Information on obtaining a position as a chemist with the Federal Government is available from the Office of Personnel Management (OPM) through a telephone-based system. Consult your telephone directory under U.S. Government for a local number or call (912) 757-3000; Federal Relay Service: (800) 877-8339. The first number is not tollfree, and charges may result. Information also is available from the OPM Internet site: **http://www.usajobs.opm.gov**.

For general information on materials science, contact:

➤ Materials Research Society (MRS), 506 Keystone Dr., Warrendale, PA 15086-7573. Internet: **http://www.mrs.org**

Environmental Scientists and Geoscientists

(O*NET 19-2041.00, 19-2042.01, 19-2043.00)

Significant Points

- Work at remote field sites is common.
- A bachelor's degree in geology or geophysics is adequate for entry-level jobs; better jobs with good advancement potential usually require at least a master's degree.
- A Ph.D. degree is required for most research positions in colleges and universities and in government.

Nature of the Work

Environmental scientists and geoscientists use their knowledge of the physical makeup and history of the Earth to locate water, mineral, and energy resources; protect the environment; predict 8.e wa[illegible] and possible hazards to human health and welfare.

one of several closely related fields of geoscience, including geology, geophysics, and oceanography. *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 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 its magnetic, electrical, and gravitational forces. *Oceanographers* use their knowledge of geology and geophysics to study the ocean floor and ocean currents and waves.

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 use two- or three-dimensional computer modeling to portray water layers and the flow of water or other fluids through rock cracks and porous materials. They use a variety of sophisticated laboratory instruments, including x ray diffractometers, which determine the crystal structure of minerals, and petrographic microscopes, for the study of rock and sediment samples.

Geoscientists working in mining or the oil and gas industry sometimes process and interpret data produced by remote sensing satellites to help identify potential new mineral, oil, or gas deposits. Seismic technology also is an important exploration tool. Seismic waves are used to develop a three-dimensional picture of underground or underwater rock formations. Seismic reflection technology may also reveal unusual underground features that sometimes indicate accumulations of natural gas or petroleum, facilitating exploration and reducing the risks associated with drilling in previously unexplored areas.

Numerous subdisciplines or specialties fall under the two major disciplines of geology and geophysics that further differentiate the type of work geoscientists do. For example, *petroleum geologists* explore for oil and gas deposits by studying and mapping the subsurface of the ocean or land. They use sophisticated geophysical instrumentation, well log data, 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 composition and structure and study their environment in order to find new mineral resources. *Paleontologists* study fossils found in geological formations to trace the evolution of plant and animal life and the geologic history of the Earth. *Stratigraphers* study the formation and layering of rocks to understand the environment in which they were formed. *Volcanologists* investigate volcanoes and volcanic phenomena to try to predict the potential for future eruptions and possible hazards to human health and welfare.

Geophysicists may specialize in areas such as geodesy, seismology, or magnetic geophysics. *Geodesists* study the size and shape of the Earth, its gravitational field, tides, polar motion, and rotation. *Seismologists* interpret data from seismographs and other geophysical instruments to detect earthquakes and locate earthquake-related faults. *Geochemists* study the nature and distribution of chemical elements in ground water and Earth materials. *Geomagnetists* measure the Earth's magnetic field and use measurements taken over the past few centuries to devise theoretical models to 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 atmospheric scientists and physicists and astronomers elsewhere in the *Handbook*.)

Hydrology is closely related to the disciplines of geology and geophysics. *Hydrologists* study the quantity, distribution, circulation, and physical properties of underground and surface waters. They study the form and intensity of precipitation, its rate of infiltration into the soil, its movement through the Earth, and its return to the ocean and atmosphere. The work they do is particularly important in environmental preservation, remediation, and flood control.

Oceanography also has several subdisciplines. *Physical oceanographers* study the ocean tides, waves, currents, temperatures, density, and salinity. They study 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. Their studies provide the Maritime Fleet with up-to-date oceanic conditions. *Chemical oceanographers* study the distribution of chemical compounds and chemical interactions that occur in the ocean and sea floor. They may investigate how pollution affects the chemistry of the ocean.

Hundreds of colleges and universities offer a bachelor's degree in geology; fewer schools offer programs in geophysics, hydrogeology, or other geosciences. Other programs offering related training for beginning geological scientists include geophysical technology, geophysical engineering, geophysical prospecting, engineering geology, petroleum geology, geohydrology, and geochemistry. In addition, several hundred universities award advanced degrees in geology or geophysics.

Traditional geoscience courses emphasizing classical geologic methods and topics (such as mineralogy, petrology, paleontology, stratigraphy, and structural geology) are important for all geoscientists and make up the majority of college training. Persons studying physics, chemistry, biology, mathematics, engineering, or computer science may also qualify for some environmental science and geoscience positions if their coursework includes study in geology. Those students interested in working in the environmental or regulatory fields, either in environmental consulting firms or for Federal or State governments, should take courses in hydrology, hazardous waste management, environmental legislation, chemistry, fluid mechanics, and geologic logging. An understanding of environmental regulations and government permit issues is also valuable for those planning to work in mining and oil and gas extraction. Hydrologists and environmental scientists should have some knowledge of the potential liabilities associated with some environmental work. Computer skills are essential for prospective environmental scientists and geoscientists; students who have some 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. A knowledge of the Global Positioning System (GPS)—a locator system that uses satellites—also is very helpful. Some employers seek applicants with field experience, so a summer internship may be beneficial to prospective geoscientists.

Environmental scientists and geoscientists must have excellent interpersonal skills, because they usually work as part of a team with other scientists, engineers, and technicians. Strong oral and written communication skills also are important, because writing technical reports and research proposals, as well as communicating research results to others, are important aspects of the work. Because many jobs require foreign travel, knowledge of -0.0consulting firms or

Median annual earnings in the industries employing the largest number of environmental scientists in 2000 were as follows:

Federal Government	$59,590
Engineering and architectural services	43,920
Management and public relations	43,900
Local government	42,880
State government	39,330

According to the National Association of Colleges and Employers, beginning salary offers in 2001 for graduates with bachelor's degrees in geology and the geological sciences averaged about $35,568 a year; graduates with a master's degree averaged $41,100; graduates with a doctoral degree averaged $57,500.

In 2001, the Federal Government's average salary for geologists