are produced. The focus of the course will be on the science, philosophy, economics, and politics of terroir, in particular as they relate to the production and marketing of wine. The course will only be open to seniors or others by consent, providing they are 21 years of age. *Prerequisite:* Geology 110 or 120 or 125 or 229. *Fee:* \$50.

**418 Introduction to Geographic Information Systems**  
**Fall**

**Bader**

**3 credits**

A geographic information system (GIS) is a powerful computer tool designed for exploring, creating, and displaying spatial information. GIS has become the primary way in which spatial information is managed and analyzed in a variety of fields. Any data that has a spatial component (including most data in the Earth and environmental sciences) can potentially benefit from a GIS. Lectures will examine the applications and the conceptual framework

for computer GIS, and lab exercises will teach students to use GIS software. The final third of the course is dedicated to individual projects. *Prerequisite:* consent of instructor.

#### **420 Structural Geology**

**Fall**

**Pogue**

**4 credits**

The description and analysis of intermediate- to large-scale rock structures. Topics include the analysis and graphical representation of stress and strain in rocks, deformation mechanisms, fabric development in metamorphic rocks, the geometry and mechanics of folding and faulting, and structures related to intrusive bodies. Geologic map interpretation and cross-section construction are used to analyze the structural geology of selected regions. Three lectures and one three-hour lab per week; field trip(s). *Prerequisites:* Geology 227 and 270.

#### **430 Cordilleran Tectonics**

**Spring**

**Pogue**

**3 credits**

An in-depth study of the tectonic events that shaped the western United States. A review of plate tectonic theory emphasizing plate interactions and orogenesis and the tectonic evolution of the western U.S. beginning with the amalgamation of Precambrian basement and ending with the development of the San Andreas transform and Cascadia subduction systems. Each week two class periods are devoted to lectures, discussions and student presentations. The third class period is reserved for practical exercises, particularly geologic map interpretation. There is one required weekend field trip. *Prerequisite:* Geology 227.

#### **460 Geochemistry**

**Spring**

**Nicolaysen**

**3 credits**

An investigation of Earth's origin and systems using the principles of equilibrium, thermodynamics, diffusion, oxidation-reduction, solution chemistry, and isotope geochemistry. Among the concepts studied will be statistical analysis of geochemical data, pressure-temperature conditions of mineral formation, weathering of minerals, dating rocks by radioactive decay, stable isotopes, water chemistry, and environmental geochemistry. May incorporate use of analytical equipment such as the Scanning Electron Microscope and Portable X-Ray Fluorescence Spectroscopy. *Prerequisites:* Geology 110 or 120 or 125, and Chemistry 126 or 140, or consent of instructor.

#### **470 Senior Seminar**

**Fall**

**Pogue**

**1 credit**

Seminar on various topics in the earth sciences. Topics to be chosen by the instructors, but are likely to include discussions of the history of geology, controversial principles of geology (such as uniformitarianism), and the ethics of the profession of geology. Students are expected to complete assigned readings and make an oral presentation. Required of all senior geology majors and combined majors.

#### **480 Field Mapping**

**Not offered 2019-20**

**1-4 credits**

An advanced course in geological field methods. In a typical course students make maps in stratified and crystalline terranes, with rocks in varying degrees of deformation. Maximum of nine credits. *Prerequisites:* Geology 227, 420, and consent of department. *Note:* Geology 480 is not regularly offered by Whitman College. Students wishing to complete major requirements with a field experience should plan to complete an approved summer field course offered by another collegiate institution. *Fee:* variable depending on location, scholarships available.

#### **490 Senior Research**

**Fall, Spring**

**Staff**

**1-3 credits**

A project involving field and laboratory research in the geological sciences. Written and oral reports are required during the senior year. Maximum of six credits. *Prerequisite:* consent of instructor.

**498 Honors Thesis**

**Fall, Spring**

**Staff**

**2-3 credits**

Designed to further independent research or projects leading to the preparation of an undergraduate thesis. Required of and limited to senior honors candidates in geology. *Prerequisite:* admission to honors candidacy.