Geoscientists

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Significant Points

- Work at remote field sites is common.
- Federal, State, and local governments employ 18 percent of all geoscientists.
- Employers prefer applicants with a master's degree for most positions; a Ph.D. degree is required for most high-level research and college teaching positions.
- Excellent job opportunities are expected for graduates with a master's degree.

Nature of the Work

Geoscientists study the composition, structure, and other physical aspects of the Earth. They study the Earth's geologic past and present by using sophisticated instruments to analyze the composition of earth, rock, and water. Many geoscientists help to search for natural resources such as groundwater, metals, and petroleum. Others work closely with environmental and other scientists to preserve and clean up the environment.

Geoscientists usually study and work in one of several closely related fields of geoscience. *Geologists* study the composition, processes, and history of the Earth. They try to find out how rocks were formed and what has happened to them since their formation. They also study the evolution of life by analyzing plant and animal fossils. *Geophysicists* use the principles of physics, mathematics, and chemistry to study not only the Earth's surface, but also its internal composition, ground and surface waters, atmosphere, oceans, and magnetic, electrical, and gravitational forces.

Within these two major disciplines of geology and geophysics are numerous subspecialties. For example, *petroleum geologists* map the subsurface of the ocean or land as they explore the terrain for oil and gas deposits. They use sophisticated instrumentation and computers to interpret geological information. *Engineering geologists* apply geologic principles to the fields of civil and environmental engineering, offering advice on major construction projects and assisting in environmental remediation and natural hazard-reduction projects. *Mineralogists* analyze and classify minerals and precious stones according to their composition and structure. They study the environment surrounding rocks in order to find new mineral resources. *Sedimentologists* study the nature, origin, distribution, and alteration of sediments, such as sand, silt, and mud. These sediments may contain oil, gas, coal, and many other mineral deposits. *Paleontologists* study fossils found in geological formations to trace the evolution of plant and animal life and the geologic history of the Earth. *Stratigraphers* examine the formation and layering of rocks to understand the environment which formed them. *Volcanologists* investigate volcanoes and volcanic phenomena to try to predict the potential for future eruptions and hazards to human health and welfare. *Glacial geologists* study the physical properties and movement of glaciers and ice sheets. *Geochemists* study the nature and distribution of chemical elements in groundwater and earth materials.

Geophysicists specialize in areas such as geodesy, seismology, and magnetic geophysics. *Geodesists* study the Earth's size, shape, gravitational field, tides, polar motion, and rotation. *Seismologists* interpret data from seismographs and other geophysical instruments to detect earthquakes and locate earthquake-related faults. *Geomagnetists* measure the Earth's magnetic field and use measurements taken over the past few centuries to devise theoretical models that explain the Earth's origin. *Paleomagnetists* interpret fossil magnetization in rocks and sediments from the continents and oceans to record the spreading of the sea floor, the wandering of the continents, and the many reversals of polarity that the Earth's magnetic field has undergone through time. Other geophysicists study atmospheric sciences and space physics. (See the statement on atmospheric scientists, and physicists and astronomers, elsewhere in the *Handbook*.)

Oceanographers use their knowledge of geology and geophysics, in addition to biology and chemistry, to study the world's oceans and coastal waters. They study the motion and circulation of the ocean waters; the physical and chemical properties of the oceans; and how these properties affect coastal areas, climate, and weather. Oceanographers are further broken down according to their areas of expertise. For example, *physical oceanographers* study the tides, waves, currents, temperatures, density, and salinity of the ocean. They examine the interaction of various forms of energy, such as light, radar, sound, heat, and wind, with the sea, in addition to investigating the relationship between the sea, weather, and climate. *Chemical oceanographers* study the distribution of chemical compounds and chemical interactions that occur in the ocean and on the sea floor. They may investigate how pollution affects the chemistry of the ocean. *Geological and geophysical oceanographers* study the topographic features and the physical makeup of the ocean floor. Their knowledge can help companies find oil and gas off coastal waters. (*Biological oceanographers*, often called marine biologists, study the distribution and migration patterns of the many diverse forms of sea life in the ocean; the statement on biological scientists discusses this occupation elsewhere in the *Handbook*.)

Geoscientists in research positions with the Federal Government or in colleges and universities frequently are required to design programs and write grant proposals in order to fund their research. Geoscientists in consulting jobs face similar pressures to market their skills and write proposals so that they will have steady work.

Work environment. Geoscientists can spend a large part of their time in the field, identifying and examining rocks, studying information collected by remote sensing instruments in satellites, conducting geological surveys, constructing field maps, and using instruments to measure the Earth's gravity and magnetic field. They often perform seismic studies, for example, which involve bouncing energy waves off buried layers of rock, to search for oil and gas or to understand the structure of the subsurface layers. Similarly, they use seismic signals generated by an earthquake to determine the earthquake's location and intensity. In laboratories, geologists and geophysicists examine the chemical and physical properties of specimens. They study fossil remains of animal and plant life or experiment with the flow of water and oil through rocks.

Some geoscientists spend the majority of their time in an office, but many others divide their time between fieldwork and office or laboratory work. Work at remote field sites is common. Many geoscientists, such as volcanologists, often take field trips that involve physical activity. Geoscientists in the field may work in warm or cold climates and in all kinds of weather. In their research, they may dig or chip with a hammer, scoop with a net, and carry equipment in a backpack. Oceanographers may spend considerable time at sea on academic research ships. Geologists frequently travel to remote field

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sites by helicopter or 4-wheel-drive vehicles and cover large areas on foot. Many exploration geologists and geophysicists work in foreign countries, sometimes in remote areas and under difficult conditions. Travel often is required to meet with prospective clients or investors. Fieldwork often requires working long hours.

Training, Other Qualifications, and Advancement

A master's degree is the primary educational requirement for most entry-level positions. A Ph.D. is necessary for most high-level research and college teaching positions, but a master's degree is preferred for most other geoscience jobs.

Education and training. A bachelor's degree is adequate for a few entry-level positions, but most geoscientists need a master's degree in geology or earth science. A master's degree is the preferred educational requirement for most entry-level research positions in private industry, Federal agencies, and State geological surveys. A Ph.D. is necessary for most high-level research and college teaching positions, but it may not be preferred for other jobs.

Many colleges and universities offer a bachelor's or higher degree in a geoscience. Traditional geoscience courses emphasizing classical geologic methods and topics (such as mineralogy, petrology, paleontology, stratigraphy, and structural geology) are important for all geoscientists. People who study physics, chemistry, biology, mathematics, engineering, or computer science may also qualify for some geoscience positions if their course work includes geology.

Licensure. A number of States require geoscientists who offer their services directly to the public, particularly geologists, to obtain a license from a State licensing board. Licensing requirements vary but often include education, experience, and a passing score on an examination.

Other qualifications. Computer skills are essential for prospective geoscientists; students who have experience with computer modeling, data analysis and integration, digital mapping, remote sensing, and Geographic Information Systems (GIS) will be the most prepared entering the job market. Knowledge of the Global Positioning System (GPS)—a locator system that uses satellites—has also become essential. Some employers seek applicants with field experience, so a summer internship is often helpful.

Geoscientists must have good interpersonal skills because they usually work as part of a team with other geoscientists and with environmental scientists, engineers, and technicians. Strong oral and written communication skills also are important because writing technical reports and research proposals and explaining research results in person are important aspects of the work. Because many jobs require foreign travel, knowledge of a second language is becoming increasingly beneficial.

Geoscientists must be inquisitive, able to think logically, and capable of complex analytical thinking, including spatial visualization and the ability to infer conclusions from sparse data. Those involved in fieldwork must have physical stamina.

Advancement. Geoscientists often begin their careers in field exploration or as research assistants or technicians in laboratories or offices. As they gain experience, they get more assignments that are difficult. Eventually, some are promoted to project leader, program manager, or to a senior research position. Those who choose to work in management will spend more time scheduling, budgeting, and reporting to top executives or clients. (See the statement on engineering and natural sciences managers elsewhere in the *Handbook*.)

Employment

Geoscientists held about 31,000 jobs in 2006. Many more individuals held geoscience faculty positions in colleges and universities, but they are classified as college and university faculty. (See the statement on teachers—postsecondary elsewhere in the *Handbook*.)

About 24 percent of geoscientists were employed in architectural, engineering, and related services, and 18 percent worked for oil and gas extraction companies. In 2006, State agencies such as State geological surveys and State departments of conservation employed about 2,900 geoscientists. Another 2,600 worked for the Federal Government, including geologists, geophysicists, and oceanographers, mostly within the U.S. Department of the Interior for the U.S. Geological Survey (USGS) and within the U.S. Department of Defense. About 2 percent of geoscientists were self-employed, most as consultants to industry or government.

Job Outlook

Although employment growth will vary by industry, overall employment of geoscientists is expected to grow much faster than the average for all occupations. Graduates with a master's degree can expect excellent job opportunities; very few geoscientist jobs are available to bachelor's degree holders. Ph.D.s should face competition for basic research and college teaching jobs.

Employment change. Employment growth of 22 percent for geoscientists is expected between 2006 and 2016, much faster than

the average for all occupations. The need for energy, environmental protection, and responsible land and water management will spur employment demand. Employment in management, scientific, and technical consulting services should continue to grow as more geoscientists work as consultants. These services have increased their hiring of geoscientists in recent years because of increased government contracting, and private corporations' need for technical assistance and environmental management plans. Moreover, many geoscientists monitor the quality of the environment, including aquatic ecosystems, deteriorating coastal environments, and rising sea levels—all of which will create employment growth for them. An expected increase in highway building and other infrastructure projects will also be a source of jobs for engineering geologists.

Employment is also expected to increase in the oil and gas extraction industry. Many geoscientists work in the exploration and production of oil and gas. Historically, employment of petroleum geologists, geophysicists, and some other geoscientists has been cyclical and affected considerably by the price of oil and gas. When prices are low, oil and gas producers curtail exploration activities and lay off geologists. When prices were higher, companies had the funds and incentive to renew exploration efforts and to hire geoscientists in larger numbers. In recent years, however, a growing worldwide demand for oil and gas and for new exploration and recovery techniques—particularly in deep water and previously inaccessible sites in Alaska and the Gulf of Mexico—has created some stability to the petroleum industry. Geoscientists who speak a foreign language and who are willing to work abroad should enjoy the best opportunities, as the need for energy, construction materials, and a broad range of geoscience expertise grows in developing nations.

Job prospects. Graduates with a master's degree should have excellent opportunities, especially in the management, scientific and technical consulting industry and in the engineering services industries. In addition to demand resulting from job growth, replacing those who leave the occupation for retirement, managerial positions, or other careers will generate a number of jobs. With relatively few students earning master's degrees in the geosciences, job openings may exceed the number of qualified job seekers over the 2006-16 projection decade. However, geoscientists with doctoral degrees, who primarily work as college and university faculty or do basic research, may face competition. There are few openings for new graduates with only a bachelor's degree in geoscience, but these graduates may have favorable opportunities in related occupations, such as high school science teacher or science technician.

There will be fewer opportunities for geoscientists in Federal and State government, mostly because of budget constraints at key agencies, such as the USGS, and the trend among governments toward contracting out to consulting firms instead of hiring new government employees. However, departures of geoscientists who retire or leave the government for other reasons will result in some job openings over the next decade.

Geoscientists may face layoffs during periods of economic recession. Especially vulnerable are those in consulting and, to a lesser extent, workers in Government. Employment for those working in the production of oil and gas, however, will largely be dictated by the cyclical nature of the energy sector and changes in government policy, although less so than in the past.

Earnings

Median annual earnings of geoscientists were $72,660 in May 2006. The middle 50 percent earned between $51,860 and $100,650; the lowest 10 percent earned less than $39,740, the highest 10 percent more than $135,950.

The petroleum, mineral, and mining industries offer higher salaries, but less job security, than other industries because economic downturns sometimes cause layoffs.

According to the National Association of Colleges and Employers, beginning salary offers in July 2007 for graduates with bachelor's degrees in geology and related sciences averaged $40,786 a year.

In 2007, the Federal Government's average salary was $87,392 for geologists, $100,585 for geophysicists, and 93,461 for oceanographers.

Related Occupations

Many geoscientists work in the petroleum and natural gas industry, an industry that also employs numerous other workers whose jobs deal with the scientific and technical aspects of the exploration and extraction of petroleum and natural gas. Among these other workers are engineering technicians; science technicians; petroleum engineers; and surveyors, cartographers, photogrammetrists, and surveying technicians. Also, some physicists and astronomers, chemists and materials scientists, atmospheric scientists, biological scientists, and environmental scientists and hydrologists perform related work both in the exploration and extraction of petroleum and natural gas and in activities having to do with the environment.

Sources of Additional Information

Information on training and career opportunities for geologists is available from either of the following organizations:

➤ American Association of Petroleum Geologists, P.O. Box 979, Tulsa, OK 74101. Internet: **http://www.aapg.org**

➤ American Geological Institute, 4220 King St., Alexandria, VA 22302-1502. Internet: **http://www.agiweb.org**

Information on obtaining a position as a geologist, geophysicist, or oceanographer with the Federal Government is available from the Office of Personnel Management through USAJOBS, the Federal Government's official employment information system. This resource for locating and applying for job opportunities can be accessed through the Internet at **http://www.usajobs.opm.gov** or through an interactive voice response telephone system at (703) 724-1850 or TDD (978) 461-8404. These numbers are not toll free, and charges may result.

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2006	Projected employment, 2016	Change, 2006-2016	
				Number	Percent
Geoscientists, except hydrologists and geographers	19-2042	31,000	38,000	6,800	22

NOTE: Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook*.