Western Oregon University
Earth and Environmental Science Program Outcomes

Career Trends, Salary and Professional Advancement Opportunities for Graduates

Earth and Physical Science Department

Updated Spring 2021

Earth and Environmental Science Program
Western Oregon University

Undergraduate Degrees

B.S. Earth and Environmental Science
B.A. Earth and Environmental Science
B.S. Earth and Environmental Science – Graduate Studies Option

Minors

Geographic Information Science
Environmental Studies

Professors: Jeffrey Myers, Stephen Taylor, Jeffrey Templeton
Assistant professor: David Szpakowski

Mission

The Earth Science program provides a liberal arts education in geoscience with an emphasis on scientific methods, problem solving and interdisciplinary science education. A key objective of the program is to prepare undergraduates for careers as professional geoscientists and educators. The program also promotes the development of an informed citizenry for wise decision-making on issues related to natural resources, environmental quality and sustainability in Oregon and beyond.

Learning Outcomes

1. Demonstrate knowledge of the physical, chemical and biological processes operating in the Earth system.

2. Apply technology-based methods to solve geologic problems and communicate results.

3. Conduct scientific investigations in laboratory and field settings.

Career Outcomes

Completion of the B.S. / B.A. degrees in Earth Science qualifies graduates to begin the process of professional licensure as registered geologists in the state of Oregon. Graduates of the program advance to careers working as professionals for academia, government and industry in the following employment sectors: geotechnical / construction, water resources management, river restoration, forestry, geospatial technology, geographic information systems, water quality, soils management, K-12 education.

EARTH and ENVIRONMENTAL SCIENCE Major: Bachelor of SCIENCE

Prefix Number	Course Name	Credits	MIN	MAX
Lower-Division Core			28	28
BI 101	General Biology: Diversity of Life	4		
CH 104	Chemistry and the Environment	4		
ES 201, 202, 203	Principles of Geology	12		
MTH 111	College Algebra	4		
MTH 243	Intro. Probability and Statistics	4		
Upper-Division Core			25	25
ES 301	Earth Materials	4		
ES 302	Quantitative Methods	3		
ES 321	Structural Geology	4		
ES 322	Geomorphology	4		
ES 340	Geospatial Techniques	4		
ES 491	Stratigraphy and Depositional Systems	4		
ES 497	Senior Seminar	2		
Choose Four UD Earth Science Courses			15	16
ES 331	Introduction to Oceanography	3		
ES 341	Geog. Information Systems I	4		
ES 342	Geog. Information Systems II	4		
ES 343	Remote Sensing	4		
ES 354	Geology of Earthquakes	4		
ES 431	Paleobiology	4		
ES 450	Petrology	4		
ES 453	Geology of the Pacific Northwest	4		
ES 454	Volcanology	4		
ES 486	Petroleum Geology	4		
ES 492	Advanced GIS Applications in Earth Science	4		
ES 493	Sedimentary Geology	4		
Choose Two UD Environmental Science Courses			6	8
BI 370	Humans and the Environment	4		
BI 461	Conservation Biology	4		
ES 324	Living with Earthquakes and Volcanoes	4		
ES 390	Basic Meteorology	3		
ES 420	Medical Geology	4		
ES 460	Energy and Mineral Resources	3		
ES 470	River Environments of Oregon	4		
ES 473	Environmental Geology	4		
ES 476	Hydrology	4		
GEOG 321	Field Geography	4		
GEOG 380	Environmental Conservation	4		
GEOG 390	Global Climate Change	4		
GEOG 393	Soils Geography	4		
GEOG 470	Energy, Environment and Society	4		
	Total credits in degree program		74	77
	Upper Division Credits		46	49

EARTH and ENVIRONMENTAL SCIENCE Major: Bachelor of ARTS

Prefix Number	Course Name	Credits	MIN	MAX
Lower-Division Core			24	24
BI 101	General Biology: Diversity of Life	4		
CH 104	Chemistry and the Environment	4		
ES 100 or 200	Choose THREE: ES 104, 106, 201, 202, 203	12		
MTH 110	Applied College Mathematics	4		
Upper-Division Core			18	18
ES 301	Earth Materials	4		
ES 340	Geospatial Techniques	4		
ES 473	Environmental Geology	4		
ES 491	Stratigraphy and Depositional Systems	4		
ES 497	Senior Seminar	2		
Choose FIVE UD Earth Science Courses			18	20
ES 302	Quantitative Methods	3		
ES 321	Structural Geology	4		
ES 322	Geomorphology	4		
ES 331	Introduction to Oceanography	3		
ES 341	Geog. Information Systems I	4		
ES 342	Geog. Information Systems II	4		
ES 343	Remote Sensing	4		
ES 354	Geology of Earthquakes	4		
ES 431	Paleobiology	4		
ES 450	Petrology	4		
ES 453	Geology of the Pacific Northwest	4		
ES 454	Volcanology	4		
ES 486	Petroleum Geology	4		
ES 492	Advanced GIS Applications in Earth Science	4		
ES 493	Sedimentary Geology	4		
Choose TWO Environmental Science Courses			6	8
BI 370	Humans and the Environment	4		
BI 461	Conservation Biology	4		
ES 324	Living with Earthquakes and Volcanoes	4		
ES 390	Basic Meteorology	3		
ES 420	Medical Geology	4		
ES 460	Energy and Mineral Resources	3		
ES 470	River Environments of Oregon	4		
ES 476	Hydrology	4		
GEOG 321	Field Geography	4		
GEOG 380	Environmental Conservation	4		
GEOG 390	Global Climate Change	4		
GEOG 393	Soils Geography	4		
GEOG 470	Energy, Environment and Society	4		
	Total credits in degree program		66	70
	Upper Division Credits		42	46

EARTH and ENV SCIENCE Major: Pre-Graduate Studies Concentration (B.S.)

Prefix Number	Course Name	min Credits	max Credits
ES 201, 202, 203	Principles of Geology	12	12
CH 221, 222, 223	General Chemistry	15	15
PH 200 sequence	General Physics	12	12
MTH 251	Calculus I	4	4
MTH 252	Calculus I	4	4
ES 301	Earth Materials	4	4
ES 302	Quantitative Methods	3	3
ES 321	Structural Geology	4	4
ES 322	Geomorphology	4	4
ES 340	Geospatial Techniques	4	4
ES 341	Geog. Information Systems I	4	4
ES 342	Geog. Information Systems II	4	4
ES 450	Petrology	4	4
ES 473	Environmental Geology	4	4
ES 491	Stratigraphy and Depositional Systems	4	4
ES 493	Sedimentary Geology	4	4
ES 497	Senior Seminar	2	2
Upper Division Earth Science Electives *(Complete 4 classes from the list below)*		15	16
ES 343	Remote Sensing	4	
ES 354	Geology of Earthquakes	4	
ES 431	Paleobiology	4	
ES 453	Geology of Pacific Northwest	4	
ES 454	Volcanology	4	
ES 460	Energy and Mineral Resources	3	
ES 470	River Environments of Oregon	4	
ES 476	Hydrology	4	
ES 486	Petroleum Geology	4	
ES 492	Advanced GIS Applications in Earth Science	4	

	Total credits in degree program	107	108
	Upper Division Credits	60	61

Geographic Information Science Minor
Professors: Jeffrey Myers, Stephen Taylor, Jeffrey Templeton
Assistant professor: David Szpakowski

Mission
The Earth Science program provides a liberal arts education in geoscience with an emphasis on scientific methods, problem solving and interdisciplinary science education. A key objective of the program is to prepare undergraduates for careers as professional geoscientists and educators. The program also promotes the development of an informed citizenry for wise decision-making on issues related to natural resources, environmental quality and sustainability in Oregon and beyond.

Learning Outcomes
1. Demonstrate knowledge of Geographic Information Science and geospatial technology.
2. Apply geospatial technology to solve real-world problems and communicate results.
3. Conduct scientific investigations in laboratory and field settings as part of baccalaureate degree studies.

Core Courses

• ES 340 Geospatial Techniques	Credits: 4
• ES 341 Geographic Information Systems I	Credits: 4
• ES 342 Geographic Information Systems II	Credits: 4
• ES343 Remote Sensing	Credits: 4
• ES 492 Advanced GIS Applications in Earth Science	Credits: 4

Choose One

• ES 202 Principles of Geology	Credits: 4
• GEOG 105 Nature & Society	Credits: 4
• GEOG 240 Map & Air Photo Interpretation	Credits: 4

Total Credits: 24

Note:
In addition to the minor, the Geographic Information Science curriculum may also be completed as a professional development certificate program.

Environmental Studies Minor

Professors: Bryan Dutton, Mark Henkels, Michael McGlade, Mary Pettenger, Emily Plec, Stephen Taylor, Jeffrey Templeton
Associate professors: Susan Daniel, Mark Van Steeter
Assistant professor: David Szpakowski

Mission
Educate students about the physical, biological and social dimensions of the environment. The program content focuses on specific topics and skills central to understanding environmental issues and promotes pathways to jobs in environmental professions.

Learning Outcomes
1. Explain the interconnectedness of humans and the environment.
2. Apply problem solving skills to real-world environmental issues.
3. Demonstrate knowledge of current environmental issues in a community context.

ENVIRONMENTAL STUDIES MINOR Curriculum

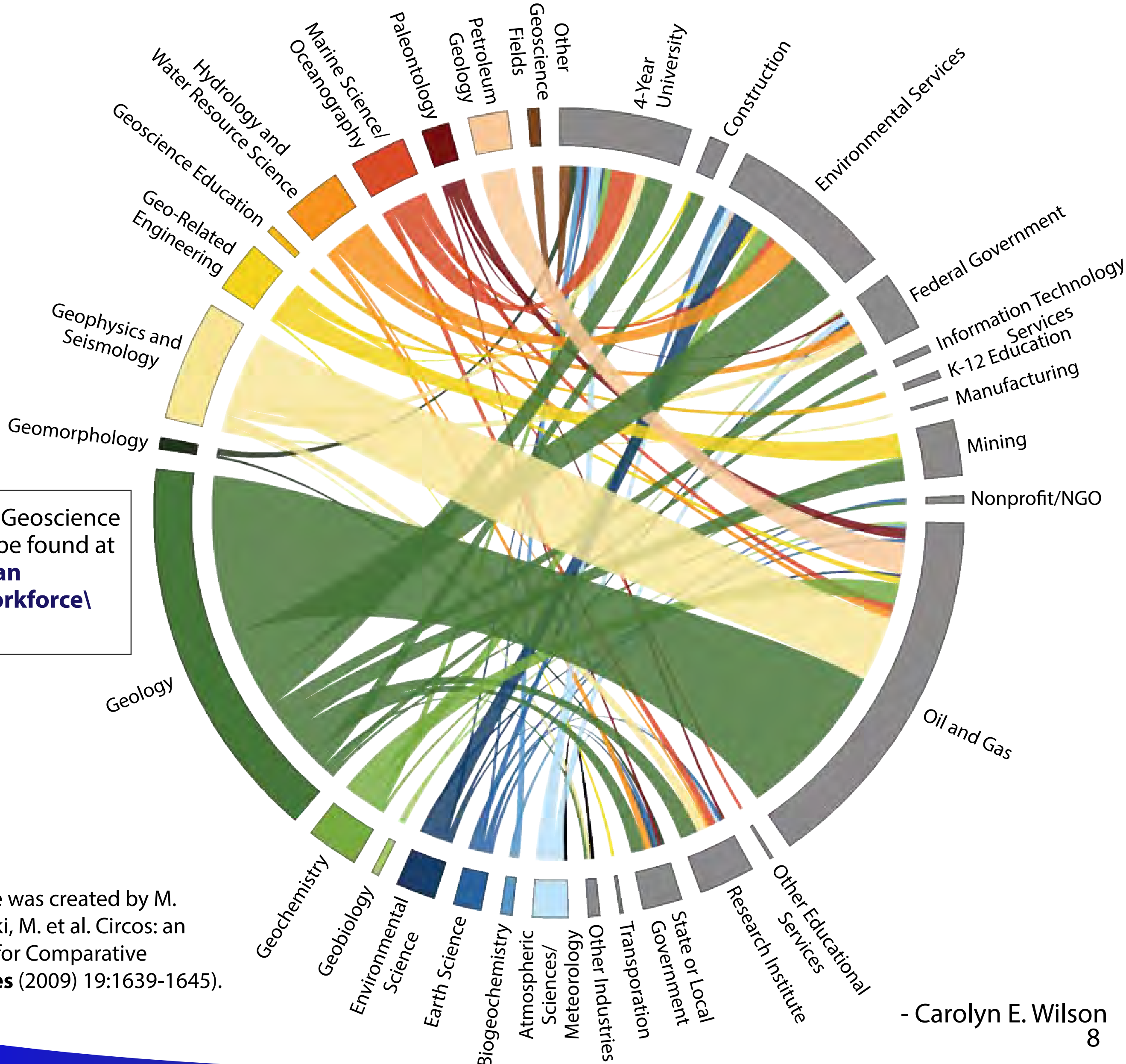
COURSE	CR
Choose 1 Foundational Natural Science Course	**4**
BI 101 General Biology: The Diversity of Life	4
CH 104 Chemistry and the Environment	4
ES 104 Exploring the Physical Earth	4
ES 105 Discoveries in Earth Science	4
ES 106 Exploring the Oceans and Atmosphere	4
ES 201 Principles of Geology I	4
ES 202 Principles of Geology II	4
ES 203 Principles of Geology III	4
Choose 1 Foundational Social Science/Humanities Course	**4**
ANTH 214 Physical Anthropology	4
COM 380 Environmental Communication	4
GEOG 105 Nature & Society	4
GEOG 106 Sustainable World	4
GEOG 240 Map & Air Photo Interpretation	4
PHL 255 Environmental Ethics	4
SOC 225 Social Problems	**4**
Choose 3 Environmental Science Courses	**9 to 12**
ANTH 311 Human Evolution	4
BI 317 Vertebrate Natural History	4
BI 321 Systematic Field Botany	4
BI 370 Humans and the Environment	4
BI 461 Conservation Biology	4

ES 322 Geomorphology and Aerial Photo Interpretation	4
ES 324 Living with Earthquakes and Volcanoes	4
ES 331 Introduction to Oceanography	3
ES 340 Geospatial Techniques	4
ES 341 Geographic Information Systems I	4
ES 354 Geology of Earthquakes	4
ES 390 Basic Meteorology	3
ES 420 Medical Geology	4
ES 431 Paleobiology	4
ES 453 Geology of the Pacific Northwest	4
ES 454 Volcanology	4
ES 460 Energy and Mineral Resources	3
ES 470 River Environments of Oregon	4
ES 473 Environmental Geology	4
ES 476 Hydrology	4
ES 486 Petroleum Geology	4
ES 491 Stratigraphy and Depositional Systems	4
GEOG 321 Field Geography	4
GEOG 385 Quantitative Methods in Geography	4
GEOG 390 Global Climate Change	4
GEOG 391 Biogeography	4
GEOG 392 Physical Geography	4
GEOG 393 Soils Geography	4
Choose 3 Environmental Policy Courses	**11 to 12**
ANTH 396 Environmental Anthropology	4
GEOG 331 Environmental Justice	4
GEOG 380 Environmental Conservation	4
GEOG 425 Urban Planning and Policy	4
GEOG 470 Energy, Environment, and Society	4
GEOG 480 Nature in the American West	4
HST 460 The Black Death	4
HST 489 Environmental History	4
HST 492 Pacific Northwest History	4
HST 496 Empire and Environment	4
PS 447 Environmental Politics and Policy	4
PS 449 Environmental Values and Political Action	4
PS 477 International Environmental Politics	4
SOC 290 World Population and Social Structure	3
SOC 327 Social Research Methods	4
SOC 400 Globalization and Development	4
TOTAL CREDITS	**28-32 CR**

The Industries of Geoscience Graduates' First Jobs by Degree Field

The circular[1] diagram below displays the connection between the degree fields of recent geoscience graduates (in color) to the industries where these geoscientists found their first job after graduation (in gray). The size of the bars along the outer edge of the circle represent the number of recent graduates that pursued a particular degree field and entered a particular industry. Each colored, inner ribbon connects a particular degree field with the various industries where graduates found jobs. The thickness of each ribbon is determined by the number of graduates within each degree field with a job in a particular industry. This visualization shows the variety of industries available to graduates with a geoscience degree, as well as the complexity of the workforce and knowledge needed in the distinct industries.

The data presented here came from the 2013 and 2014 results of AGI's Geoscience Student Exit Survey. Look forward to the Status of Recent Geoscience Graduates 2014, which will detail the survey results for the 2013-2014 academic year, available in September.



The Status of Recent Geoscience Graduates 2013 can be found at **http://www.americangeosciences.org\workforce\reports.**

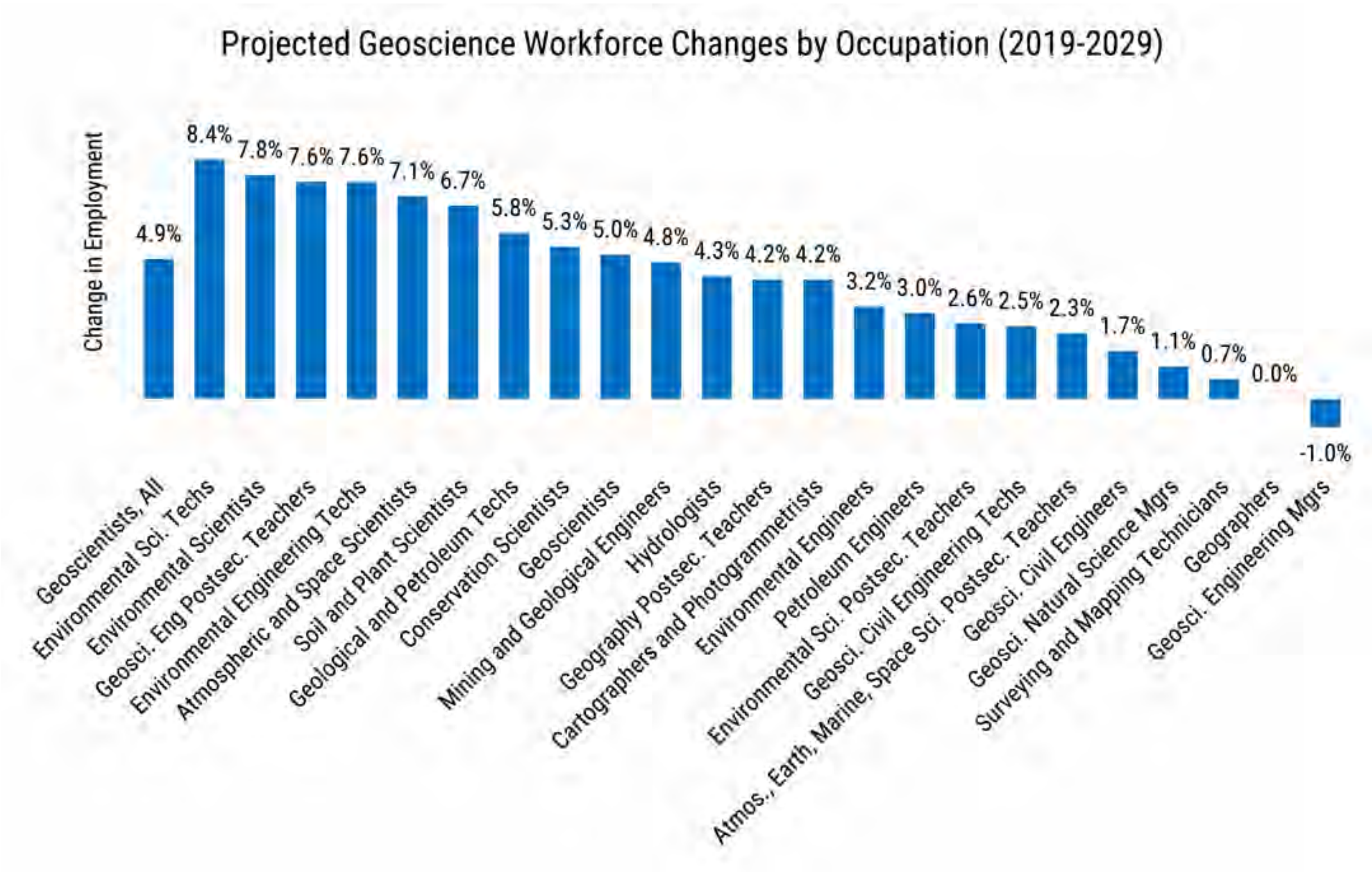
[1] The visualization code was created by M. Krzywinski (Krzywinski, M. et al. Circos: an Information Aesthetic for Comparative Genomics. **Genome Res** (2009) 19:1639-1645).

- Carolyn E. Wilson

Geoscience Workforce Projections 2019-2029

Geoscience workforce expected to grow by 4.9%

Employment projections from the U.S. Bureau of Labor Statistics (BLS) indicate an overall 4.9% increase in geoscience jobs between 2019 and 2029, from 460,242 jobs in 2019 to 482,726 jobs in 2029. For comparison, the projected growth of the U.S. workforce over the same timeframe is expected to be 3.7%. While growth rates for individual geoscience occupations range between 0% and 8.4% for all but geoscience engineering managers (-1%), those occupations projected to gain the greatest number of jobs are environmental scientists (7,100 jobs), environmental science technicians (2,900 jobs), and environmental engineers (1,800 jobs).

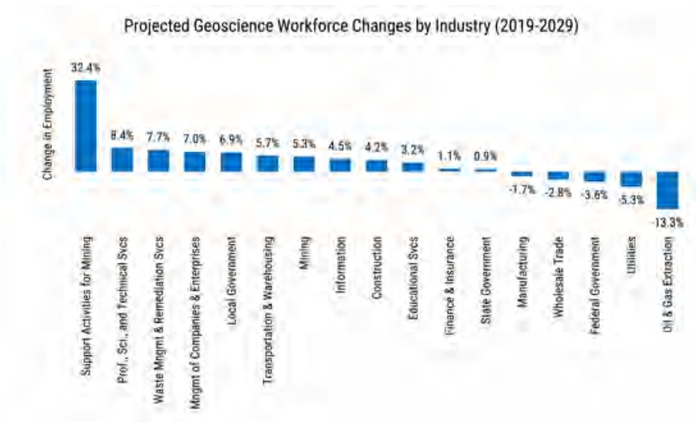


Credit: AGI; data derived from the U.S. Bureau of Labor Statistics, Employment Projections

Written and compiled by Leila Gonzales and Christopher Keane, AGI

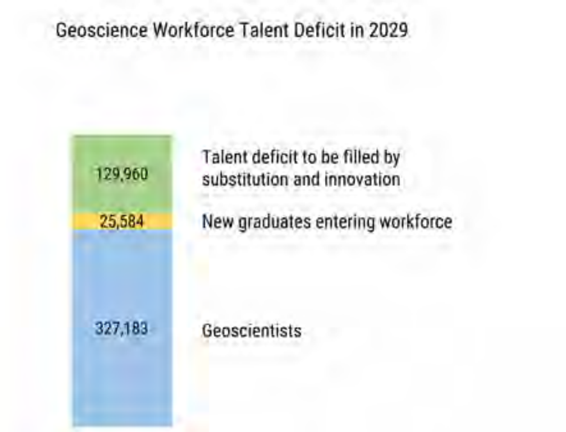
The majority of geoscience job growth over the coming decade will be within the professional, scientific and technical services sector where 39% of geoscientists currently work. This sector is projected to gain just over 16,000 jobs between 2019 and 2029, an 8.4% increase over this period. The support activities for mining sector which includes oil and gas support activities, currently employs approximately 2% of geoscientists and is expected to grow by 32% gaining just over 3,500 jobs.

Of those industries projected to see a decline in total geoscience employment between 2019 and 2029, the oil and gas extraction industry is projected to contract the most with a reduction of just over 2,800 jobs, followed by the federal government which is projected to shed just over 1,000 jobs. The utilities, wholesale trade, and manufacturing sectors are projected to shed a total of 700 jobs by 2029.



Credit: AGI; data derived from the U.S. Bureau of Labor Statistics, Employment Projections

Based on the age demographics of the current geosciences workforce as identified by the BLS, with an average retirement age of 65, then 27% of the existing geoscience workforce will be retiring by 2029. The number of geoscience graduates entering the workforce each year will not be sufficient to fill the gap created by these retirements and the addition of over 22,000 new jobs that are projected to be created in the profession by 2029. As a result, the expected geoscience workforce deficit will be approximately 130,000 full-time equivalent geoscientists by 2029.



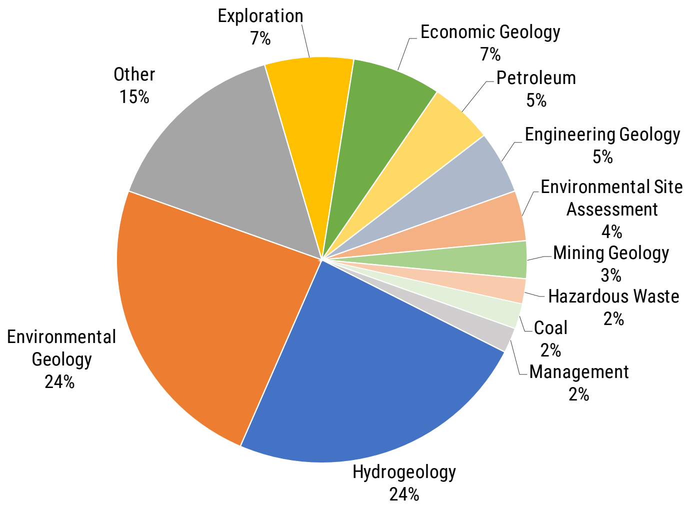
Credit: AGI; data derived from the U.S. Bureau of Labor Statistics, Employment Projections and Current Population Survey, and from AGI's Directory of Geoscience Departments

Full employment in the geosciences is expected to continue over the coming decade and we expect there will be a continued increase in the use of innovative technologies such as artificial intelligence and machine learning to fill the expected talent gap by increasing workplace efficiencies.

How do geologists make a living in 2019?

According to recent American Geosciences Institute (AGI) workforce data, less than 11% of geoscience graduates receiving a BA/BS or MA/MS degree develop a career in academia and/or research. Given this statistic, the question then arises: How are geologists making a living upon graduation in 2019? The majority of graduates are developing careers by applying knowledge as opposed to deriving new knowledge as done in academic and/or research positions.

Areas of expertise for geologists who are members of the American Institute of Professional Geologists

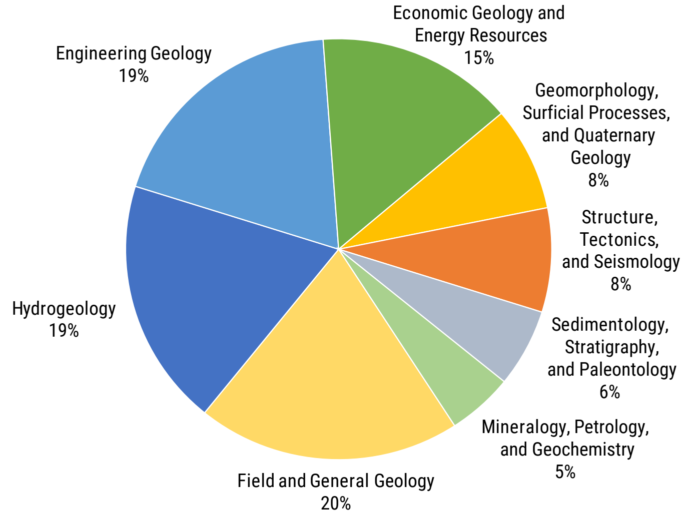


Credit: American Institute of Professional Geologists

Although the most common perception is that geologists look for oil, gas, and coal, the fact is that nearly everything a person touches on a given day, will have required the work of a geologist at some point along the way. Based on workforce surveys conducted by the American Institute of Professional Geologists (AIPG), National Association of State Boards of Geology (ASBOG®), and AGI, geologists are predominantly securing employment in three broad sectors:

- Environmental remediation and management
- Natural resource discovery and utilization
- Engineering and Construction

ASBOG® Task Analysis Survey
Practice of Geology Blueprint - Domain Percentages



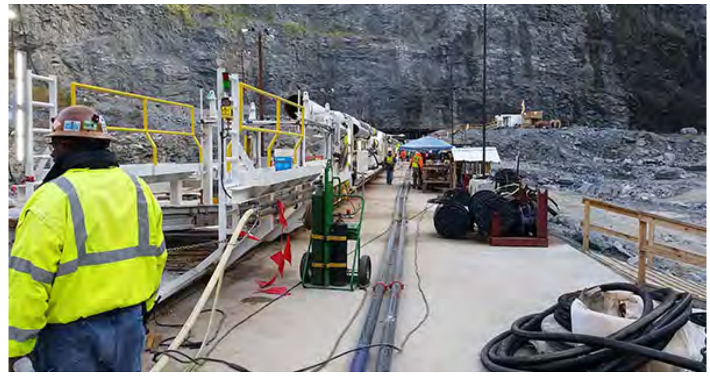
Credit: National Association of State Boards of Geology

Geologists working in environmental remediation and management strive to mitigate human impacts. Geologists in this sector respond to spills and accidents, work to clean up sites where past human activities have created negative impacts, and work with companies, municipalities, and individuals to minimize the impacts of new projects. This work requires that geologists conduct field site assessments, using state-of-the-art technology to identify and understand the distribution of contaminants, determine the sources and pathways along which those chemical species move, and develop a mechanism to remove or otherwise mitigate the impact of those species on the environment.

Geologists working in natural resource discovery and utilization are tasked with finding the raw materials to provide the resources necessary to support modern society. Geologists working in this field use cutting edge technology to locate and define specific resources, and to plan for the extraction of those resources. All metals, building stone, as well as coal, oil, and gas, are located by geologists in this sector. As we transition from hydrocarbons to renewable sources of energy, the types of resources these geologists locate will change, but the work must continue. Every wind turbine, solar panel, and hydroelectric plant requires copper, cobalt, silicon, aggregate, and a vast number of other metals and minerals. As society determines its best way forward, geologists will be there to help find and provide the raw materials that are needed.

Field photograph of the Emerson Barite Mine.
Credit: R. Kath, 2015

Geologists working in engineering and construction work directly with architects and geotechnical/civil engineers to characterize the earth materials upon which new construction projects will be sited. These engineering geologists may also work with geologists in other subdisciplines to help design treatment facilities, retention structures, mine plans, or other structures that are required for geologic projects. Geologists in this field may conduct rock- and soil-strength tests to determine if rocks and other earth materials exhibit the correct properties to be used in the project at hand.



Trailing gear of TBM, Bellwood Quarry, Atlanta, Georgia.
Credit: R. Kath, 2015

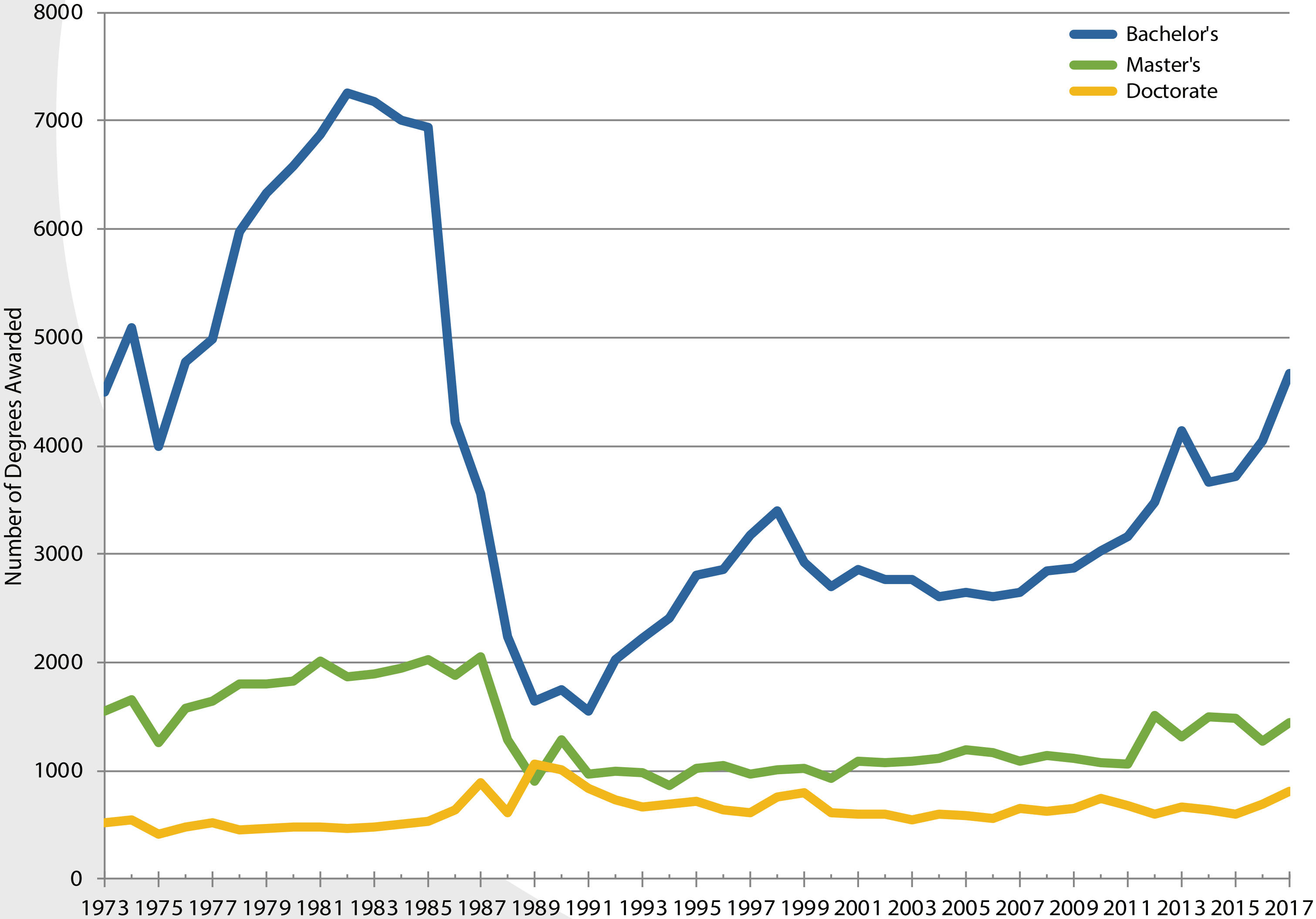
While geologists comprise a small percentage of the global workforce, their work extends support to nearly every aspect of modern society. Since less than 11% of graduating BA/BS and MA/MS students work in academia, it is incumbent upon college and university educators to align academic requirements for undergraduate and graduate degree programs with skills that are needed for professionals to hit the ground running in the largest areas of employment for geologists.

Geologists make use of their special knowledge for the benefit of others. No profession affects the public more than geology. "Civilization exists by geological consent, subject to change without notice"

- William Durant

U.S. Geoscience Degrees Granted Increases Across the Board in 2016-2017

Across all degree levels, the number of degrees awarded in the geosciences in the U.S. increased in the 2016-2017 academic year. The continued increase in bachelor's degrees reflects the rapid increase in geoscience enrollments earlier in the decade. The number of bachelor's degrees awarded increased 15%, master's degrees increased 13%, and doctorates increased by almost 18%. At the graduate level, the accelerated throughput likely reflects the overall growth of enrollments at the bachelor's level propagating through the system. It may also reflect students who continued their education when hiring slowed during the most recent downturn in the energy industry.

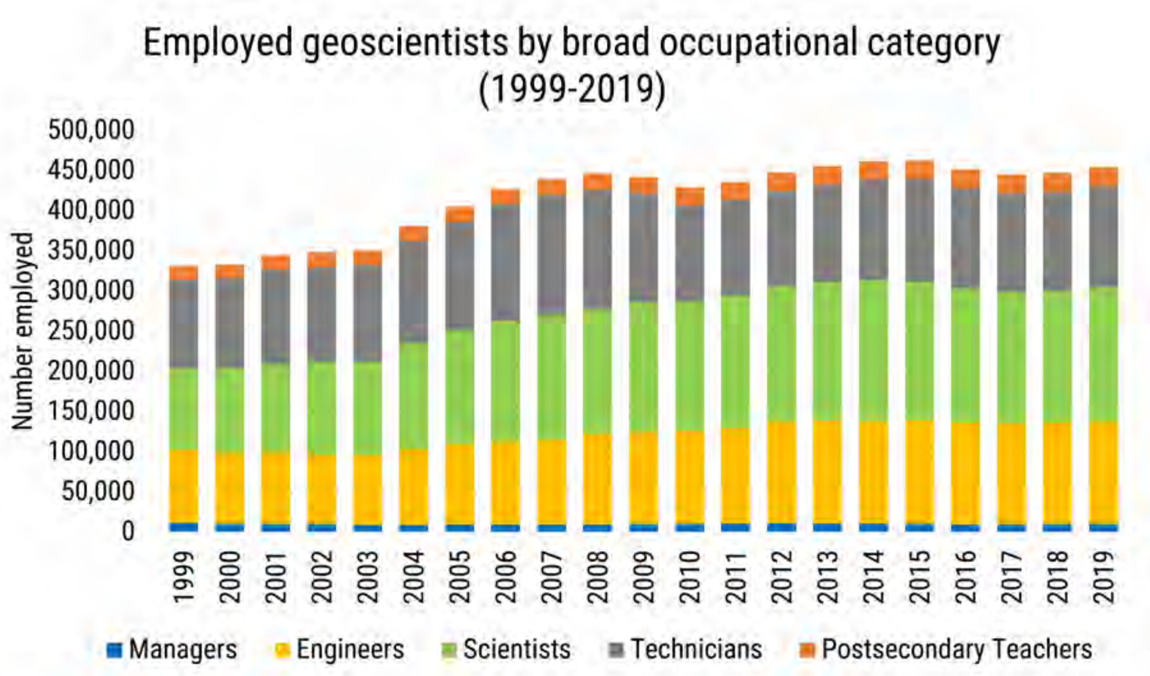


- Christopher Keane

Composition of the Geoscience Workforce (1999-2019)

The U.S. Bureau of Labor Statistics (BLS) uses the Standard Occupational Classification (SOC) system to categorize occupations at the federal level. We use BLS datasets to estimate employment projections, salaries, and the industries where geoscientists work, and we periodically re-assess the SOC categories used by the BLS to ensure we have a complete list of occupational categories that are representative of the geoscience workforce. Updates to the SOC occur roughly about every decade, and these updates can result in re-classification of occupations, including merging and disaggregation of existing occupational categories, as well as inclusion of new occupational categories. With the release of the new Employment Projections data this September, BLS began using the newest set of SOC categories from the recently released 2018 SOC. Currently there are 23 occupational categories that fall within the purview of the geoscience workforce, and these occupations fall into five broad categories: *managers*, *engineers*, *scientists*, *technicians*, and *postsecondary teachers*.

This year, in addition to re-assessing the list of SOC categories, we also examined changes to the proportion of broad occupational categories within the geoscience workforce to see how the composition of the profession has changed over the past 20 years. Most of the changes in the composition of the geoscience workforce has been in the proportion of *scientists* and *technicians*. The percentage of *scientists* increased from 31% to 37% between 1999 and 2019 while the percentage of *technicians* declined from 33% to 28%. Meanwhile, the percentage of *engineers* fluctuated between 24% and 28% over the same period, while the proportion of *managers* and *postsecondary teachers* remained relatively steady.



Credit: AGI; data derived from the U.S. Bureau of Labor Statistics, Occupational Employment Statistics

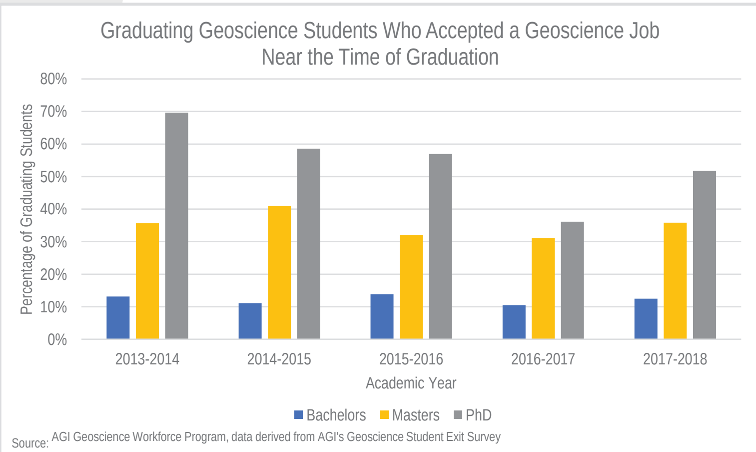
Written and compiled by Leila Gonzales and Christopher Keane, AGI

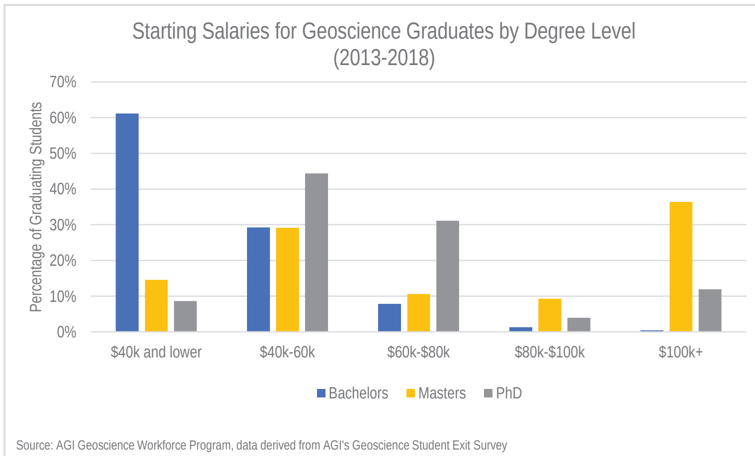
american geosciences institute
connecting earth, science, and people
April 16, 2019

GEOSCIENCE CURRENTS
No. 138

Starting Salaries for Graduating Geoscience Students (2013-2018)

Between 2013 and 2018 the percentage of graduating students accepting a job within the geosciences fluctuated with changes in the job market and the employment-seeking trends of graduating students. During the 2016-2017 academic year, the percentage of students at all degree levels securing employment in the geosciences near the time of graduation hit its lowest point with 10% of bachelor's graduates, 31% of master's graduates, and 36% of doctoral graduates securing geoscience positions near the time of graduation. Much of this can be traced to slower hiring within the energy and environmental and engineering services sectors where a large percentage of master's and bachelor's graduates typically find jobs. For doctoral graduates, there was a decline in the percentage of graduates securing employment within the academic sector, which is a primary employer of geoscience doctorate recipients. In the 2017-2018 academic year, however, hiring rebounded as 13% of bachelor's graduates, 36% of master's graduates, and 52% of doctoral graduates secured geoscience positions near the time of graduation.





Where graduating students secure employment directly impacts starting salary trends. Between 2013 and 2018, 61% of geoscience bachelor's graduates who secured jobs within the geoscience profession near the time of graduation reported starting salaries of $40,000 or less. These graduates predominantly accepted positions within the academic sector, environmental and engineering services, federal government, and energy sector. Twenty-nine percent of geoscience bachelor's graduates reported salaries between $40,000 and $60,000, and most of these graduates accepted jobs within the and engineering services and energy sectors. Ten percent of geoscience bachelor's graduates reported salaries of $60,000 or more, and they predominantly accepted jobs within the energy sector.

Between 2013 and 2018, 15% of master's graduates reported starting salaries of $40,000 or less, reflecting employment in the academic, environmental and engineering services, state and local government, and energy sectors. Starting salaries between $40,000 and $60,000 are primarily driven by employment in the environmental and engineering services, and to a lesser extent within the federal government and energy sectors. Starting salaries between $60,000 and $80,000 are primarily driven by employment in the energy and resource sector, and salaries above $80,000 reflect employment in the energy sector.

Geoscience doctoral graduates starting salary trends are reflective of employment within the academic sector, with 75% of doctoral graduates reporting starting salaries between $40,000 and $80,000. Similar to master's graduates, starting salaries above $80,000 for doctoral graduates reflect employment in the energy and resource sectors.

Read more in the 2018 Status of the Geosciences Report available at:
https://store.americangeosciences.org/status-of-the-geoscience-workforce-report-2018-digital-edition.html

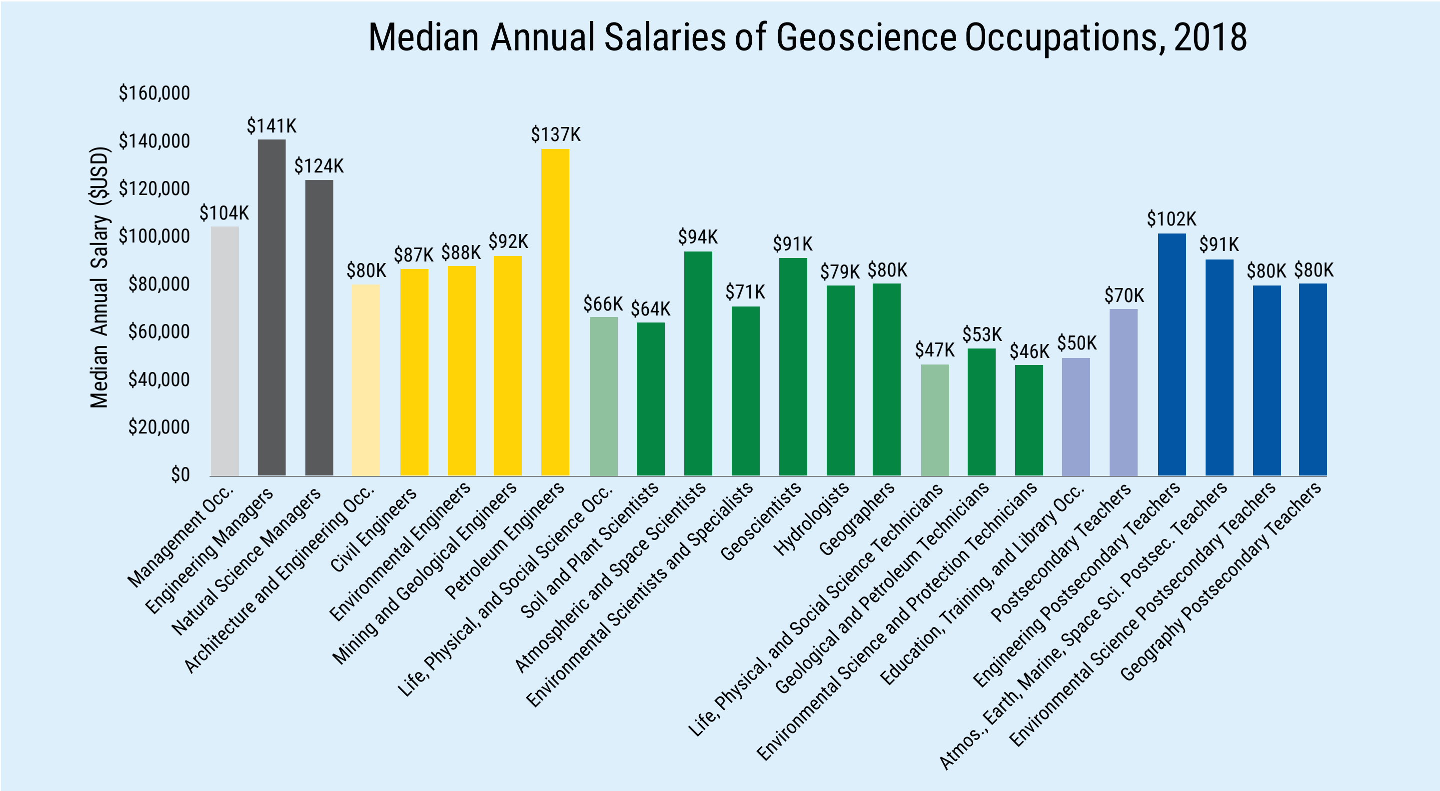
- Leila Gonzales

2018 Median Salaries for Geoscience-related Occupations

Salaries increase by 2% between 2017 and 2018

As a whole, geoscience-related median salaries increased by 2% between 2017 and 2018, on par with other major science and engineering occupational categories. The geoscience occupations with the largest increases between 2017 and 2018 include Environmental Science Postsecondary Teachers (5%), Natural Science Managers (4%), Petroleum Engineers (4%), Geographers (4%), and Atmospheric, Earth, Marine, and Space Science Postsecondary Teachers (4%). Geoscience occupations that had decreases in median salaries include Mining and Geological Engineers (-2%), Geological and Petroleum Technicians (-2%), and Hydrologists (-1%).

The majority of geoscience-related occupations have higher median salaries than salaries for related broad occupational categories (highlighted in lighter shades in the chart below), reinforcing that geoscience careers continue to be lucrative career paths within the U.S. The two geoscience-related careers that do not have salaries higher than related broad occupational categories are soil and plant scientists and environmental science and protection technicians; however, both occupations have similar (-$2K, and -$1K) median salaries to the broader occupational categories.



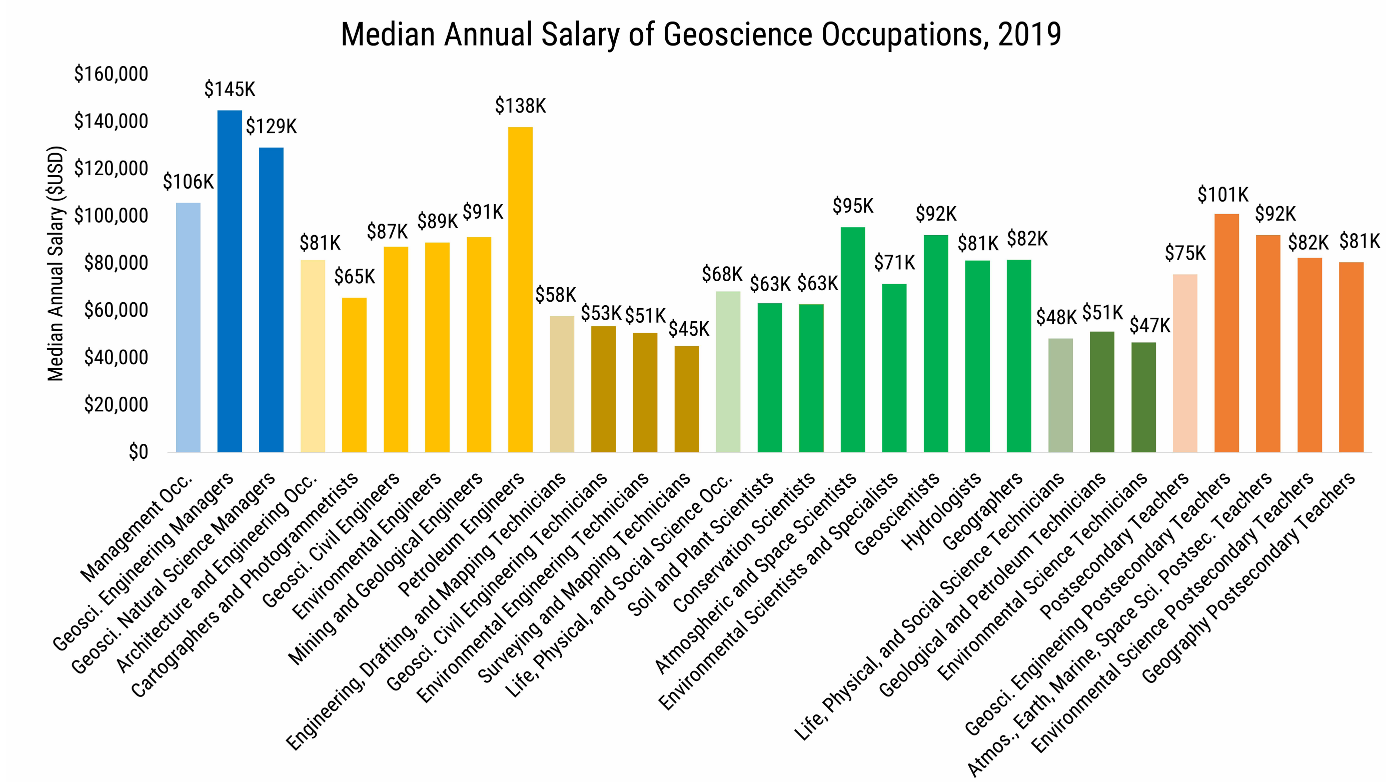
Median Annual Salaries of Geoscience Occupations, 2018
American Geosciences Institute, Workforce Program; Data derived from the U.S. Bureau of Labor Statistics, Occupational Employment Statistics, 2018.

Written and compiled by Leila Gonzales for AGI

2019 Median Annual Salaries of Geoscience-related Occupations

As a whole, geoscience-related median salaries increased by 1% between 2018 and 2019, which is slightly lower than other science and engineering occupations which increased by 3% and 2% respectively. Geoscience-related occupations with the largest salary increases were *engineering and natural science managers* (3% and 4% respectively) and *environmental science post-secondary teachers* (3%). *Geologic and petroleum technicians* had the largest decline in median salaries (-4%) between 2018 and 2019. Changes in median salaries for most geoscience-related occupations were 2% or less.

Although salary increases were relatively flat between 2018 and 2019, median salaries for most geoscience-related occupations outpaced salaries for most other management, science, engineering and post-secondary teaching occupations in 2019. Geoscience-related occupations with lower median salaries than other related occupations included *cartographers and photogrammetrists*, *geoscience engineering technicians*, *environmental science technicians*, *soil and plant scientists* and *conservation scientists*.



Credit: AGI; data derived from the U.S. Bureau of Labor Statistics, Occupational Employment Statistics

Data Brief 2020-022; October 09, 2020

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11 December 2014

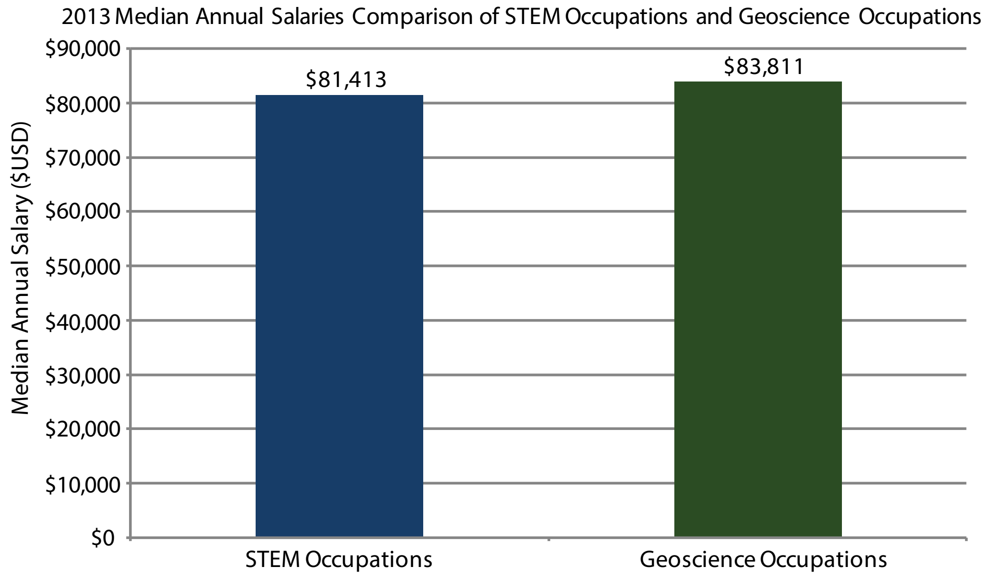
GEOSCIENCE CURRENTS
No. 95

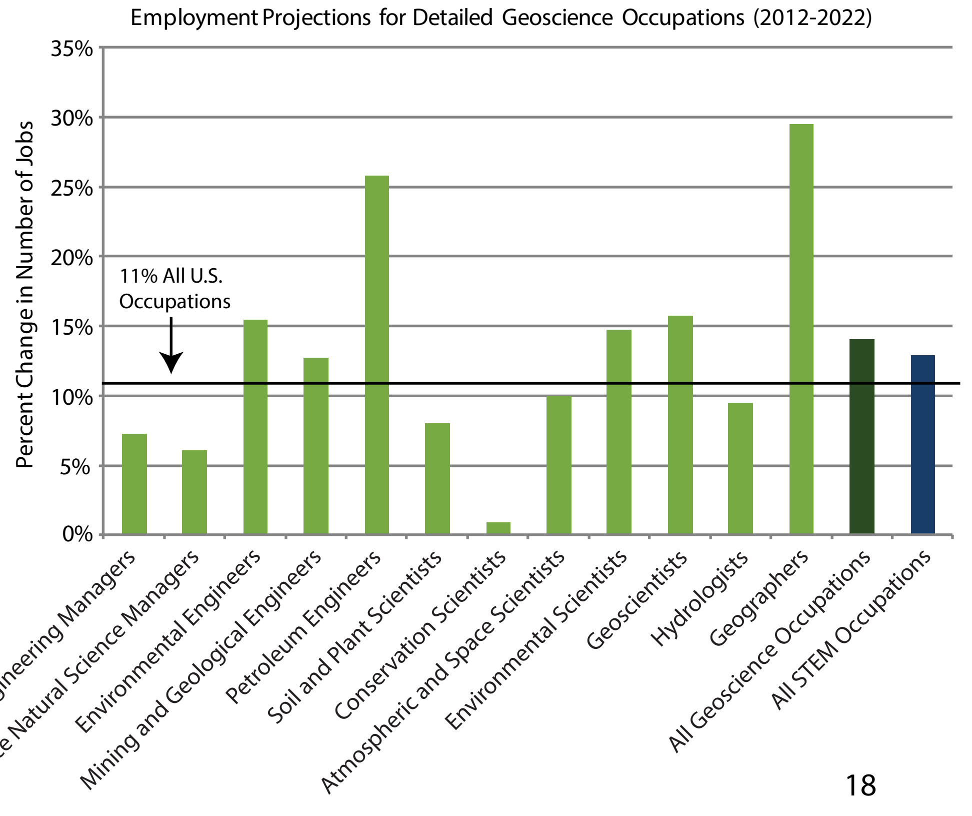
Comparison of STEM and Geoscience Occupation Growth Over the Next Decade

Recent discussions have focused on the current and future job market for science, technology, engineering, and mathematics (STEM) graduates, and AGI has received multiple requests for comparisons between the geoscience workforce and the STEM workforce.

According to the Bureau of Labor Statistics (BLS), there are approximately 300,000 geoscientists and 8.7 million STEM workers employed in the United States with average median salaries of $83,811 and $81,413 respectively. Both annual median salaries are well over the overall annual median salary of $35,080 in the U.S. workforce.

Over the next decade, the BLS projects a 14% increase in geoscience jobs and a 13% increase in STEM jobs. This predicted growth is a bit higher than the overall average growth of 11% for all occupations in the United States. Within the geosciences, environmental scientists and environmental engineers are predicted to have the most workers, increasing to 103,200 and 61,400 jobs respectively, and the occupations with the greatest increase in jobs will be petroleum engineers (26%) and geographers (29%). Within STEM, computer occupations and engineers are predicted to have the most workers, increasing to 4.3 million and 1.7 million jobs respectively, and the occupations with the greatest increase in jobs will be within the mathematical sciences (26%) and computer occupations (18%).





- Carolyn E. Wilson

www.americangeosciences.org/workforce/ workforce@americangeosciences.org

Geologist-In-Training Certification in the United States, 2019

Geologist-In-Training (GIT) certification is formal recognition that a person has passed the ASBOG® Fundamentals of Geology (FG) examination and also met specific education requirements. GIT certification is required in some states and optional in others; and it demonstrates a level of technical competence to potential employers. The GIT certification is one step along the pathway towards professional geologist licensure during the time when the individual is gaining the required amount of work experience under the supervision of a Professional Geologist and preparing for the ASBOG® Practice of Geology (PG) examination.

A person seeking to use a GIT title should refer to their state's licensing board website for references to the state-specific criteria, rules and regulations. Some states issue a GIT number or certificate after the state-specific criteria are met. In other states, the GIT title is approved for use after the state-specific criteria are met, but no GIT number or certificate is given.

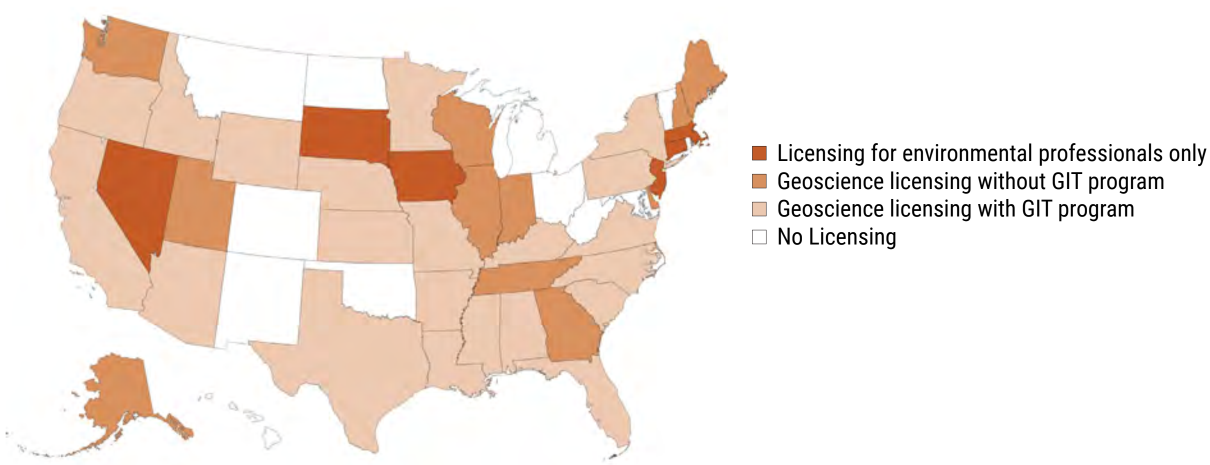
Not all states with a pathway to licensure for professional geologists or geoscientists offer a GIT certificate. For candidates in these states, it is common to see on a work resume "FG examination – passed" accompanied with "eligible for licensure pending additional work experience" if additional professional experience is needed to qualify to take the PG examination. If all education and work experience are met but the PG examination has not been taken, "eligible for licensure" will be stated. Additionally, in states that do not offer a GIT certificate, some geoscientists elect to use GIT as an informal title if the state-specific criteria for higher education and/or work experience requirements have been met and the candidate has passed the FG examination.

Other GIT Facts

Kansas, Nebraska, and New York use the title "Intern Geologist" or "Geologist Intern" as their Geologist-In-Training title equivalent.

Michigan does not offer licensing for Professional Geologists or a GIT program, but the FG is exam is offered by Central Michigan University.

Licensing of Geologists, GIT, and Environmental Professionals



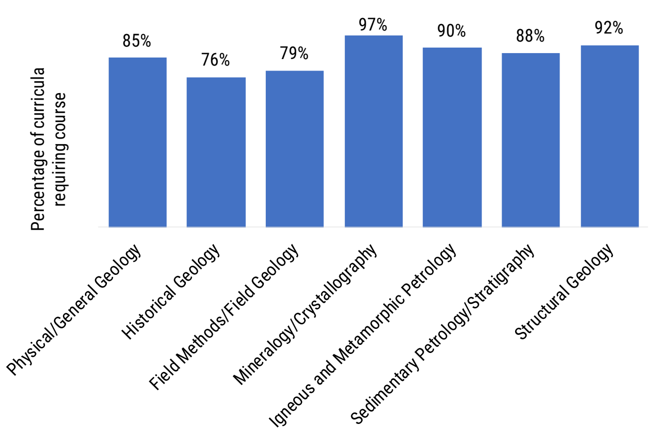
States with licensure programs as of October 2019

State	License Type	Licensing Board Website
Alabama	PG Licensure with GIT Program	www.algeobd.alabama.gov
Alaska	PG licensure without GIT Program	www.commerce.alaska.gov/web/cbpl/ProfessionalLicensing/ProfessionalGeologists.aspx
Arizona	PG Licensure with GIT Program	btr.az.gov
Arkansas	PG Licensure with GIT Program	www.arpgboard.org
California	PG Licensure with GIT Program	www.bpelsg.ca.gov
Connecticut	No PG or GIT Program environmental professional license only	www.ct.gov/deep/lepboard
Delaware	PG licensure without GIT Program	dpr.delaware.gov/boards/geology
Florida	PG Licensure with GIT Program	www.myfloridalicense.com/DBPR/geologists
Georgia	PG licensure without GIT Program	sos.ga.gov/index.php/licensing/plb/26
Idaho	PG Licensure with GIT Program	ibol.idaho.gov/IBOL
Illinois	PG licensure without GIT Program	www.idfpr.com/profs/Geology.asp
Indiana	PG licensure without GIT Program	igws.indiana.edu/LPG
Iowa	No PG or GIT Program environmental professional license only	www.iowadnr.gov/Environmental-Protection/Land-Quality/Underground-Storage-Tanks/Groundwater-Professionals
Kansas	PG Licensure with GIT Program	www.ksbtp.ks.gov/professions/geologists
Kentucky	PG Licensure with GIT Program	bpg.ky.gov/Pages/default.aspx
Louisiana	PG Licensure with GIT Program	www.lbopg.org
Maine	PG licensure without GIT Program	www.maine.gov/pfr/professionallicensing/professions/geologists/index.html
Massachusetts	No PG or GIT Program environmental professional license only	www.mass.gov/orgs/board-of-registration-of-hazardous-waste-site-cleanup-professionals
Michigan	No PG Licensure, FG exam administered by Central Michigan University	www.cmich.edu/colleges/se/earth_atmos/ASBOGExam/Pages/default.aspx
Minnesota	PG Licensure with GIT Program	www.mn.gov/aelslagid/geology.html
Mississippi	PG Licensure with GIT Program	www.msbrpg.ms.gov/Pages/default.aspx
Missouri	PG Licensure with GIT Program	www.pr.mo.gov/geologists.asp
Nebraska	PG Licensure with GIT Program	nebog.nebraska.gov
Nevada	No PG or GIT Program environmental professional license only	ndep.nv.gov/environmental-cleanup/certification/certified-environmental-manager
New Hampshire	PG licensure without GIT Program	www.oplc.nh.gov/geologists
New Jersey	No PG or GIT Program environmental professional license only	www.nj.gov/lsrpboard
New York	PG Licensure with GIT Program	www.op.nysed.gov/prof/geo
North Carolina	PG Licensure with GIT Program	www.ncblg.org
Oregon	PG Licensure with GIT Program	www.oregon.gov/osbge/Pages/default.aspx
Pennsylvania	PG Licensure with GIT Program	www.dos.pa.gov/eng
Puerto Rico	PG Licensure with GIT Program	estado.pr.gov/en/geologists
South Carolina	PG Licensure with GIT Program	www.llr.sc.gov/geo
South Dakota	No PG or GIT Program environmental professional license only	dlr.sd.gov/btp
Tennessee	PG licensure without GIT Program	www.tn.gov/commerce/regboards/geologists.html
Texas	PG Licensure with GIT Program	tbpg.state.tx.us
Utah	PG licensure without GIT Program	dopl.utah.gov/geo
Virginia	PG Licensure with GIT Program	www.dpor.virginia.gov/Boards/SSWPG
Washington	PG licensure without GIT Program	www.dol.wa.gov/business/geologist
Wisconsin	PG licensure without GIT Program	dsps.wi.gov/Pages/BoardsCouncils/GHSS/Default.aspx
Wyoming	PG Licensure with GIT Program	wbpg.wyo.gov

Does your department have a Licensure Qualifying Program?

Traditional geoscience departments commonly require 60 semester hours of geology and geology-related elective courses to achieve a BA/BS degree. Of the 60 hours, typically half are required courses in geology. Recently, the National Association of State Boards of Geology (ASBOG®) evaluated more than 10% of all geoscience curricula (62 universities) and compiled a list of required and elective courses necessary to achieve a BA/BS degree. The universities selected for the survey were based on the number of students that had taken the ASBOG® Fundamentals of Geology examination, which is an indicator that these departments understand of the need for professional licensure for non-academic, practicing geologists.

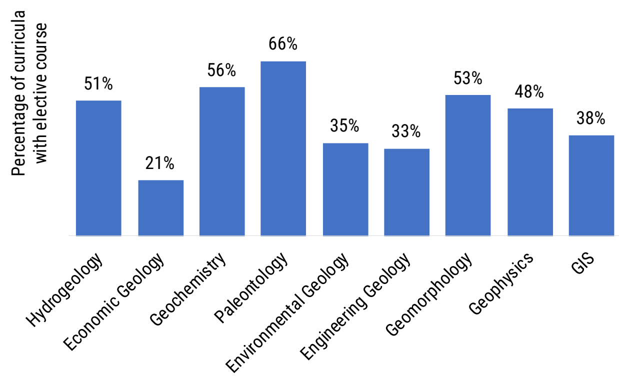
Common Required Courses for Geology Bachelor Degrees



Credit: National Association of State Boards of Geology

Many university geology programs have started to combine and rename courses for a variety of reasons: to provide students more freedom in selection of elective courses, as a result of course compression, and/or to simply add environment or sustainability to the course title to attract more students. For example, some geology programs now offer non-traditional course names such as Earth Materials, Surficial and Near-Surficial Processes, Life and Ecologies of the Past, Environmental Science, Sustainability, Internal Earth Processes, etc. This becomes problematic for graduates who seek licensure, given that these non-traditional course titles are often not considered by the State Licensing Boards to fulfill academic requirements. Furthermore, most State licensing statutes indicate a candidate must have a degree in Geology, Engineering Geology, and Geological Engineering.

Common Elective Courses for Geology Bachelor Degrees



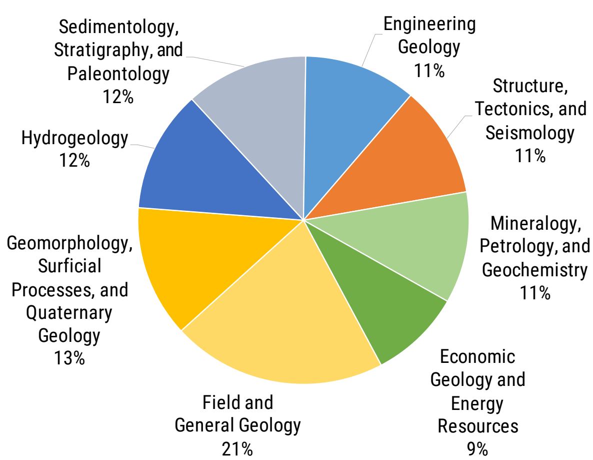
Credit: National Association of State Boards of Geology

With the current diversity in geology courses and degree programs, many students are graduating with degrees in Environmental Geology, Environmental Science, Earth and Atmospheric Science, Earth and Planetary Sciences, and Geosciences to name a few. Are these degrees from a Licensure Qualifying Program? State Licensure Boards report accounts of many disappointed and disgruntled candidates when the young professionals realize they have not received adequate academic training and/or degree in the geosciences to qualify for licensure.

Regardless of course names and evolving degree titles, faculty in geoscience departments are training the future workforce in geoscience-related sectors; consequently, geology departments need to align their curricula with requirements in the workforce so that they can better prepare students to practice geology. Occupational/task surveys, which include practitioners and academicians, are conducted by ASBOG® every 5- to 7-years to define the scope and content of national licensure examinations. Results of the surveys are useful to identify changes in the practice of the profession through time. Given that licensure examinations are based on blueprints developed from these occupational/task survey results, students will most benefit professionally when university faculty align their course content with ASBOG®s blueprint for the Fundamentals of Geology examination. Degree programs that are deemed to be Licensure Qualifying ensure this type of alignment through their course requirements.

Results from the Fundamentals of Geology examination can also be used for curriculum development, curriculum modification, departmental assessment, and accreditation using ASBOG®s Curriculum Performance Assessment Tool (CPAT). The Fundamentals of Geology examination emphasizes knowledge and skills that are typically acquired in an academic setting and lead to a BA/BS degree in geology. From the perspective of a university/college, information from the Fundamentals of Geology examination can be utilized to assess how well the geology faculty are relating an educational background in geology to skill sets needed by students to develop a fruitful career in geology.

ASBOG® Task Analysis Survey
Fundamentals of Geology Blueprint - Domain Percentages



Credit: National Association of State Boards of Geology

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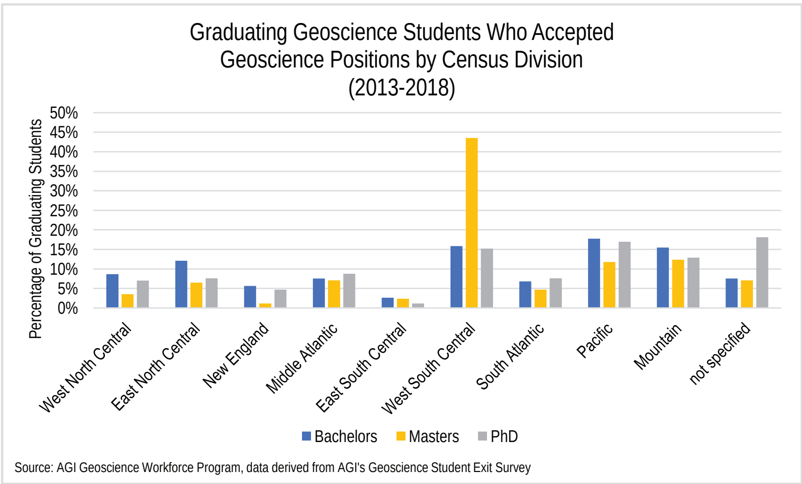
April 29, 2019

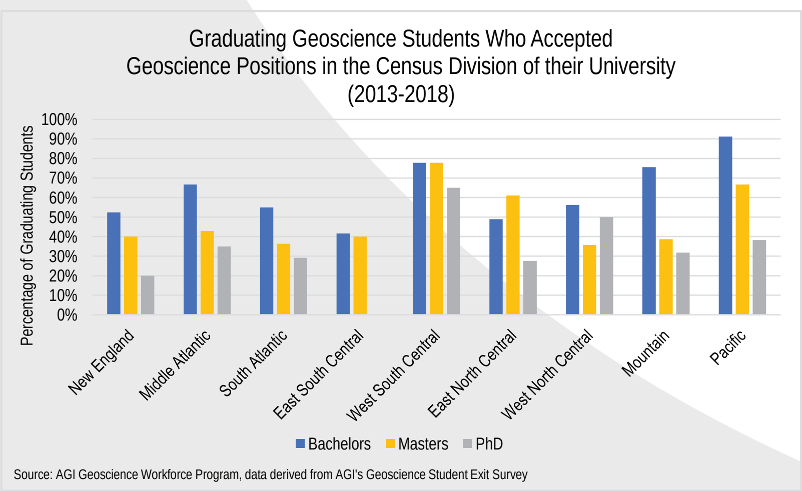
GEOSCIENCE CURRENTS
No. 139

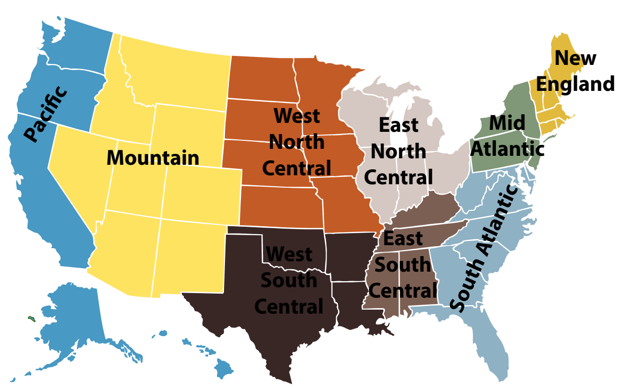
Employment Locations of Graduating Geoscience Students (2013-2018)

While most geoscience graduates who secured geoscience positions near the time of graduation found jobs domestically, 4% of bachelor's graduates, 2% of master's graduates, and 9% of doctoral graduates accepted geoscience positions outside of the United States. Within the United States, graduating students who secured employment near graduation mostly found geoscience positions in the West South Central, Pacific, and Mountain divisions, primarily due to finding employment in Texas, California, and Colorado.



Within the United States, bachelor's graduates were the most likely to accept geoscience positions within the same region as defined by US Census Divisions as the university they attended for all regions except East South Central and East North Central. Master's graduates who secured employment within the geosciences near the time of graduation more frequently accepted positions outside of their university's region, with the exception of those master's graduates attending universities in the West South Central, East North Central, and Pacific regions. There were only two regions where at least half of doctorate graduates accepted geoscience jobs in the same Census division as the university they attended: West South Central and West North Central.





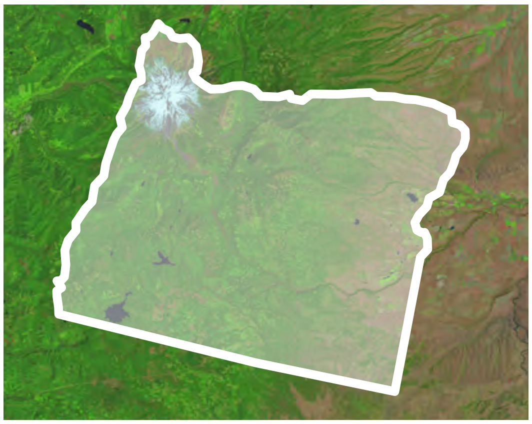
U.S Census Divisions

- Leila Gonzales

Geoscience in Oregon

WHAT IS GEOSCIENCE?

Geoscience is the study of the Earth and the complex geologic, marine, atmospheric, and hydrologic processes that sustain life and the economy. Understanding the Earth's surface and subsurface, its resources, history, and hazards allows us to develop solutions to critical economic, environmental, health, and safety challenges.



Satellite image: NASA/USGS Landsat Program. State outline (not to scale): Matt Battison.

By the numbers: OREGON

- 4,914 geoscience employees (excludes self-employed)[1]
- 1.48 billion gallons/day: total groundwater withdrawal[3]
- $474 million: value of nonfuel mineral production in 2017[4]
- 73 total disaster declarations, including 40 fire, 14 flood, and 13 severe storm disasters (1953-2017)[6]
- $143 million: NSF GEO grants awarded in 2017[14]

WORKFORCE IN OREGON

- 4,914 geoscience employees (excludes self-employed) in 2017[1]
- $78,367: average median geoscience employee salary[1]
- 7 academic geoscience departments[2]

WATER USE IN OREGON

- 1.48 billion gallons/day: total groundwater withdrawal[3]
- 5.10 billion gallons/day: total surface water withdrawal[3]
- 567 million gallons/day: public supply water withdrawal[3]
- 5.16 billion gallons/day: water withdrawal for irrigation[3]
- 105 million gallons/day: industrial fresh water withdrawal[3]
- 84% of the population is served by public water supplies[3]

ENERGY AND MINERALS IN OREGON

- $474 million: value of nonfuel mineral production in 2017[4]
- Stone (crushed), sand and gravel (construction), cement (portland): top three nonfuel minerals in order of value produced in 2017[4]
- 6.51 million megawatt hours: wind produced in 2017[5]
- 36.6 million megawatt hours: hydroelectricity produced in 2017[5]
- 193,000 megawatt hours: geothermal produced in 2017[5]

NATURAL HAZARDS IN OREGON

- 73 total disaster declarations, including 40 fire, 14 flood, and 13 severe storm disasters (1953-2017)[6]
- $6 million: individual assistance grants (2005-2017)[6]
- $105 million: mitigation grants (2005-2017)[6]
- $248 million: preparedness grants (2005-2017)[6]
- $132 million: public assistance grants (2005-2017)[6]
- 27 weather and/or climate events, each with costs exceeding $1 billion (inflation adjusted) (1980-2017)[7]

1 U.S. Bureau of Labor Statistics, Occupational Employment Statistics, May 2017
2 American Geosciences Institute, Directory of Geoscience Departments, 53rd Edition (2018)
3 U.S. Geological Survey, Estimated Use of Water in the United States in 2015
4 U.S. Geological Survey, Mineral Commodity Summaries 2018
5 U.S. Energy Information Administration
6 FEMA Data Vizualization: Summary of Disaster Declarations and Grants (accessed May 2, 2018)
7 NOAA National Centers for Environmental Information, U.S. Billion-Dollar Weather and Climate Disasters from 1980 to 2018 (accessed April 6, 2018)

Geoscience, Oregon, and Federal Agencies

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U.S. GEOLOGICAL SURVEY (USGS)

- $1.15 billion: total USGS budget in FY 2018 (5.8% increase from FY 2017)[8]
- The National Cooperative Geologic Mapping Program funds geologic mapping projects with federal (FEDMAP), state (STATEMAP), and university (EDMAP) partners
- $3.96 million: Oregon STATEMAP funding (1993-2016)[9]
- Oregon State University, Portland State University, and the University of Oregon have participated in EDMAP[9]
- USGS streamgages collect real-time or recent streamflow, groundwater, and water-quality data throughout Oregon

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

- $20.7 billion: total NASA budget in FY 2018 (5.5% increase from FY 2017)[10]
- $1.9 billion: total NASA Earth Science budget in FY 2018 (0% change from FY 2017)[10]
- Gravity Recovery and Climate Experiment (GRACE) satellites measure groundwater changes in Oregon
- Soil Moisture Active Passive (SMAP) satellite measures soil moisture in Oregon

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA)

- $5.9 billion: total NOAA budget in FY 2018 (4.1% increase from FY 2017)[11]
- Next-generation geostationary (GOES) and polar orbiting (JPSS) satellites provide weather forecasting over Oregon
- Deep Space Climate Observatory (DISCOVR) satellite monitors radiation and air quality over Oregon
- 22 National Weather Service Automated Surface Observing Systems (ASOS) stations in Oregon[12]
- 272 National Weather Service Cooperative Observer Program (COOP) sites in Oregon[12]

8 U.S. Department of the Interior, FY 2019 Budet in Brief
9 U.S. Geological Survey, National Cooperative Geologic Mapping Program
10 National Aeronautics and Space Administration, FY 2019 Budget Estimates
11 National Oceanic and Atmospheric Administration, FY 2019 Bluebook
12 NOAA In Your State and Territory

NATIONAL SCIENCE FOUNDATION (NSF)

- $7.8 billion: total NSF budget in FY 2018 (4% increase from FY 2017)[13]
- $1.4 billion: total NSF Geosciences Directorate (GEO) awards in FY 2017 (7.2% increase from FY 2016)[14]
- 78 NSF GEO awards in Oregon totaling $143 million in 2017[14]
- $138 million: NSF GEO grants awarded to Oregon State University in 2017[14]

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

- $8.1 billion: total EPA budget in FY 2018 (0% change from FY 2017)[15]
- 13 active Superfund sites in Oregon in 2018[16]
- $11.7 million: Drinking Water State Revolving Fund (DWSRF) grants in Oregon in 2017[17]
- $400,000: Brownfield cleanup grants awarded to Oregon in 2018[18]

FEDERAL FACILITIES IN OREGON

- USGS Oregon Water Science Center, Portland
- NSF Center for Coastal Margin Observation & Prediction (CMOP), Portland
- USGS Forest and Rangeland Ecosystem Science Center, Corvalis
- DOE National Energy Technology Laboratory, Albany

YOUR STATE SOURCE FOR GEOSCIENCE INFORMATION

Oregon Department of Geology and Mineral Industries
800 NE Oregon Street, Suite 965
Portland, OR 97232-2162
http://www.oregongeology.org/sub/default.htm
971-673-1555

13 U.S. House of Representatives, FY 2018 Omnibus Spending Bill (Division B) – Commerce, Justice, Science, and Related Agencies Appropriations Act, 2018
14 National Science Foundation, Budget Information System
15 U.S. House of Representatives, FY 2018 Omnibus Spending Bill (Division G) – Department of the Interior, Environment, and Related Agencies Appropriations Act, 2018
16 U.S. Environmental Protection Agency, Superfund Sites
17 U.S. Environmental Protection Agency, Drinking Water State Revolving Fund National Information Management System Reports
18 U.S. Environmental Protection Agency, Brownfields Grant Fact Sheet Search

Geoscience in Washington

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Satellite image: NASA/USGS Landsat Program. State outline (not to scale): Matt Battison.

By the numbers: WASHINGTON

- 12,118 geoscience employees (excludes self-employed)[1]
- 1.53 billion gallons/day: total groundwater withdrawal[3]
- $901 million: value of nonfuel mineral production in 2017[4]
- 132 total disaster declarations, including 78 fire, 28 flood, and 16 severe storm disasters (1953-2017)[6]
- $34.4 million: NSF GEO grants awarded in 2017[14]

WORKFORCE IN WASHINGTON

- 12,118 geoscience employees (excludes self-employed) in 2017[1]
- $80,786: average median geoscience employee salary[1]
- 11 academic geoscience departments[2]

ENERGY AND MINERALS IN WASHINGTON

- $901 million: value of nonfuel mineral production in 2017[4]
- Sand and gravel (construction), stone (crushed), gold: top three nonfuel minerals in order of value produced in 2017[4]
- 82.8 million megawatt hours: hydroelectricity produced in 2017[5]
- 7.48 million megawatt hours: wind produced in 2017[5]
- 1.7 million megawatt hours: wood-derived fuels produced in 2017[5]

WATER USE IN WASHINGTON

- 1.53 billion gallons/day: total groundwater withdrawal[3]
- 2.73 billion gallons/day: total surface water withdrawal[3]
- 867 million gallons/day: public supply water withdrawal[3]
- 2.52 billion gallons/day: water withdrawal for irrigation[3]
- 412 million gallons/day: industrial fresh water withdrawal[3]
- 86% of the population is served by public water supplies[3]

NATURAL HAZARDS IN WASHINGTON

- 132 total disaster declarations, including 78 fire, 28 flood, and 16 severe storm disasters (1953-2017)[6]
- $38 million: individual assistance grants (2005-2017)[6]
- $145 million: mitigation grants (2005-2017)[6]
- $571 million: preparedness grants (2005-2017)[6]
- $327 million: public assistance grants (2005-2017)[6]
- 23 weather and/or climate events, each with costs exceeding $1 billion (inflation adjusted) (1980-2017)[7]

1 U.S. Bureau of Labor Statistics, Occupational Employment Statistics, May 2017
2 American Geosciences Institute, Directory of Geoscience Departments, 53rd Edition (2018)
3 U.S. Geological Survey, Estimated Use of Water in the United States in 2015
4 U.S. Geological Survey, Mineral Commodity Summaries 2018
5 U.S. Energy Information Administration
6 FEMA Data Visualization: Summary of Disaster Declarations and Grants (accessed May 2, 2018)
7 NOAA National Centers for Environmental Information, U.S. Billion-Dollar Weather and Climate Disasters from 1980 to 2018 (accessed April 6, 2018)

AGI is a network of 52 member societies, representing more than 260,000 geoscientists.

https://www.americangeosciences.org/policy/factsheet/states | govt@americangeosciences.org

Geoscience, Washington, and Federal Agencies

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U.S. GEOLOGICAL SURVEY (USGS)

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- The National Cooperative Geologic Mapping Program funds geologic mapping projects with federal (FEDMAP), state (STATEMAP), and university (EDMAP) partners
- $4.14 million: Washington STATEMAP funding (1993-2016)[9]
- 4 Washington universities, including University of Washington and Washington State Univserity, have participated in EDMAP[9]
- USGS streamgages collect real-time or recent streamflow, groundwater, and water-quality data for Washington

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

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- 195 National Weather Service Cooperative Observer Program (COOP) sites in Washington[12]

NATIONAL SCIENCE FOUNDATION (NSF)

- $7.8 billion: total NSF budget in FY 2018 (4% increase from FY 2017)[13]
- $1.4 billion: total NSF Geosciences Directorate (GEO) awards in FY 2017 (7.2% increase from FY 2016)[14]
- 111 NSF GEO awards in Washington totaling $34.4 million in 2017[14]
- $29 million: NSF GEO grants awarded to University of Washington in 2017[14]

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

- $8.1 billion: total EPA budget in FY 2018 (0% change from FY 2017)[15]
- 49 active Superfund sites in Washington in 2018[16]
- $18.4 million: Drinking Water State Revolving Fund (DWSRF) grants in Washington in 2017[17]

FEDERAL FACILITIES IN WASHINGTON

- USGS Cascades Volcano Observatory, Vancouver
- NOAA Olympic Coast National Marine Sanctuary, Port Angeles
- NOAA National Marine Fisheries Service, Seattle
- NOAA Pacific Marine Environmental Laboratory, Seattle
- DOE Pacific Northwest National Laboratory, Richland
- DOE Office of River Protection - Hanford Site, Richland

YOUR STATE SOURCE FOR GEOSCIENCE INFORMATION

Washington Geological Survey
1111 Washington St, SE
Olympia, WA 98504
https://www.dnr.wa.gov/geology
360-902-1450

8 U.S. Department of the Interior, FY 2019 Budet in Brief
9 U.S. Geological Survey, National Cooperative Geologic Mapping Program
10 National Aeronautics and Space Administration, FY 2019 Budget Estimates
11 National Oceanic and Atmospheric Administration, FY 2019 Bluebook
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13 U.S. House of Representatives, FY 2018 Omnibus Spending Bill (Division B) – Commerce, Justice, Science, and Related Agencies Appropriations Act, 2018
14 National Science Foundation, Budget Information System
15 U.S. House of Representatives, FY 2018 Omnibus Spending Bill (Division G) – Department of the Interior, Environment, and Related Agencies Appropriations Act, 2018
16 U.S. Environmental Protection Agency, Superfund Sites
17 U.S. Environmental Protection Agency, Drinking Water State Revolving Fund National Information Management System Reports

AGI's Geoscience Policy and Critical Issues programs support well-informed public policy and decision making by providing information and facilitating dialogue between the geoscience community and decision makers at all levels.

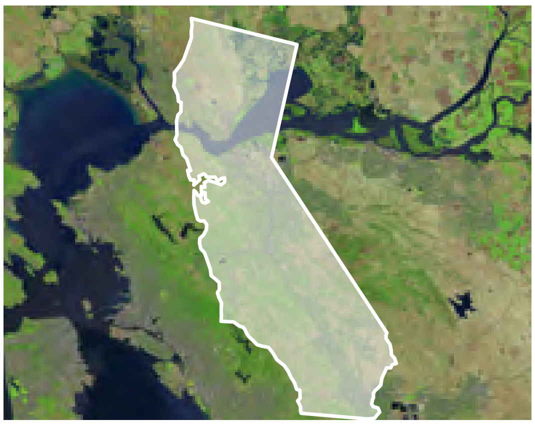
https://www.americangeosciences.org/policy/factsheet/states | govt@americangeosciences.org

Geoscience in California

american geosciences institute
connecting earth, science, and people

WHAT IS GEOSCIENCE?

Geoscience is the study of the Earth and the complex geologic, marine, atmospheric, and hydrologic processes that sustain life and the economy. Understanding the Earth's surface and subsurface, its resources, history, and hazards allows us to develop solutions to critical economic, environmental, health, and safety challenges.



Satellite image: NASA/USGS Landsat Program. State outline (not to scale): Matt Battison.

By the numbers: CALIFORNIA

- 48,528 geoscience employees (excludes self-employed)[1]
- 17.4 billion gallons/day: total groundwater withdrawal[3]
- $3.52 billion: value of nonfuel mineral production in 2017[4]
- 252 total disaster declarations, including 184 fire, 35 flood, and 12 earthquake disasters (1953-2017)[6]
- $190 million: NSF GEO grants awarded in 2017[14]

WORKFORCE IN CALIFORNIA

- 48,528 geoscience employees (excludes self-employed) in 2017[1]
- $90,530: average median geoscience employee salary[1]
- 53 academic geoscience departments[2]

ENERGY AND MINERALS IN CALIFORNIA

- $3.52 billion: value of nonfuel mineral production in 2017[4]
- Sand and gravel (construction), cement (portland), boron minerals: top three nonfuel minerals in order of value produced in 2017[4]
- 202 billion cubic feet: natural gas produced in 2017[5]
- 42.7 million megawatt hours: hydroelectricity produced in 2017[5]
- 23.1 million megawatt hours: solar produced in 2017[5]
- 13.97 million megawatt hours: wind produced in 2017[5]

WATER USE IN CALIFORNIA

- 17.4 billion gallons/day: total groundwater withdrawal[3]
- 11.3 billion gallons/day: total surface water withdrawal[3]
- 5.2 billion gallons/day: public supply water withdrawal[3]
- 19 billion gallons/day: water withdrawal for irrigation[3]
- 399 million gallons/day: self-supplied industrial fresh water withdrawal[3]
- 96% of the population is served by public water supplies[3]

NATURAL HAZARDS IN CALIFORNIA

- 252 total disaster declarations, including 184 fire, 35 flood, and 12 earthquake disasters (1953-2017)[6]
- $84 million: individual assistance grants (2005-2017)[6]
- $614 million: mitigation grants (2005-2017)[6]
- $3.74 billion: preparedness grants (2005-2017)[6]
- $1.34 billion: public assistance grants (2005-2017)[6]
- 33 weather and/or climate events, each with costs exceeding $1 billion (inflation adjusted) (1980-2017)[7]

1 U.S. Bureau of Labor Statistics, Occupational Employment Statistics, May 2017
2 American Geosciences Institute, Directory of Geoscience Departments, 53rd Edition (2018)
3 U.S. Geological Survey, Estimated Use of Water in the United States in 2015
4 U.S. Geological Survey, Mineral Commodity Summaries 2018
5 U.S. Energy Information Administration
6 FEMA Data Visualization: Summary of Disaster Declarations and Grants (accessed May 2, 2018)
7 NOAA National Centers for Environmental Information, U.S. Billion-Dollar Weather and Climate Disasters from 1980 to 2018 (accessed April 6, 2018)

AGI is a network of 52 member societies, representing more than 260,000 geoscientists.

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Geoscience, California, and Federal Agencies

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U.S. GEOLOGICAL SURVEY (USGS)

- $1.15 billion: total USGS budget in FY 2018 (5.8% increase from FY 2017)[8]
- The National Cooperative Geologic Mapping Program funds geologic mapping projects with federal (FEDMAP), state (STATEMAP), and university (EDMAP) partners
- $4.58 million: California STATEMAP funding (1993-2016)[9]
- 11 California universities, including Stanford University and University of Southern California, have participated in EDMAP[9]
- USGS streamgages collect real-time or recent streamflow, groundwater, and water-quality data throughout California

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

- $20.7 billion: total NASA budget in FY 2018 (5.5% increase from FY 2017)[10]
- $1.9 billion: total NASA Earth Science budget in FY 2018 (0% change from FY 2017)[10]
- Gravity Recovery and Climate Experiment (GRACE) satellites measure groundwater changes in California
- Soil Moisture Active Passive (SMAP) satellite measures soil moisture in California

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA)

- $5.9 billion: total NOAA budget in FY 2018 (4.1% increase from FY 2017)[11]
- Next-generation geostationary (GOES) and polar orbiting (JPSS) satellites provide weather forecasting over California
- Deep Space Climate Observatory (DISCOVR) satellite monitors radiation and air quality over California
- 86 National Weather Service Automated Surface Observing Systems (ASOS) stations in California[12]
- 493 National Weather Service Cooperative Observer Program (COOP) sites in California[12]

8 U.S. Department of the Interior, FY 2019 Budet in Brief
9 U.S. Geological Survey, National Cooperative Geologic Mapping Program
10 National Aeronautics and Space Administration, FY 2019 Budget Estimates
11 National Oceanic and Atmospheric Administration, FY 2019 Bluebook
12 NOAA In Your State and Territory

NATIONAL SCIENCE FOUNDATION (NSF)

- $7.8 billion: total NSF budget in FY 2018 (4% increase from FY 2017)[13]
- $1.4 billion: total NSF Geosciences Directorate (GEO) awards in FY 2017 (7.2% increase from FY 2016)[14]
- 396 NSF GEO awards in California totaling $190 million in 2017, including $28 million awarded to UC San Diego Scripps Institute of Oceanography[14]

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

- $8.1 billion: total EPA budget in FY 2018 (0% change from FY 2017)[15]
- 98 active Superfund sites in California in 2018[16]
- $77.6: Drinking Water State Revolving Fund (DWSRF) grants in California in 2017[17]
- $600,000: Brownfield cleanup grants awarded to California in 2018[18]

FEDERAL FACILITIES IN CALIFORNIA

- NOAA OAR Cooperative Institute for Ocean Exploration, Research, and Technology, Menlo Park
- DOE Lawrence Berkeley National Laboratory
- DOE Lawrence Livermore National Laboratory
- DOD Hydrologic Engineering Center, Davis
- DOI Pacific Outer Continental Shelf Region Office, Camarillo
- NSF International Ocean Discovery Program (IODP), La Jolla

YOUR STATE SOURCE FOR GEOSCIENCE INFORMATION

California Geological Survey
801 K Street, MS 12-30
Sacramento, CA 95814
http://www.consrv.ca.gov/cgs
916-445-1825

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17 U.S. Environmental Protection Agency, Drinking Water State Revolving Fund National Information Management System Reports
18 U.S. Environmental Protection Agency, Brownfields Grant Fact Sheet Search

Seven Projections for Earth and Space Science Jobs

iStock.com/zimmytws

"Prediction is difficult, especially about the future."

—Niels Bohr

The year 2017 promises to be a time of political turbulence and change. New leaders have been elected or have come to power by other means in several countries. Conflict rages in many regions, and the global economy continues to equilibrate. In the United States and most European countries, large portions of the population are pushing back against social and economic changes that they perceive to be in their disfavor, resulting in protectionism and opposition to globalization.

What do these political and socioeconomic changes mean for the job market?

In the short term, probably not much. Employment rates in the United States this year should stay about the same as in 2016 because we expect the U.S. gross domestic product (GDP) to stay about the same.

In the decade to come, though, a few employment trends are likely. Here are seven things to expect as the future unfolds.

1 No Huge Employment Changes Are Likely in the United States in 2017

Yes, there will be much political rhetoric and many governmental and policy changes in 2017. However, governments and bureaucracies are built to protect the status quo, not to promote change.

In economics, the relationship between unemployment and economic growth is described by Okun's law. Arthur Okun, a former chair of the Council of Economic Advisors (1968–1969) and a Yale economist, found that for every 1% increase in a country's unemployment rate, there is an approximately 2% fall in the country's GDP.

> Employment rates in the United States this year should stay about the same as in 2016.

Major economists—from Forbes, Goldman Sachs, Edward Jones, and Wallet Hub—predict that the U.S. GDP will continue modestly upward at a feeble pace toward a growth target of 2.2% to 2.5% in 2017 (see, e.g., http://bit.ly/ForbesForecast).

Although that is nothing to party about, it is not apocalyptic. Thus, we can predict a steady state for U.S. employment, in accordance with Okun's law.

2 Trends in Other Countries May Not Be Applicable to the United States

European economies will continue to improve slowly throughout 2017, as will most of the emerging economies, including China (see http://bit.ly/GSOutlook). Economic growth in China is predicted to slow but will likely meet its published goal of 6.5% for its GDP (see http://bit.ly/MKChinaOutlook).

But it's important to note that employment statistics for most other countries are not directly comparable to ours. Granted, employment in Europe is expected to increase modestly, but employment is not easily defined for developing economies where independent subsistence is more common than working for money or for communist countries in which, technically, everyone is employed.

3 People with Advanced Degrees Will Fare Better

The average 2015 unemployment rate for Ph.D.s in the United States was 1.7%, and the rate for people with a high school diploma or less was 8.0%. The overall average unemployment rate for 2015 was 4.3%, which is about as good as it gets for the general population.

So, similar to in past years, those with a higher-education degree had much less unemployment and made more money than those without one. (Insert sigh of relief.) People with advanced degrees, especially in the Earth and space sciences, fared particularly well (see Table 1).

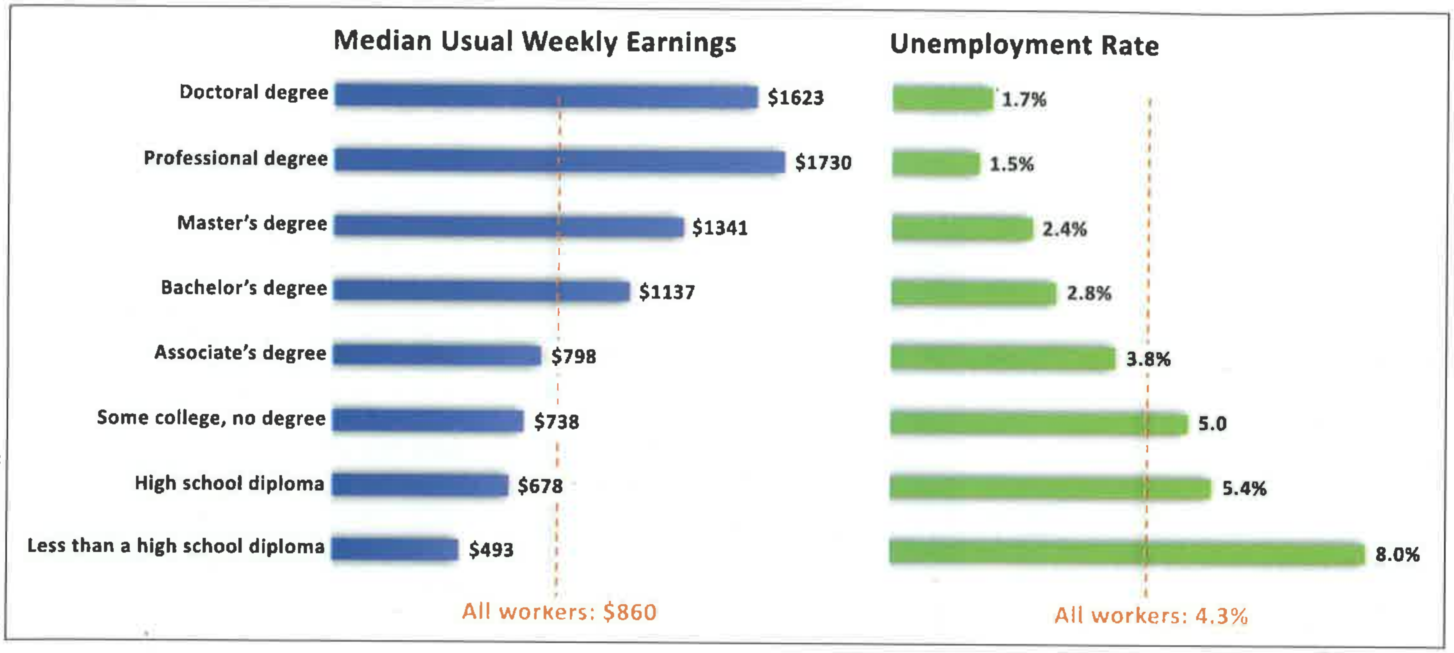
Those years of study to gain an advanced degree really were worth it in the end.

Although the full accounting of data isn't in yet, 2015 trends likely continued in 2016. The U.S. unemployment rate was 4.7% in December 2016.

I have received many questions from job seekers about the way-too-common perception that people with advanced degrees have a harder time finding employment than those with lower-level degrees. As can be seen from Figure 1, the higher the level of degree attainment is, the lower the unemployment level is.

In the Great Recession of 2008, when the U.S. manufacturing sector lost more than 2.7 million jobs, 1.6 million were lost by people with a high school diploma or less. In the economic recovery that followed, people with no college training gained back only 214,000 jobs out of the total 1.7 million created (see http://bit.ly/EconValueCollege). Many workers in lower-skilled jobs were replaced by technological efficiencies: robots, drones, and algorithms.

Without a doubt, the recession created an even greater divide between those with a high school diploma or less and those with at least



U.S. Bureau of Labor Statistics

Fig. 1. Earnings and unemployment rates by educational attainment for 2015. Data are for persons age 25 and over. Earnings are for full-time wage and salary workers.

some college education. I offer this as further proof that a college education is necessary for success in the modern economy.

4 Earth and Space Science Employment: Cloudy, with a Silver Lining for Some

The employment outlook for the Earth and space sciences is still quite good compared with most professions. Both the U.S. Bureau of Labor Statistics and the American Geosciences Institute predict high demand in most fields (see http://bit.ly/BLSscience and http://bit.ly/AGIEmployment).

However, these employment reports were compiled prior to the 2016 election. Thus, predictions related to jobs in energy and environmental monitoring, regulation, and policy are likely inflated, especially for government agencies and academic positions. The current administration is, instead, leaning heavily toward practices and policies that favor U.S. businesses.

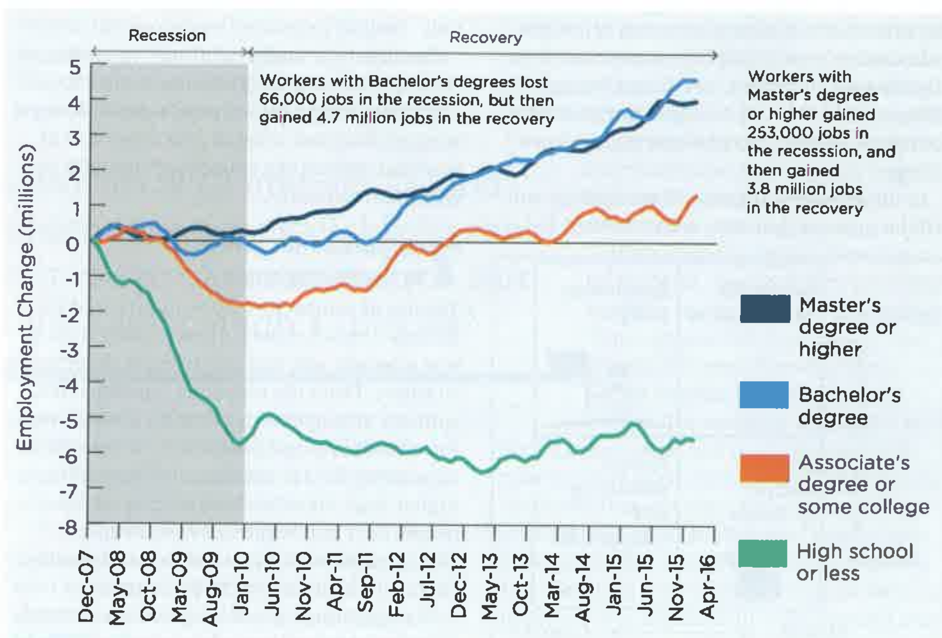
With that in mind, it's very possible that federal funding for climate change research could take a hit, which would affect not only federal agencies but also the university researchers who depend on that funding. It is possible that private foundations and industry may offer some measure of safety in the coming storm.

Taking shelter with state agencies may be a mixed bag. Already, some states, such as California, are vowing to step in to support climate change research regardless of what the federal government does. However, other states have been feeling a squeeze in all areas of geoscience research for some time now (see http://bit.ly/Eos-StateBudgets).

5 Government Jobs Will Start to Be Privatized

Business-oriented administrations favor the use of private companies for operations and services traditionally provided by government agencies. This does not necessarily mean that the net need for specific services will go down.

For example, although some regulations may be lifted for private businesses, there will still be a need for environmental specialists in many fields. Most large companies are global and thus will still need to meet regulatory policy requirements in all of the countries in which they have operations and



Georgetown University CEW (CPS)

Employment data from 2007 to 2016, separated by education level. Employment includes all workers age 18 and older. The monthly employment numbers were seasonally adjusted using the U.S. Census Bureau X-12 procedure and smoothed using a 4-month moving average.

Table 1. Occupational Outlook and Salaries for Selected Earth and Space Science Occupations[a]

OCCUPATIONS	REQUIRED ENTRY-LEVEL EDUCATION	2015 MEDIAN SALARY (US$)	PROJECTED GROWTH RATE: 2014 TO 2024
Astronomers	doctorate	$111,000	7%, average
Atmospheric scientists, including meteorologists	bachelor's	$90,000	9%, above average
Chemists	bachelor's	$73,000	3%, below average
Environmental scientists	bachelor's	$67,000	11%, above average
Geoscientists, except hydrologists	bachelor's	$90,000	10%, above average
Hydrologists	bachelor's	$80,000	7%, average
Mining and geological engineers	bachelor's	$94,000	6%, below average
Petroleum engineers	bachelor's	$130,000	10%, above average
Professors	doctorate	$72,000	13%, above average
All physical scientists		$76,000	
All occupations		$36,000	

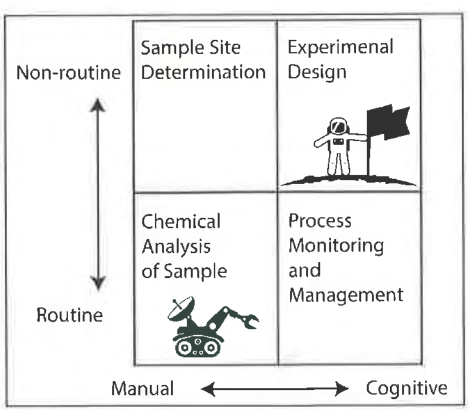
[a]Data are for persons age 25 and over. Earnings are 2015 annual averages for full-time wage and salary workers. Credit: U.S. Bureau of Labor Statistics (12 January 2017)

sales. Thus, the service of providing environmental assessments will still have a place.

Although privatization puts existing federal workers at risk, it may, in fact, be easier for job seekers to gain employment with contracting agencies than to apply through the federal hiring process. So privatization may be of benefit to new graduates looking for entry-level positions.

Most existing federal regulation jobs will likely remain, but budgets could be cut significantly. Hiring freezes may also be common in the future, to decrease the size of the government workforce through attrition. Because 25.5% of all nonseasonal full-time permanent federal employees are currently eligible for retirement (see http://bit.ly/OPMretirement), not hiring replacements for recent retirees may be one way of downsizing.

In other words, regulation watchdogs will still be present, but they won't be well fed.



Dave Harwell

Jobs fitting into the category of routine/manual can easily be done by a computer or machine, but humans still have the edge for nonroutine/cognitive jobs.

6 Automation Is Here to Stay

If a robot on Mars can do your job, you may need to worry.

Massachusetts Institute of Technology economists Daron Acemoglu and David Autor detail the kinds of jobs that are more likely to be filled by a robot or a computer algorithm than by a more expensive and more demanding human (see http://bit.ly/MIT-economists). Humans still have the edge for nonroutine jobs requiring creativity.

The key is to learn enough so that you can use technology as a tool. When you become the tool, you can easily be replaced. Don't be a tool.

Because technology continues to evolve, so should you. X-ray diffraction was once a technique requiring a skilled professional. Today a semiautonomous robot on the other side of the solar system can collect samples and analyze them remotely.

7 Opportunities Will Rise in the Gig Economy

The use of contractors, consultants, and freelancers is much more common today than it was a decade ago, and this trend is expected to continue. From the employer's perspective, contract arrangements allow for greater workforce flexibility and lower costs. Although the base salary for a contractor may be slightly higher than for a full-time employee, the overall cost to contract may be cheaper because contractors generally do not qualify for health insurance or other benefits.

If employment based on government funds is expected to go down, contractors will likely fill the void. Contractors are present in all sectors of employment, including industry, academia, and government.

For example, opportunities to work as technical writers or geological surveyors, or in any other area with easily defined deliverables, will likely increase. In academia, there has been a growing trend for the use of instructors and adjunct faculty to cover course loads. This trend will likely continue.

Holding multiple contracts may be the new modus operandi of the now and future worker. Although this is not as stable as full-time employment, it does give the worker flexibility to pursue several opportunities, gain varied experiences, keep skills fresh, and build a wide network of possible future employers.

Back to the Future

No one knows what the future has in store, but being aware of expected trends and adapting to changing conditions are your best strategies for success. As you set your goals for 2017, here are some suggestions to build your adaptability skill set:

- Learn something new every day. Keep your mind sharp and flexible.
- Be aware of your surroundings. Stay on top of changes to your field, your sector, and society; know your options and the risks to your employment and success.
- Have a plan for your success, and update it as situations change. Let the little stuff go, so that you can focus on what is most important to your success.

Change is the only constant in life. Plan on it always being there, and live your life accordingly.

By **David Harwell** (email: dharwell@agu.org; @deharwell), Assistant Director, Talent Pool, AGU