Status of the Geoscience Workforce

Carolyn Wilson

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Front cover photo: Near Valentine, Nebraska's Niobrara River rushes through a narrow opening that it has found in the resistant bedrock. ©Michael Collier

Back cover photo: The Colorado River exits Topock Gorge and flows into Lake Havasu. ©Michael Collier

If you have any questions or comments related to this report, please contact:

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Introduction

The *Status of the Geoscience Workforce 2014* report provides a comprehensive benchmark of the geoscience profession. This report is based on original data collected by the American Geosciences Institute and existing data from federal sources, industry sources, and professional membership organizations. This report synthesizes all the readily available data related to the geosciences from the education and training of new geoscientists, to the employment trends in the geoscience workforce, to the federal funding trends for the geosciences and economic trends of the major geoscience industries. The report is broken into 5 chapters:

Chapter 1: Trends in K–12 Geoscience Education — Preparing Students for College Geoscience Programs and Society
Chapter 2: Trends in Two-Year College Geoscience Programs
Chapter 3: Trends in Four-Year Institution Geoscience Programs
Chapter 4: Trends in Geoscience Employment — Examining Student Transitions and Workforce Dynamics
Chapter 5: Trends in Economic Metrics and Drivers of the Geoscience Workforce

Some highlights of this report include:

- 12% of doctoral graduates, 16% of master's graduates, and 27% of bachelor's graduates transferred from a two-year college during their education, which hints at an increase in the quantity of geoscience majors that originated at a two-year college.

- 77% of all geoscience bachelor's graduates take Calculus I and 66% of all geoscience bachelor's graduates take Calculus II. However, the percentages of bachelor's graduates taking higher quantitative courses drops dramatically to 32% taking Calculus III and lower in other courses. A similar, but less severe decrease occurs among master's graduates, with 75% having taken Calculus I and 67% having taken Calculus II, dropping to 43% taking Calculus III and lower for other higher quantitative courses.

- Field camp attendance continues to steadily increase. In 2013, 2,973 students attended a field camp, which is a 92% increase since 2006. With this steady increase, there is concern that the available field camps have or will soon reach capacity.

- 60% of bachelor's graduates, 37% of master's graduates, and 65% of doctoral graduates did not participate in an internship. Of those that did participate in an internship, 80% of bachelor's graduates, 88% of master's graduates, and 67% of doctoral graduates found their internship(s) to be very important for their academic and professional development.

- Starting salaries for recent bachelor's graduates with a geoscience degree range from $30,000–$70,000, from $30,000–$120,000 for master's graduates, and $30,000–over $120,000 for doctoral graduates depending on the industry. Every graduate making more than $90,000 are working within the oil and gas industry.

- Overall number of faculty and staff at four–year institutions increased slightly. However, the percentage of academics in tenure-track faculty positions in 2013 continues to slowly decrease from 2009. Currently, there are 14% assistant professors, 15% associate professors, 34% professors, 15% emeritus faculty, 4% instructors and lecturers, and 8% adjuncts working at four year institutions.

- Mean salaries for geoscientists continue to increase in all major industries. Petroleum engineers make the most money per year at nearly $150,000 on average; geoscientists are making a mean annual salary of over $106,000; mining and geological engineers are making a mean annual salary of over $91,000; and hydrologists are making a mean annual salary of nearly $79,000, to name a few occupations.

- There was a clear decrease in hiring of federal geoscientists in all areas expect for meteorologists. It appears hiring at the federal level all but ceased in 2010 and 2011. There have been a few new employees hired in 2012, so this might change in the future.

- There were approximately 340,000 geoscientists employed in the United States in 2012. Over the next decade, 48% of the workforce will be at or near retirement. However, while there will still be a predicted shortage of around 150,000 geoscientists, this number is less than previously predicted. People associated with the geosciences have recognized the future shortage of qualified geoscientists and are working to increase the supply of geoscientists for the future.

Acknowledgements

I would like to thank the AGI Foundation for funding the AGI Workforce Program and for their support for this report.

I also want to thank the people and organizations that allowed my use of their data for this report, including: Ann Benbow for the K–12 earth science education data; Dr. Penelope Morton for the field camp attendance data; the National Mining Association for the data on mining employment demographics; the American Association of Petroleum Geologists, the National Ground Water Association, the Society of Economic Geologists, and the Society of Exploration Geophysicists for their membership data; and GeoRef Information Services for data on publications, theses, and dissertations.

I want to acknowledge the multiple organizations and agencies that freely provide their data and information online, including: the American Geophysical Union, the American Meteorological Society, the Association for the Sciences of Limnology and Oceanography, ACT, Baker Hughes, the College Board, the Energy Information Administration, the National Association of Geoscience Teachers, the National Science Foundation's National Center for Science and Engineering Statistics, the National Science Foundation award database, the U.S. Bureau of Economic Analysis, the U.S. Census Bureau, the U.S. Bureau of labor Statistics, the U.S. Department of Education's Integrated Postsecondary Education Database, the U.S. Department of Education's National Center of Education Statistics, the U.S. Geological Survey, the U.S. Office of Personnel Management, and the World Gold Council.

I want to give special recognition to Leila Gonzales for all her help, her advice, and her connections within various organizations. She also originated this report and built a strong foundation for this edition.

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Chapter 1: Trends in K–12 Geoscience Education — Preparing Students for College Geoscience Programs and Society

Earth science education is becoming pervasive in middle school and high school curriculums across the U.S. due to an increased awareness of the importance of earth science and environmental science to a functioning society.[1] Nearly every state in the United States allows for earth science courses to count as a science credit for graduation and assesses students' knowledge of earth science concepts during middle school and high school. The College Board recognizes earth science as an essential domain for college readiness in science.[2] The majority of colleges also accept earth science courses as a credible science course with over 77% accepting these courses for student admission into their programs.[3]

However, the earth sciences still have the fewest trained teachers at the elementary and secondary levels than other sciences. In elementary schools the majority of teachers providing computer, math and science education have degrees in the social or related sciences, instead of a science or engineering field. In secondary schools, the majority of computer, math, and science teachers have degrees in computer or math sciences or in life and related sciences. However, there are more than twice as many elementary school teachers with geoscience degrees than secondary teachers with geoscience degrees.

College readiness among students is often indicated through course selection of higher level math and science courses, such as Advanced Placement (AP) course selection, and SAT test scores. There continues to be growth in the rates of high school graduates taking higher level math courses with 75% completing algebra II, 35% completing pre-calculus, and 16% completing calculus in 2009. There is similar growth among high school graduates taking science courses, with 96% completing biology, 70% completing chemistry, 36% completing physics, and 28% completing geology/earth science in 2009. Science and calculus AP courses show similar growth over time. The data presented within this report do not yet reflect the increasing participation of high school students in the Environmental Sciences AP course. However, this course is the closest to presenting advanced earth science concepts in high school and has rapidly grown over the past 10 years. Generally SAT test-takers with coursework in the sciences tend to have higher average scores than the average of all test-takers, however, this is not the case for students with coursework in the earth and space sciences. It is encouraging to see increasing numbers of SAT test-takers interested in majoring in the physical sciences in college.

AGI surveyed students graduating with a geoscience degree using AGI's Geoscience Student Exit Survey about their educational background in the geosciences. Approximately half of the graduates had taken a formal earth science course while in high school, which was a higher percentage than expected. This indicates the usefulness of these courses to start recruiting students into geoscience majors during their postsecondary education, as well as reiterates the increasing inclusion of earth science courses in the high school curriculum.

While earth science education is typically presented as a single course in middle school or high school for most students, new developments may lead to earth science concepts becoming integrated through the whole K–12 curriculum. The National Research Council, the National Science Teachers Association, the American Association for the Advancement of Science, and Achieve recognized the need for new science standards for K–12 education and therefore developed and released the Next Generation Science Standards in 2013. One of the recognized Disciplinary Core Ideas is Earth and Space Science, which makes earth science concepts equally represented with the other science disciplines within the state standards. All the Disciplinary Core Ideas will be integrated throughout the entire K–12 science curriculum as set standards for what students should know at each grade level. As of the end of February 2014, nine states, plus the District of Columbia, have adopted the Next Generation Science Standards, with more states looking to adopt in the near future. For more information about the Next Generation Science Standards, please visit http://www.nextgenscience.org.

1 National Research Council, Board on Science Education. (2012) A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas. Retrieved from http://www.nap.edu/catalog.php?record_id=13165#

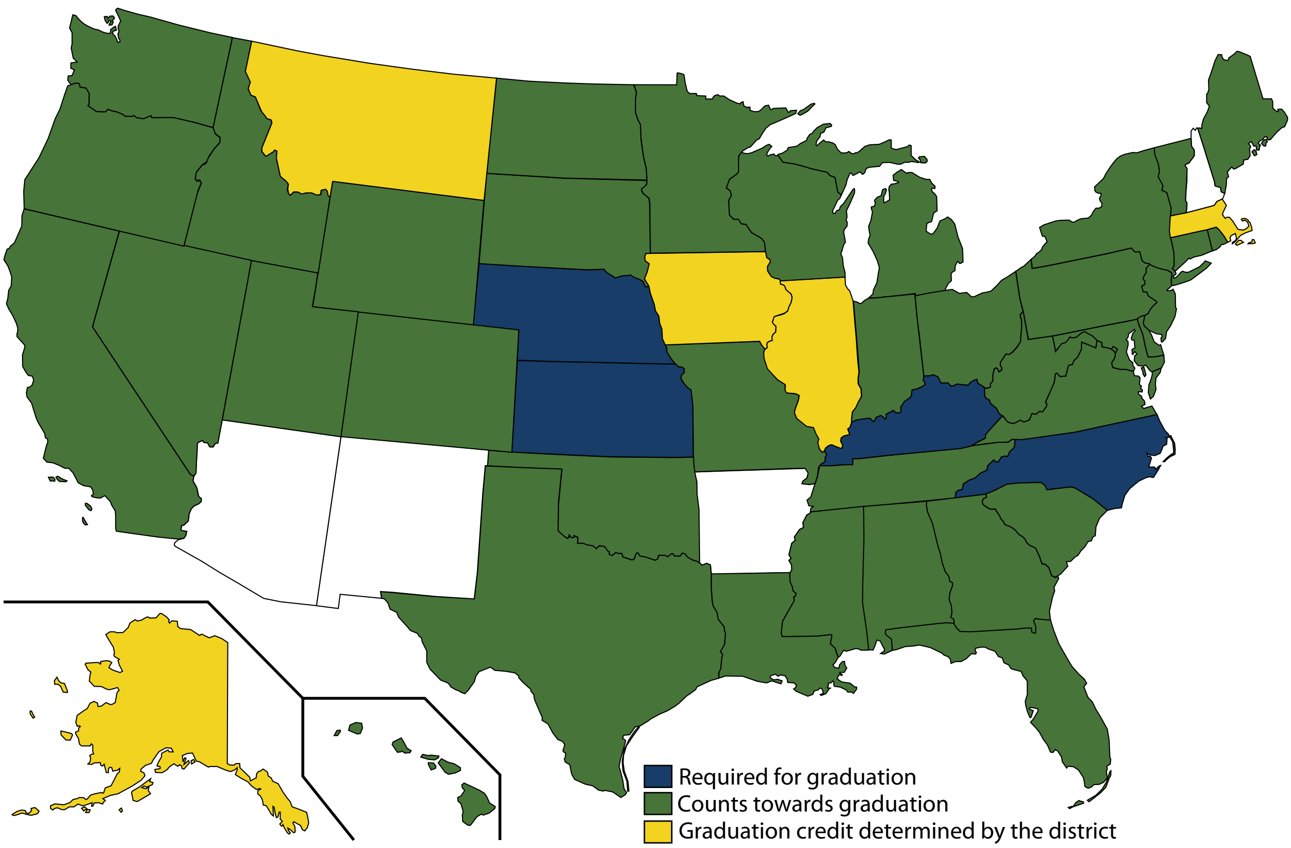
2 College Board. (2010) Science College Board Standards for College Success. Retrieved from http://media.collegeboard.com/digitalServices/pdf/research/Science_College_Board_Standards_for_College_Success_SCAS.pdf

3 Center for Geoscience Education and Public Understanding. (2013) Earth and Space Science Education In U.S. Secondary Schools: Key Indicators and Trends. Retrieved from http://geocntr.org/wp-content/uploads/2013/08/ESS_sec_status_report_10_17_13.pdf

Earth Science Education

Figures 1.1 and 1.2 and Tables 1.1 and 1.2 show the increased representation of earth science education in middle and high school curriculum. One more state since 2010, Nebraska, has made earth science a required course for graduation, and 46 states in the United States will accept an earth science course as a science credit for graduation, compared to 12 states in 2010. However, it is important to note that in 2010, all states that didn't include earth science courses toward graduation did list earth science in the state high school standards. The framework was in place then to move towards this increase in the inclusion of earth science courses as a graduation credit. Forty-eight states also include the assessment in either middle or high school.

Figure 1.1: Earth Science Education Graduation Requirements in High School



AGI Geoscience Workforce Program; Data derived from Ann Benbow and AGI's Education Program data

Table 1.1: Changes in State-Level Earth Science Requirements for Graduation

Is Earth Science a Required Course for Graduation?				
State	**2002**	**2007**	**2010**	**2013**
Alaska	No	Determined by District	No	No
Arizona	No	Determined by District	No	No
Colorado	No	Determined by District	No	No
Connecticut	No	Determined by District	No	No
Idaho	No	Yes	No	No
Illinois	No	Determined by District	No	No
Indiana	No	Yes	No	No
Kansas	No	Yes	Yes	Yes
Kentucky	Yes	Yes	Yes	Yes
Louisiana	No	Yes	No	No
Massachusetts	No	Determined by District	No	No
Michigan	No	Yes	No	No
Nebraska	No	No	No	Yes
Nevada	No	Determined by District	No	No
New Hampshire	No	Determined by District	No	No
New Jersey	No	Determined by District	No	Environmental Lab-Based Course Required
New York	Yes	No	No	No
North Carolina	Yes	Yes	Yes	Yes
North Dakota	No	Determined by District	No	No
Oregon	No	Determined by District	No	No
Pennsylvania	Yes	Determined by District	No	No
Rhode Island	No	Determined by District	No	No
Wyoming	Yes	Determined by District	No	No

AGI Geoscience Workforce Program; Data derived from Ann Benbow and AGI's Education Program data

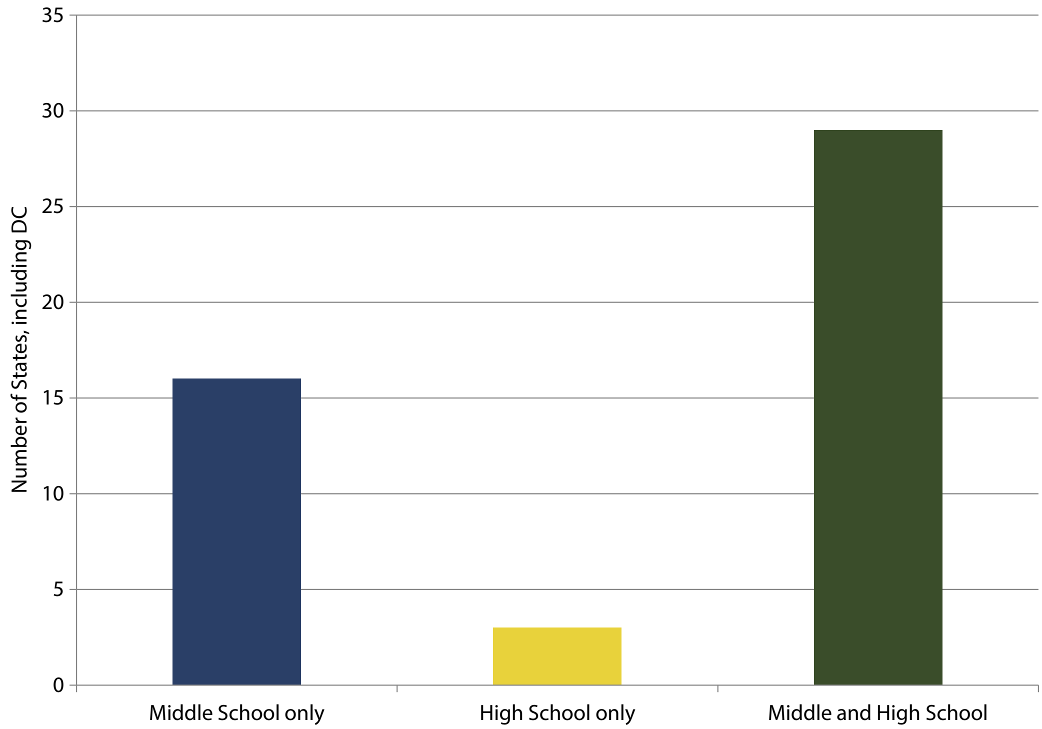
Table 1.2: States Counting Earth Science Courses Towards Graduation Requirements

Does an Earth Science Course Count Towards Graduation Requirements?				
State	2002	2007	2010	2013
Alabama	Yes	Yes	Yes	Yes
Alaska	Yes	Determined by District	No*	Determined by District
Arizona	Yes	Determined by District	No*	Integrated Concepts into other Courses
Arkansas	Yes	No	Yes	No
California	Yes	Yes	No*	Yes
Colorado	Yes	Determined by District	No*	Yes
Connecticut	-	Yes	No*	Yes
Delaware	-	Yes	No*	Yes
District of Columbia	-	Yes	No*	Yes
Florida	Yes	Yes	Yes	Yes
Georgia	Yes	Yes	No*	Yes
Hawaii	Yes	-	No*	Yes
Idaho	Yes	Yes	No*	Yes
Illinois	Yes	Determined by District	No*	Determined by District
Indiana	Yes	Yes	Yes	Yes
Iowa	-	Determined by District	No*	Determined by District
Kansas	Yes	Yes	No*	Yes
Kentucky	Yes	Yes	No*	Yes
Louisiana	Yes	Yes	Yes	Yes
Maine	Yes	Yes	No*	Yes
Maryland	Yes	Yes	Yes	Yes
Massachusetts	Yes	Determined by District	No*	Determined by District
Michigan	No	Determined by District	No*	Yes
Minnesota	Yes	Yes	No*	Yes
Mississippi	Yes	Yes	Yes	Yes
Missouri	Yes	Yes	No*	Yes
Montana	Yes	Yes	No*	Determined by District
Nebraska	-	Determined by District	Yes	Yes
Nevada	Yes	Yes	No*	Yes
New Hampshire	No	Determined by District	No*	No
New Jersey	Yes	Yes	No*	Yes
New Mexico	Yes	Yes	No*	No
New York	Yes	Yes	Yes	Yes
North Carolina	Yes	Yes	No*	Yes
North Dakota	Yes	Determined by District	No*	Yes
Ohio	Yes	Determined by District	No*	Yes
Oklahoma	Yes	Yes	Yes	Yes
Oregon	Yes	Determined by District	No*	Yes
Pennsylvania	Yes	Yes	No*	Yes
Rhode Island	-	Determined by District	No*	Yes
South Carolina	No	Yes	No*	Yes
South Dakota	Yes	Yes, with Lab only	No*	Yes
Tennessee	-	Yes	No*	Yes
Texas	No	No	No*	Yes
Utah	Yes	Yes	Yes	Yes
Vermont	Yes	Yes	No*	Yes
Virginia	Yes	Yes	Yes	Yes
Washington	Yes	Yes, with Lab only	No*	Yes
West Virginia	Yes	Yes	No*	Yes
Wisconsin	Yes	Determined by District	No*	Yes
Wyoming	Yes	Determined by District	No*	Yes

* denotes earth science is included in the high school state science standards.

AGI Geoscience Workforce Program; Data derived from Ann Benbow and AGI's Education Program data

Figure 1.2: States that Assess Earth and Space Science Concepts in Middle and High School



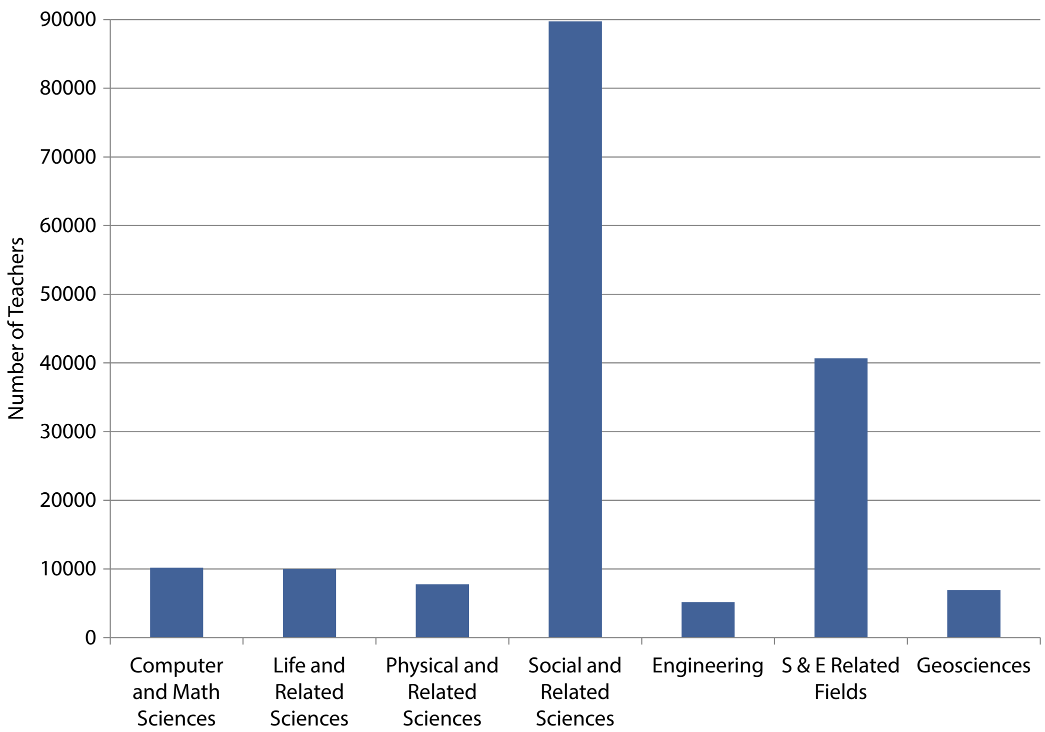
AGI Geoscience Workforce Program; Data derived from Ann Benbow and AGI's Education Program data

Teachers

Figures 1.3 and 1.4 show the degree fields for teachers of computer science, math or science as measured by the National Science Foundation. While 53% of elementary teachers teaching these subjects have degrees in social or related sciences, there are more than twice as many elementary teachers than secondary teachers teaching these subjects with a degree in the geosciences. The number of geoscience teachers at the secondary level is down from the numbers reported in the 2011 Status of the Geoscience Workforce report.

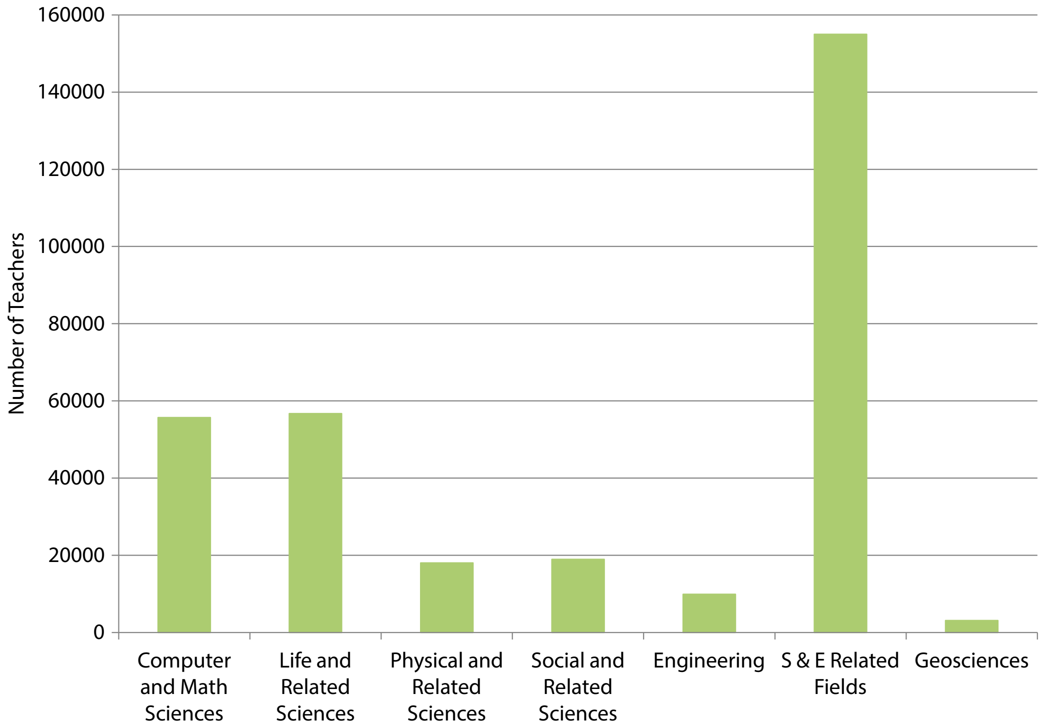
The majority of these teachers are gaining their certification with a teaching degree at the undergraduate or master's level, and approximately a fifth of math and science teachers gain their certification after their degree. However, the percentage of teachers without formal preparation, while small, increases from elementary to high school. Figure 1.6 does not include percentages for high school because geoscience teachers were not reported for this level.

Figure 1.3: Degree Fields of Elementary School Teachers, 2010



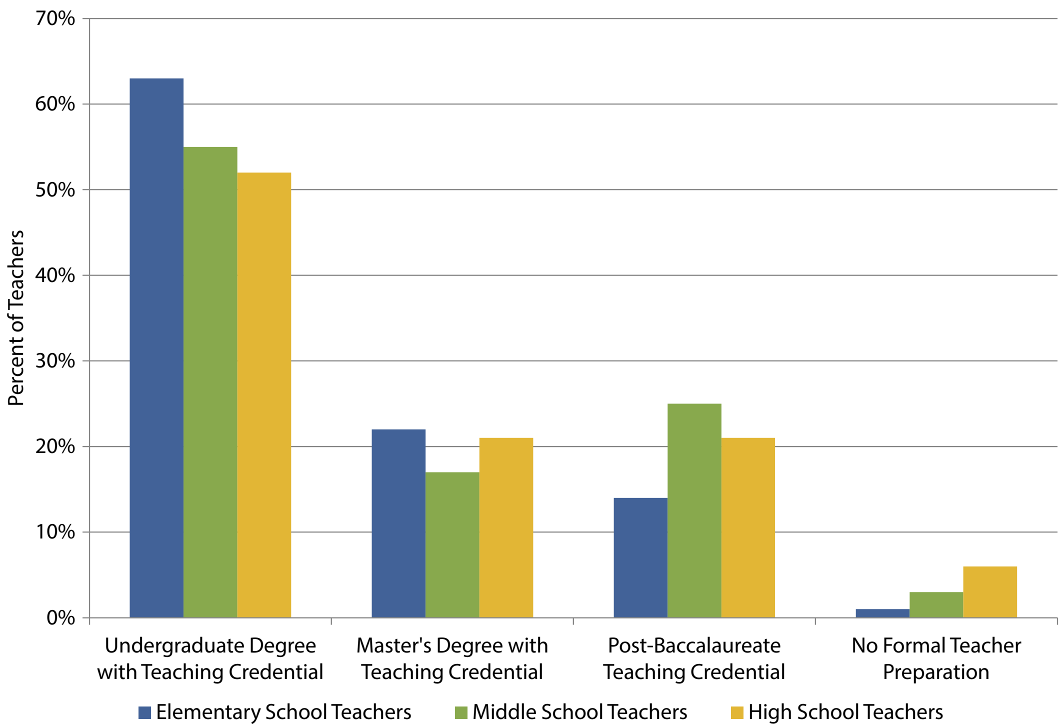
AGI Geoscience Workforce Program; Data derived from NSF SESTAT Public Data Files

Figure 1.4: Degree Fields of Secondary Teachers, 2010



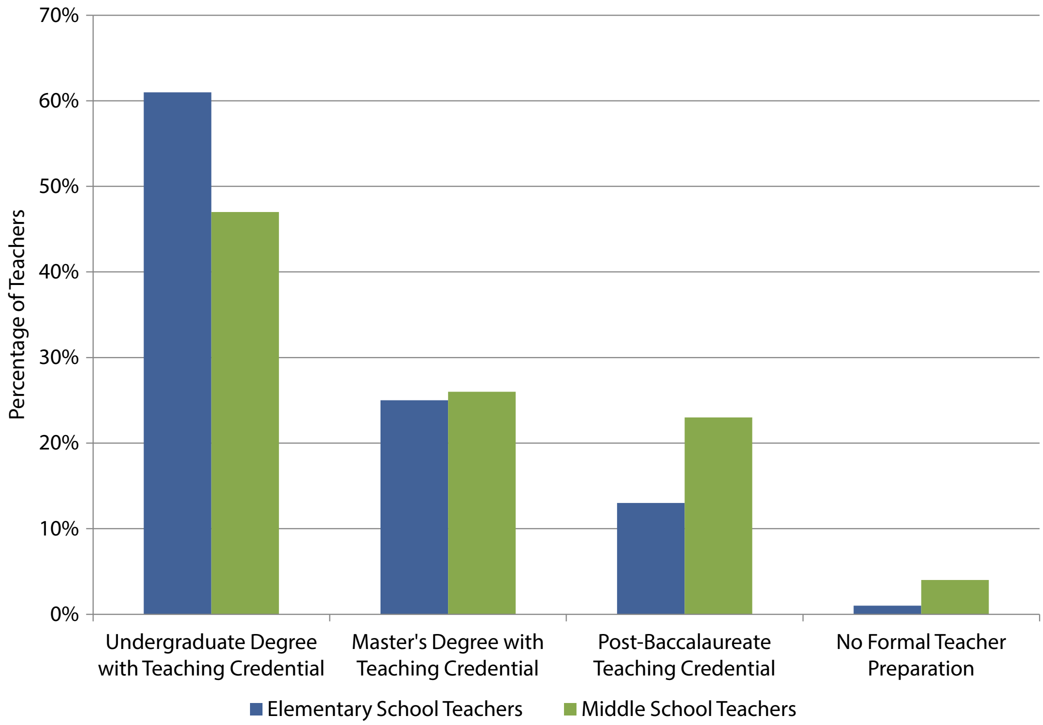
AGI Geoscience Workforce Program; Data derived from NSF SESTAT Public Data Files

Figure 1.5: Paths to Certification for Math Teachers at Elementary, Middle, and High Schools



AGI Geoscience Workforce Program; Data derived from the 2012 National Survey of Science and Mathematics Education

Figure 1.6: Paths to Certification for Science Teachers at Elementary and Middle Schools



AGI Geoscience Workforce Program; Data derived from the 2012 National Survey of Science and Mathematics Education

Students

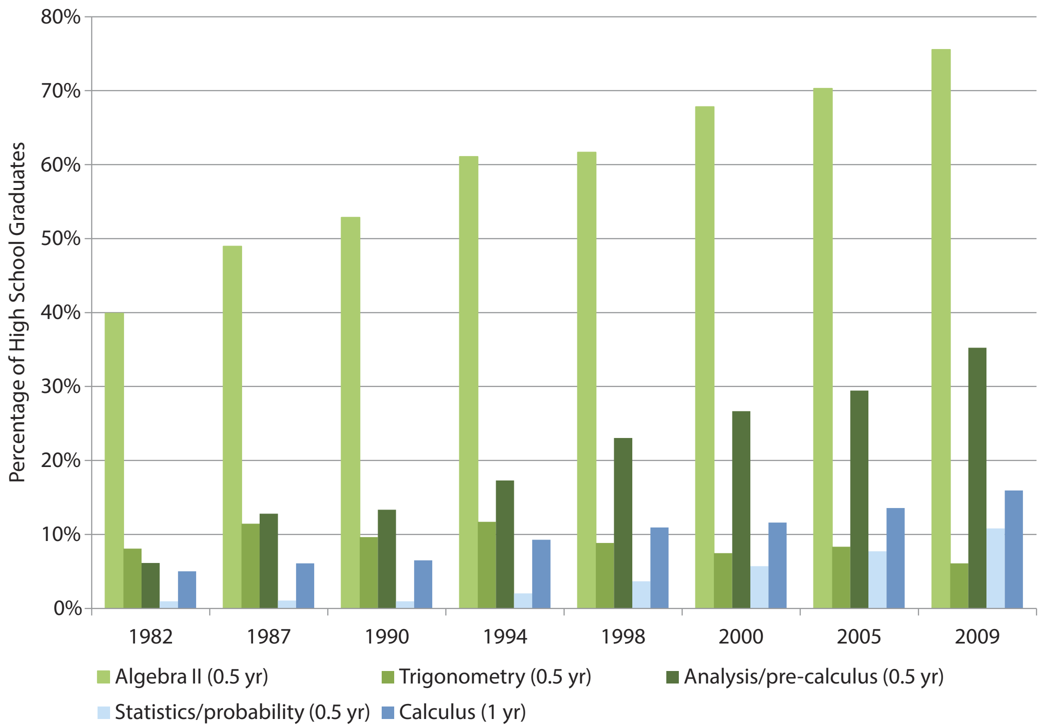
High school course selection in math and science and Advanced Placement (AP) are used as indicators of future college success by demonstrating students' ability to handle the coursework. Continually increasing percentages of students are completing coursework in all math courses presented in Figure 1.7, except trigonometry. The same is generally true for the science courses presented in Figure 1.10. While it appears the percentages of graduates taking geology/earth science varied some for 12 years, this subject is steadily increasing in participation rate since 2000.

For Advanced Placement courses, participation from high school graduates has increased since 1982. While no gender difference surfaced in math and science course-taking among high school graduates, there is gender variation in AP course selection, 6% more females taking AP/honors biology and 4% more males taking AP/honors physics. While there is no geology/earth science AP course, there is an environmental science AP course, which is not presented in Figures 1.13–1.15. According to the College Board in their 10th Annual AP Report to the Nation, there has been tremendous growth in the number of high school graduates taking the environmental science AP course with 22,039 students in 2003 to 97,918 students in 2013. In 2013, among the students that took the environmental science AP test, 56% were females and 44% were males.

Figures 1.16–1.19 present data about SAT test-takers with coursework in the sciences. Average SAT scores in critical reading, writing, and math appear low for students that took geology, earth, or space science. However, it is important to note that this course is typically considered a science elective for graduation in the United States, so it tends to draw lower achieving students and those students not interested in AP courses. It is encouraging to see the increased interest in SAT test-takers in physical science degrees since 2009 (Figure 1.21). In 2013, just over 21,000 students expressed interest, which is a 43% increase since 2009.

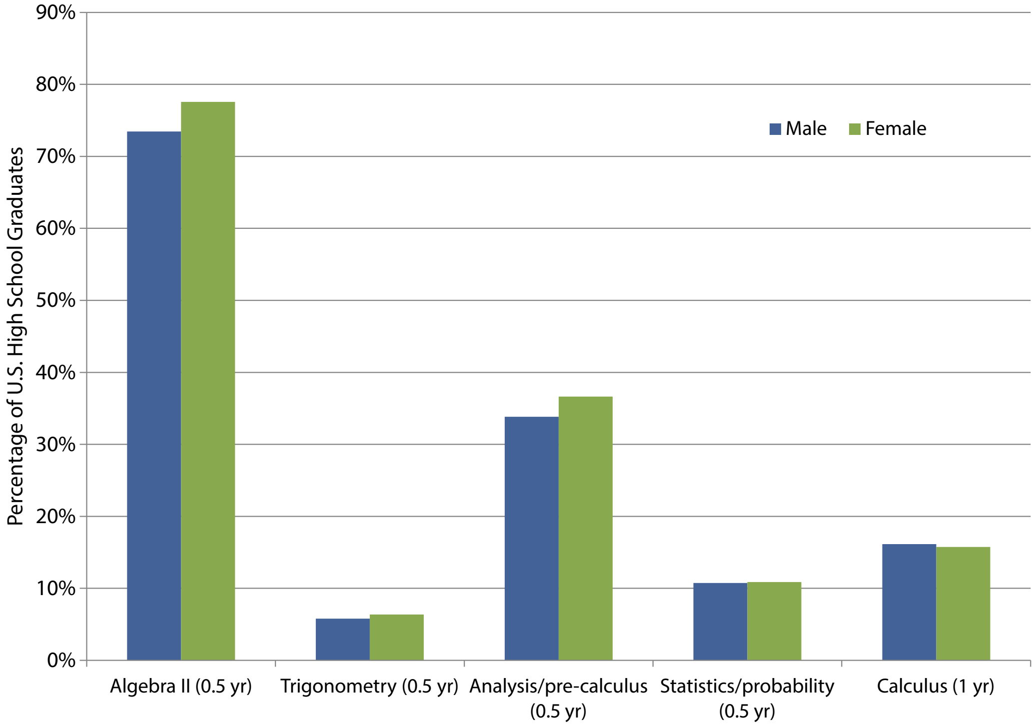
Surveys of geoscience graduates about their educational backgrounds in the geosciences revealed approximately half of the graduates at all degree levels took a formal earth science course while in high school, which indicates the importance of these high school courses for recruitment of future geoscience majors at the postsecondary level.

Figure 1.7: Selected Math Course-Taking Patterns of U.S. High School Graduates



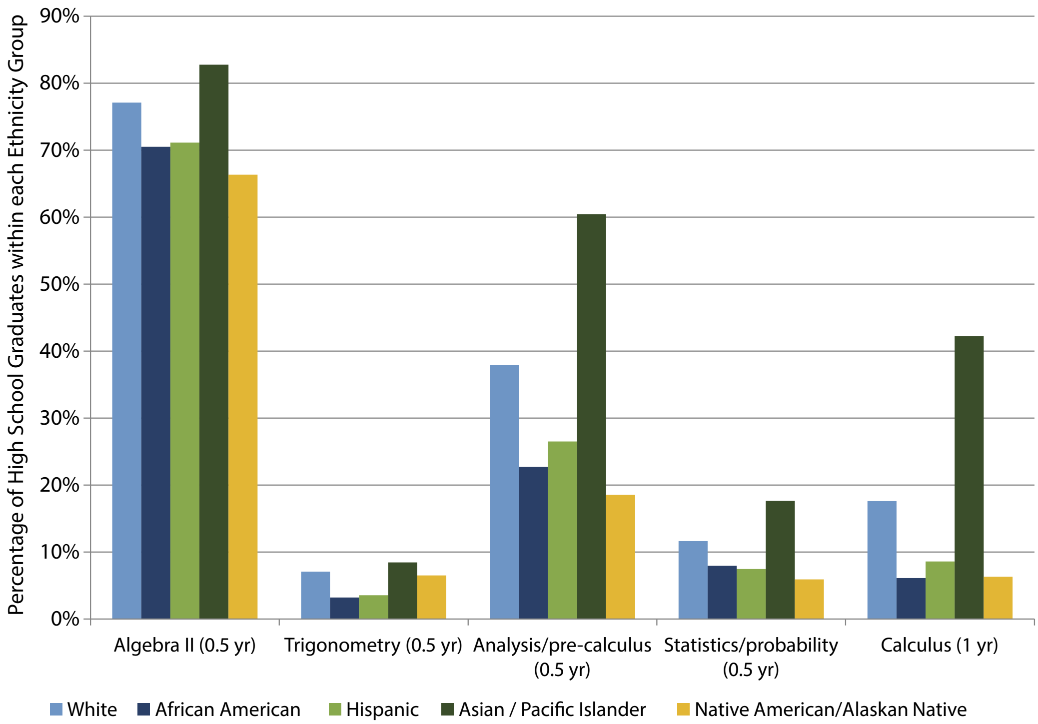
AGI Geoscience Workforce Program; Data derived from NCES Digest of Education Statistics, 2012

Figure 1.8: Selected Math Course-Taking Patterns by Gender of U.S. High School Graduates



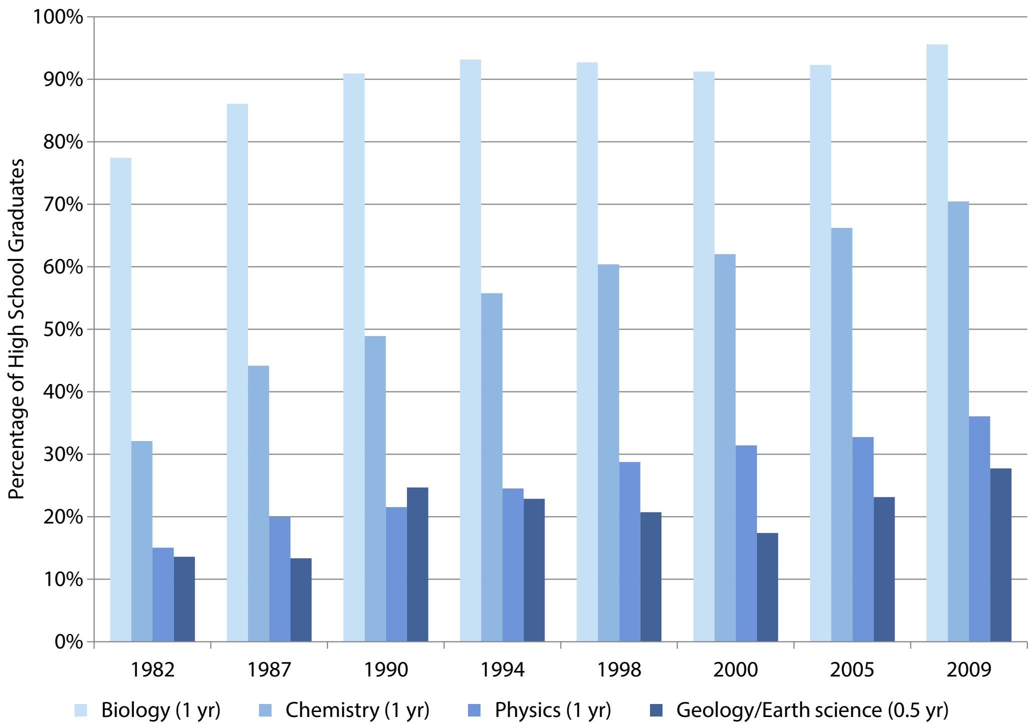
AGI Geoscience Workforce Program; Data derived from NCES Digest of Education Statistics, 2012

Figure 1.9: Selected Math Course-Taking Patterns by Race and Ethnicity of U.S. High School Graduates



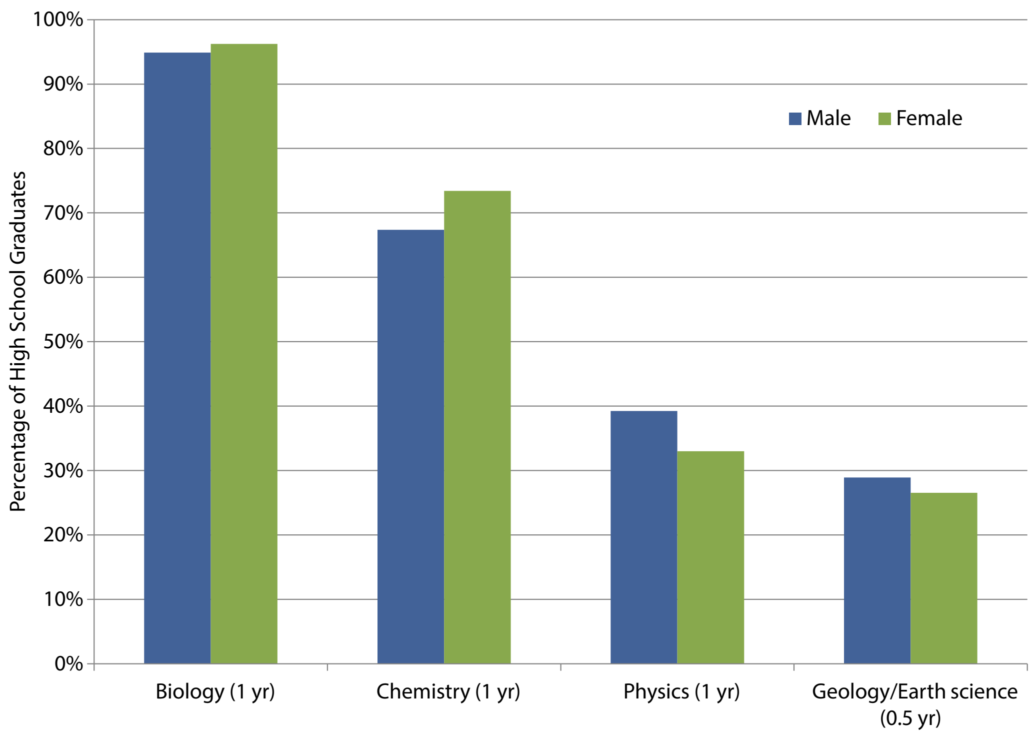
AGI Geoscience Workforce Program; Data derived from NCES Digest of Education Statistics, 2012

Figure 1.10: Science Course-Taking Patterns of U.S. High School Graduates



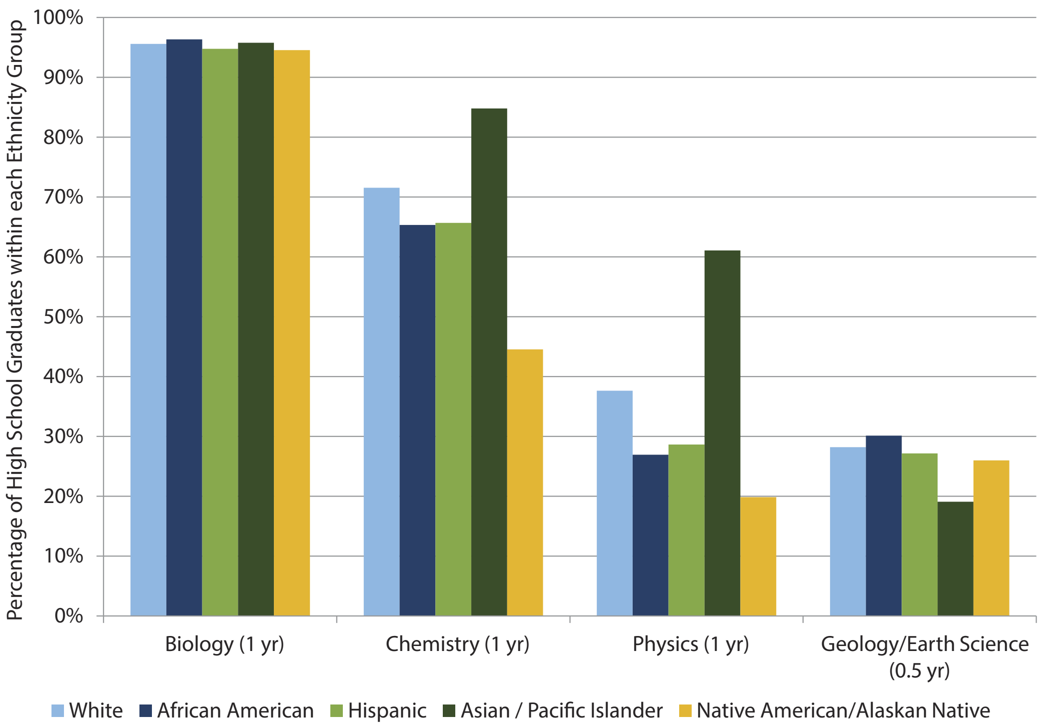
AGI Geoscience Workforce Program; Data derived from NCES Digest of Education Statistics, 2012

Figure 1.11: Science Course-Taking Patterns by Gender of U.S. High School Graduates



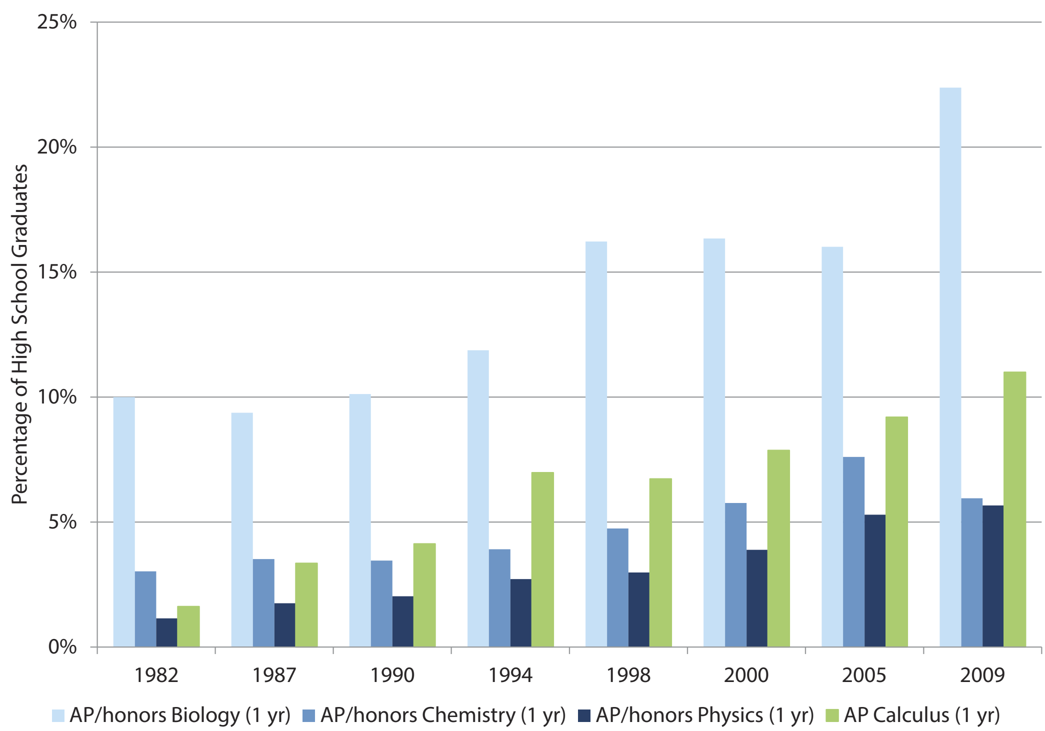
AGI Geoscience Workforce Program; Data derived from NCES Digest of Education Statistics, 2012

Figure 1.12: Science Course-Taking Patterns by Race and Ethnicity of U.S. High School Graduates



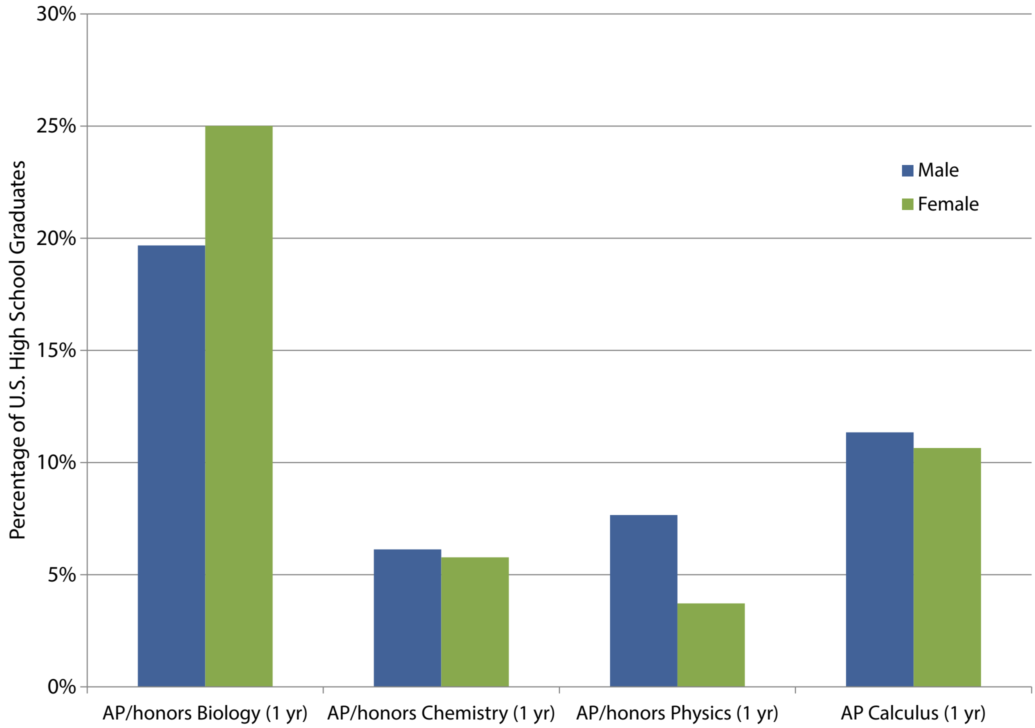
AGI Geoscience Workforce Program; Data derived from NCES Digest of Education Statistics, 2012

Figure 1.13: Advanced Placement Course-Taking Patterns by U.S. High School Graduates



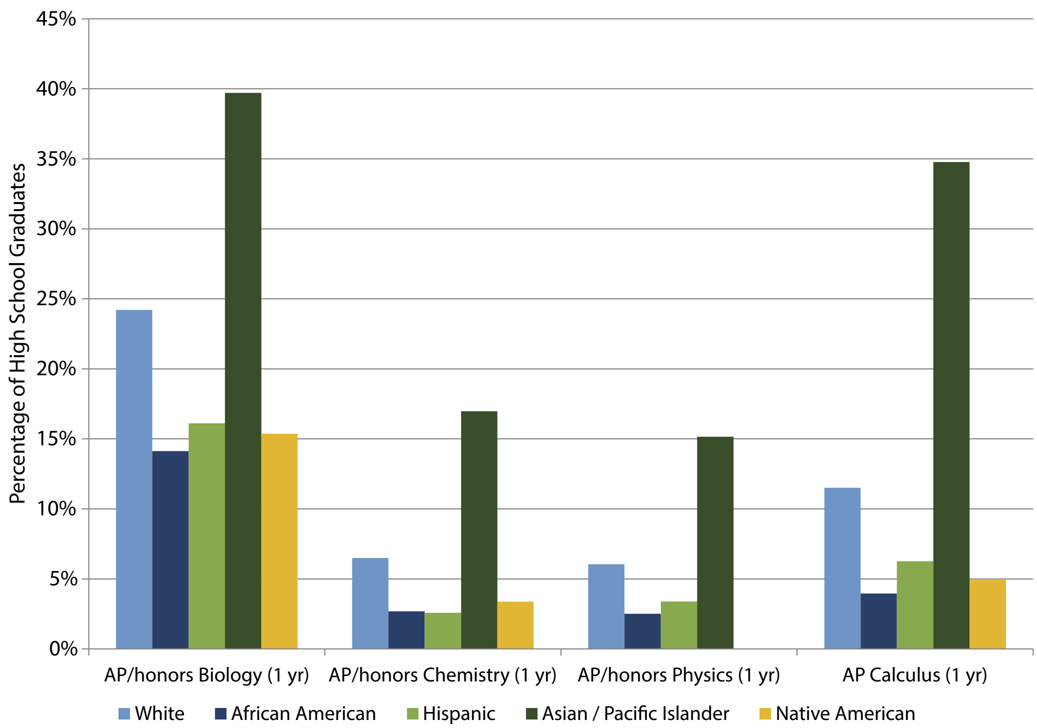
AGI Geoscience Workforce Program; Data derived from NCES Digest of Education Statistics, 2012

Figure 1.14: Advanced Placement Course-Taking Patterns by Gender of U.S. High School Graduates



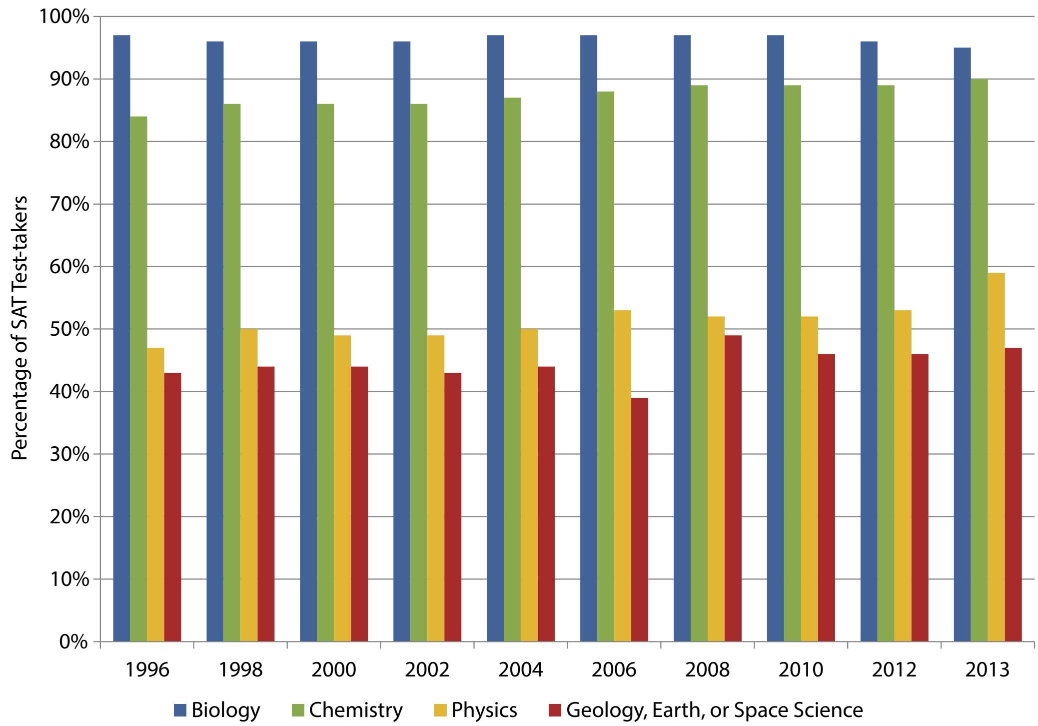
AGI Geoscience Workforce Program; Data derived from NCES Digest of Education Statistics, 2012

Figure 1.15: Advanced Placement Course-Taking Patterns by Race and Ethnicity of U.S. High School Students



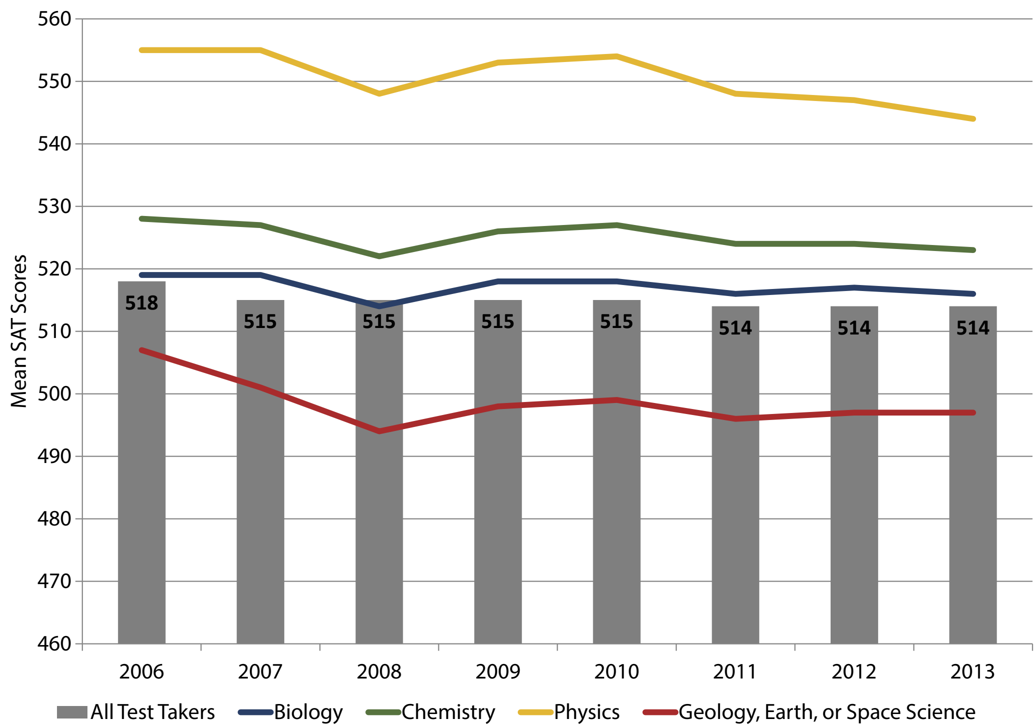
AGI Geoscience Workforce Program; Data derived from NCES Digest of Education Statistics, 2012

Figure 1.16: SAT Test-Takers with Coursework or Experience in Selected Sciences



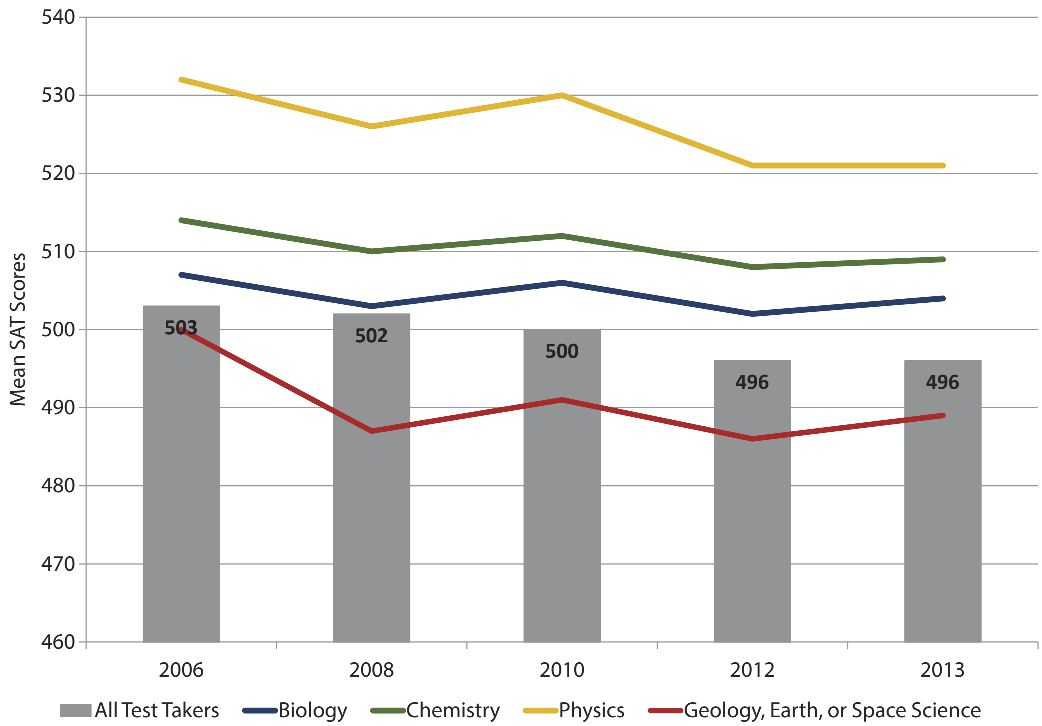
AGI Geoscience Workforce Program; Data derived from the College Board College-Bound Seniors, Total Group Report, 1996-2013

Figure 1.17: Mean Math SAT Scores for Test-Takers with Coursework in Science



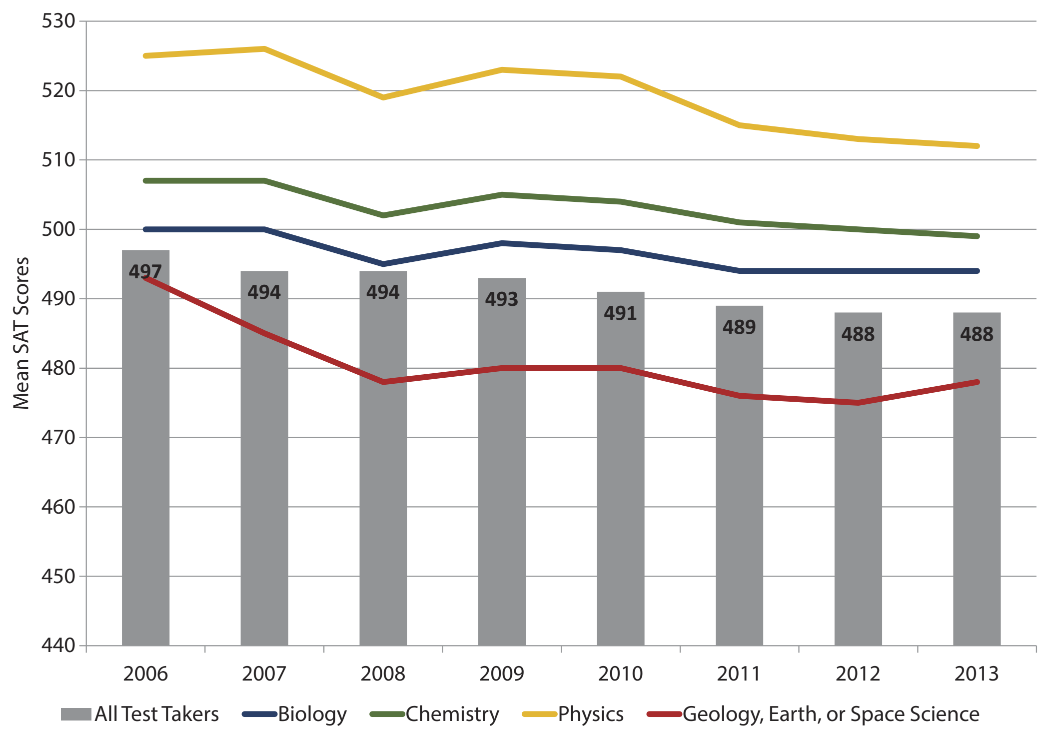
AGI Geoscience Workforce Program; Data derived from the College Board College-Bound Seniors, Total Group Report, 1996-2013

Figure 1.18: Mean Critical Reading SAT Scores with Coursework in Science



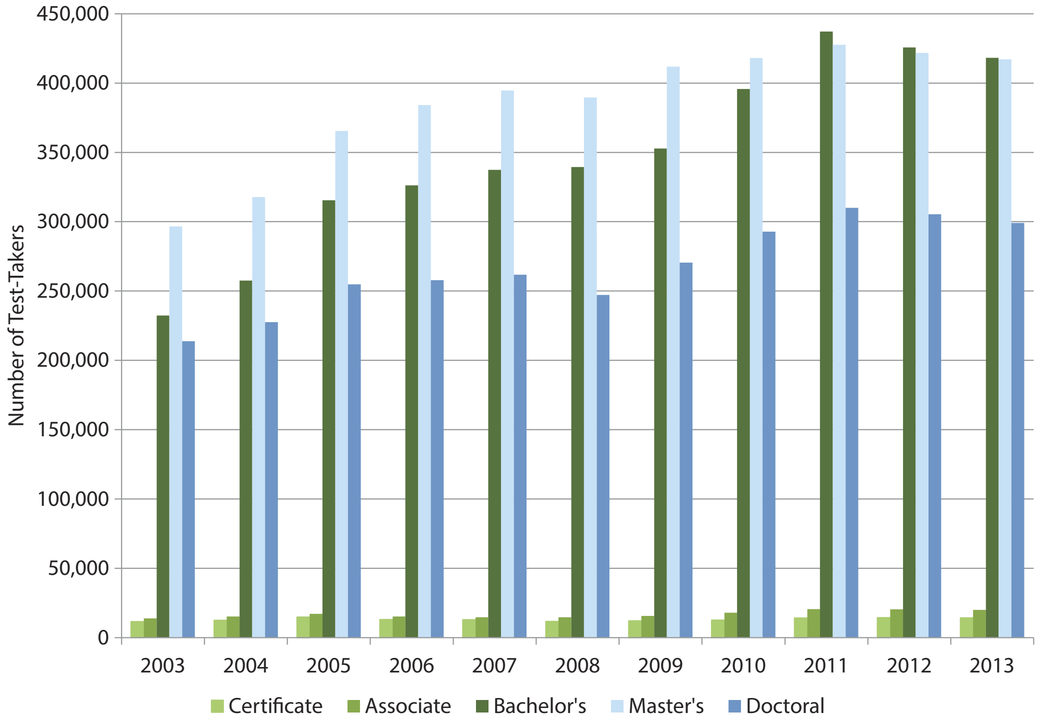
AGI Geoscience Workforce Program; Data derived from the College Board College-Bound Seniors, Total Group Report, 1996-2013

Figure 1.19: Mean Writing SAT Scores for Test-Takers with Coursework in Science



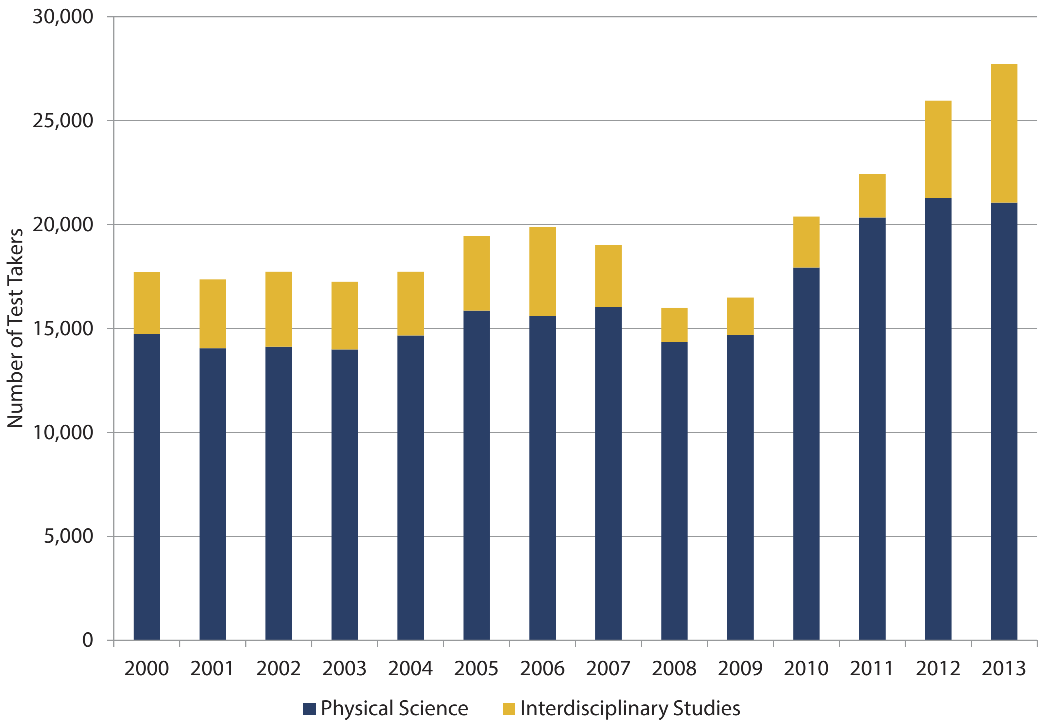
AGI Geoscience Workforce Program; Data derived from the College Board College-Bound Seniors, Total Group Report, 1996-2013

Figure 1.20: Intended Degree Level of College-Bound High School Seniors that took the SAT



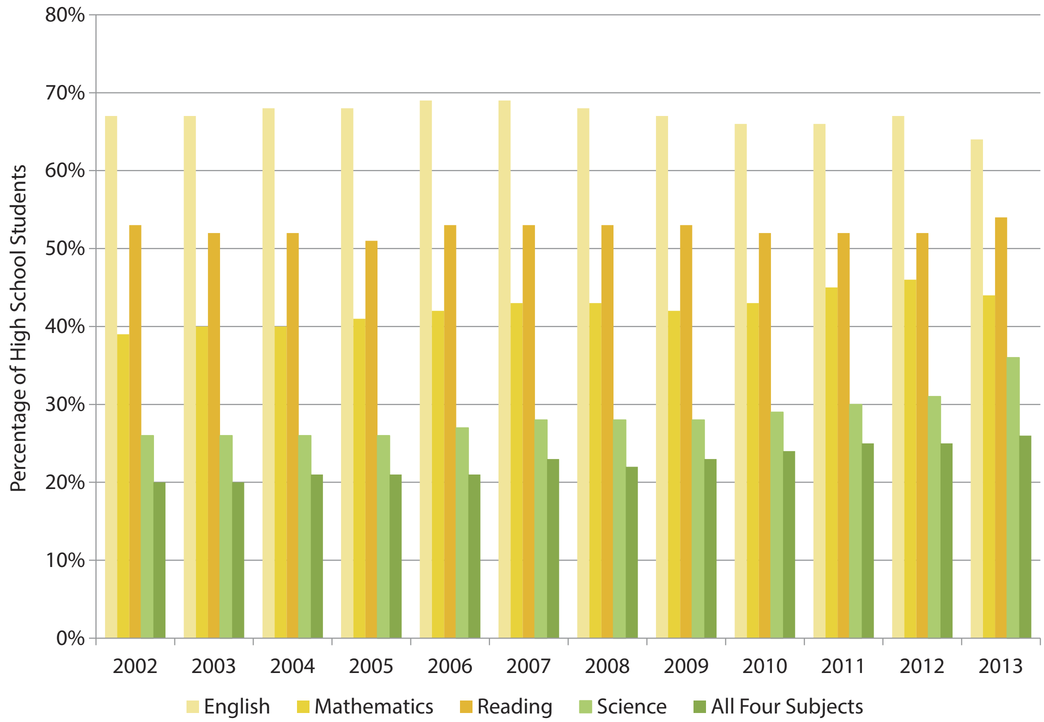
AGI Geoscience Workforce Program; Data derived from the College Board College-Bound Seniors, Total Group Report, 1996-2013

Figure 1.21: SAT Test-Takers Intending College Degrees in Physical Sciences or Interdisciplinary Studies



AGI Geoscience Workforce Program; Data derived from the College Board College-Bound Seniors, Total Group Report, 1996-2013

Figure 1.22: High School Students Meeting ACT College Readiness Benchmarks



AGI Geoscience Workforce Program; Data derived from ACT National Profile Report, 2002-2013

Chapter 2: Trends in Two-Year College Geoscience Programs

The steadily increasing number of students at two-year colleges each year represents a critical talent pool for the geosciences to recruit. This pool is particularly rich with populations that the geosciences have struggled to recruit: underrepresented minorities. Underrepresented minorities' enrollments at two year institutions have steadily increased since 1990 particularly within the Hispanic population, which made up 19% of enrollments in 2011.

The number of identified geoscience programs at two-year colleges continues to increase, with 24% of two-year colleges in the United States offering a geoscience program or course. While AGI's database is extensive, it may not contain all the geoscience programs in existence at a given time for two-year colleges due to periodic changes in programs, course offerings, and faculty. There is an identifiable relationship between states with major geoscience industries and the number of two-year institutions with a geoscience presence, such as Texas, California, Washington, Indiana, New York, and Arizona.

Most geoscience activities within two-year colleges only have one or two faculty members slated to teach a geoscience course, and these faculty members tend to be within a natural sciences or physical sciences division. Two-year colleges tend to have younger faculty and a higher percentages of female faculty in tenure and tenure-track positions than at four-year institutions.

Geoscience faculty teaching at two-year colleges have indicated a growing interest in the geosciences among their students, particularly in states with strong geoscience industries, and they tend to encourage their students to transfer to four-year institutions to complete their geoscience degrees. Thus, this student population is an ideal target for recruitment of geoscience majors at four-year institutions. In fact, more bachelor's graduates with a degree in the physical sciences tend to have transferred from a two-year college than any other science discipline. Specifically for the geosciences, 27% of students graduating with a bachelor's degree in the geosciences spent at least a semester at a two-year college before transferring to a four-year institution.

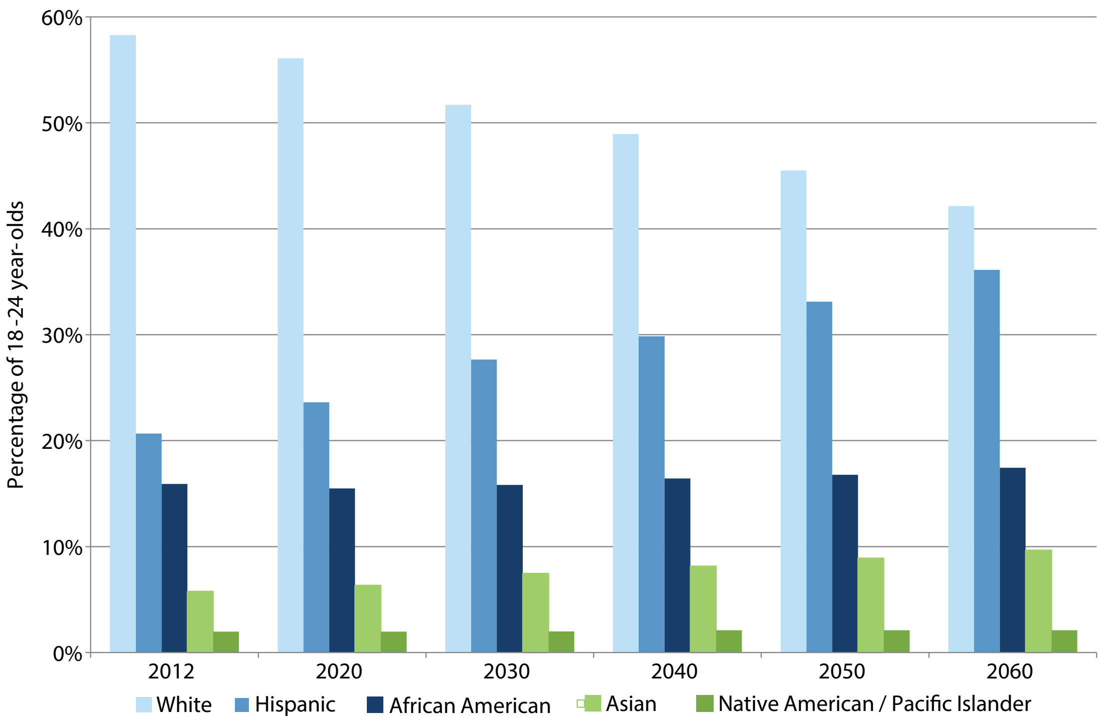
The number of associate's degrees awarded in the geosciences by two-year colleges has fluctuated widely over the past decade, but an increasing trend in awarded associate's degrees since 2010 is evident with more than 230 conferred in 2012. While it is clear that attendance of underrepresented minorities at two-year colleges is steadily increasing, the percentage of geoscience associate's degrees awarded to minorities is lower than for any other science discipline at 18%. With Hispanics alone making up 19% of the enrollments at two-year colleges, this low percentage of awarded associate's degrees in the geosciences reinforces the need for more recruitment efforts for geoscience majors among underrepresented minority populations at the two-year college level.

All employment sectors in the geosciences have begun to investigate the skills portfolio and workforce development of students at the two-year college level. AGI recognizes the need for more data collection about two-year college students transferring into four-year institutions for a geoscience degree or into the geoscience workforce, so future research will focus on this pool of students. Therefore, future efforts at AGI will look at students' reasons for transferring into four-year institutions to pursue a geoscience degree, as well as the composition of the geoscience workforce with an associate's or technical degree.

National Benchmarks

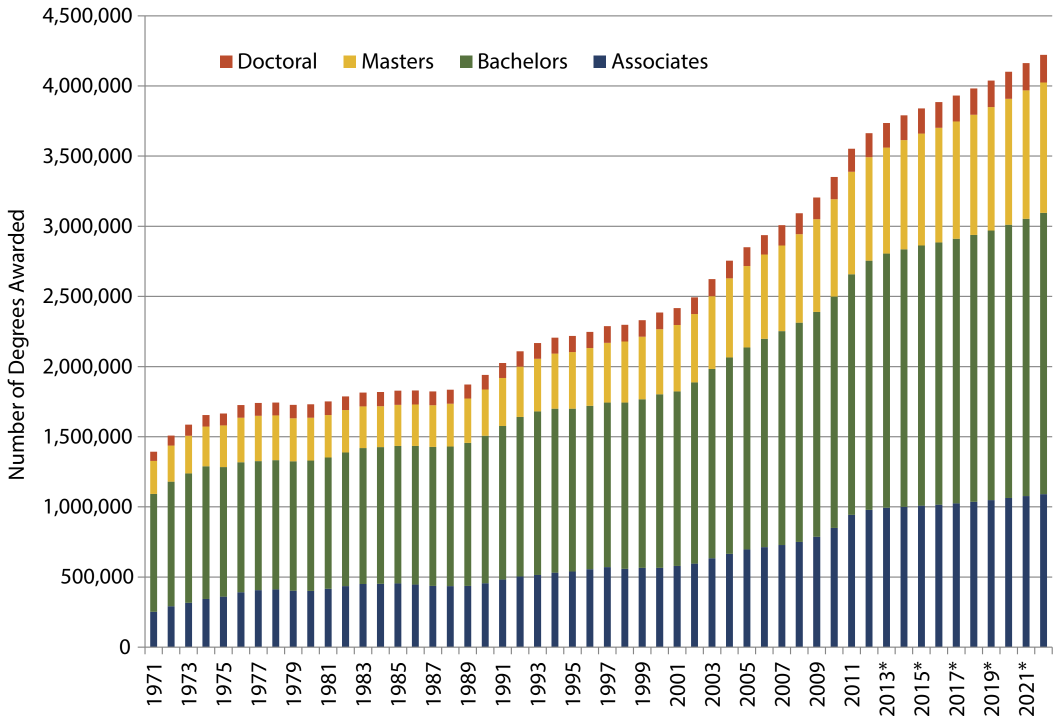
This section clearly shows the rapidly growing talent pool of college-age underrepresented minority groups, particularly Hispanics, and women. By 2060, the Hispanic college-age population is projected to grow to near parity with the Caucasian U.S. college-age population (Figure 2.1). Currently 49% of the U.S. college-age population is female; however, the majority of all degrees are awarded to women (Figure 2.3). This is particularly true for two-year colleges with increasing percentages of associate's degrees awarded to underrepresented minorities and consistently high rates of women earning associate's degrees (Figures 2.3 and 2.4). Figures 2.2 and 2.3 present projected data based on the most recent data reported for 2011.

Figure 2.1: Race/Ethnicity of U.S. College-Age Population, 2012-2060



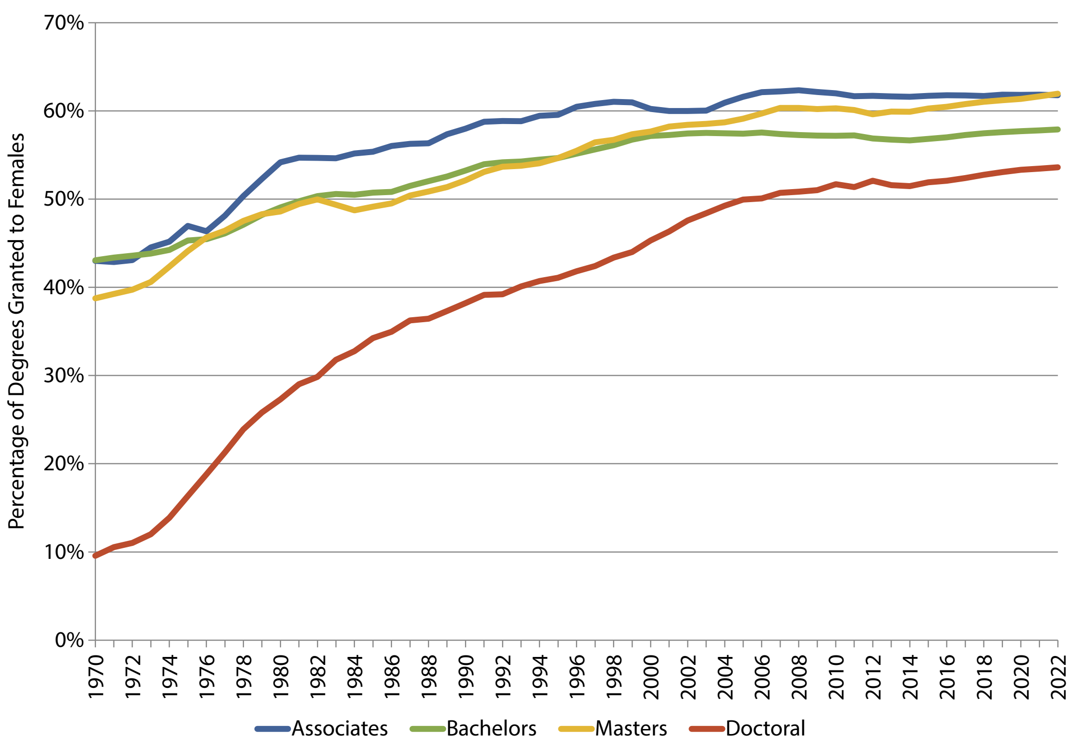
AGI Geoscience Workforce Program; Data derived from US Census Bureau Population Estimates

Figure 2.2: Degrees Granted from U.S. Postsecondary Institutions



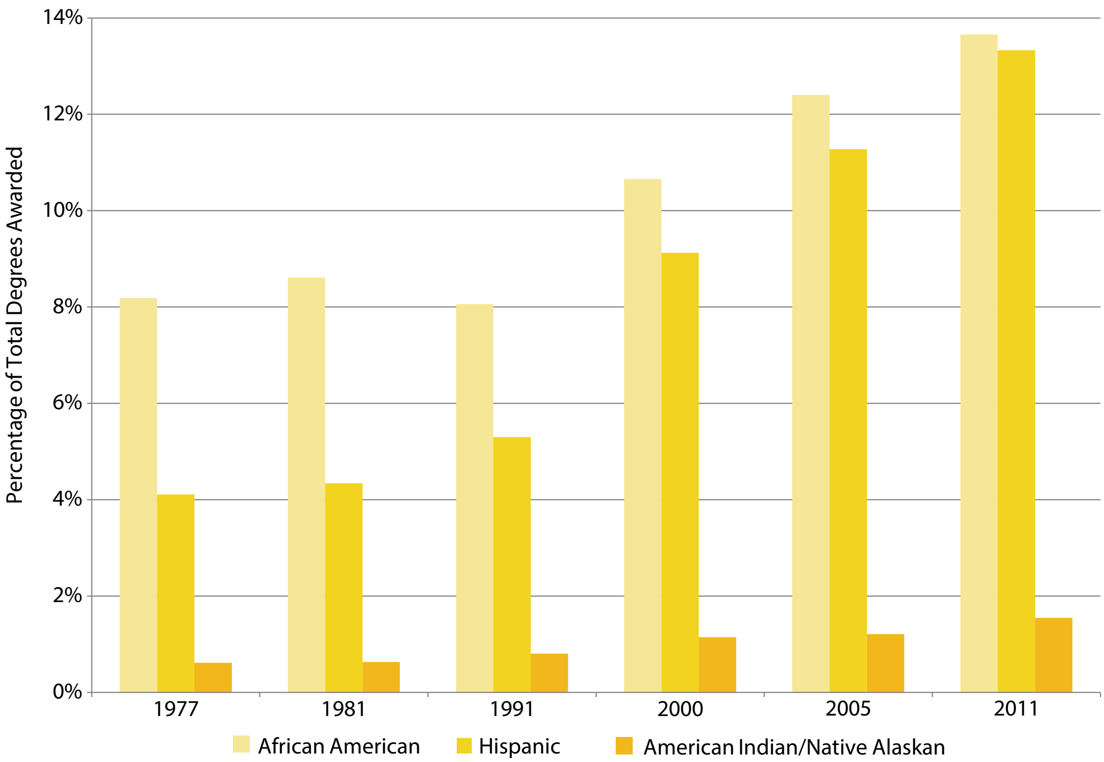
AGI Geoscience Workforce Program; Data derived from NCES Digest of Education Statistics, 2012

Figure 2.3: Percentage of Degrees Granted to Women by Degree Level, All Majors



AGI Geoscience Workforce Program; Data derived from NCES Digest of Education Statistics, 2012

Figure 2.4: Percentage of Associate's Degrees Awarded to Underrepresented Minorities, All Degree Fields

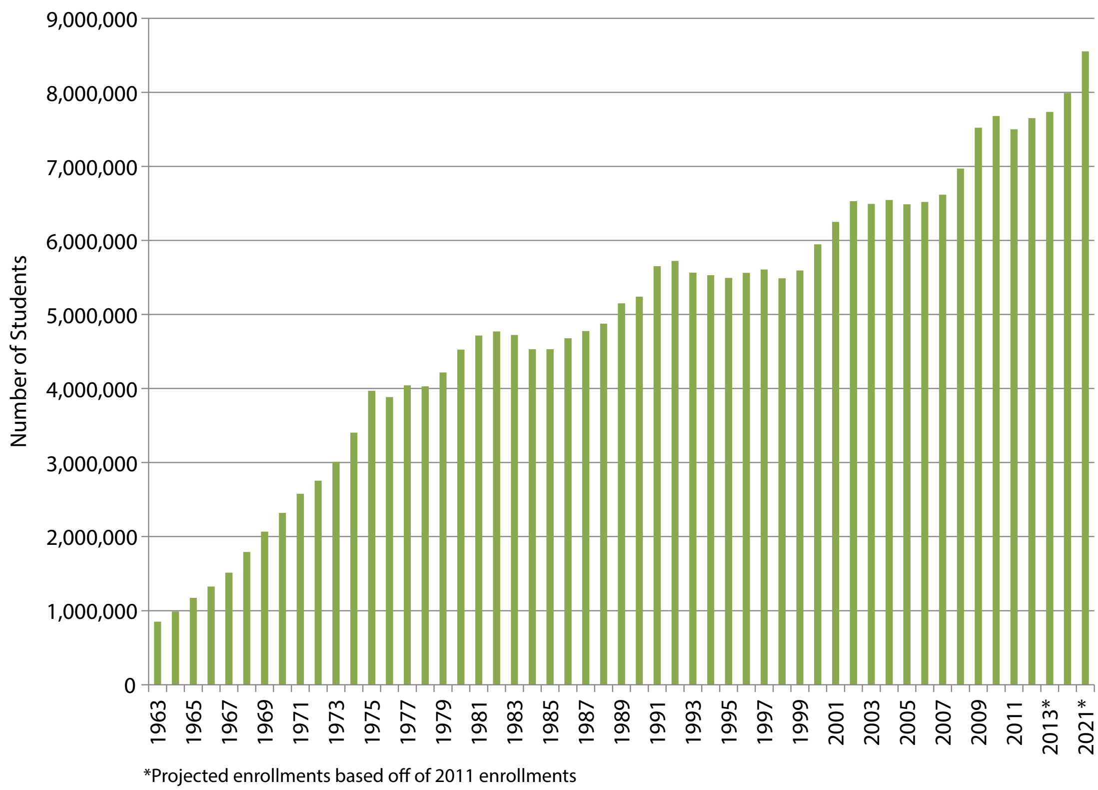


AGI Geoscience Workforce Program; Data derived from NCES Digest of Education Statistics, 2012

Two-Year Enrollments

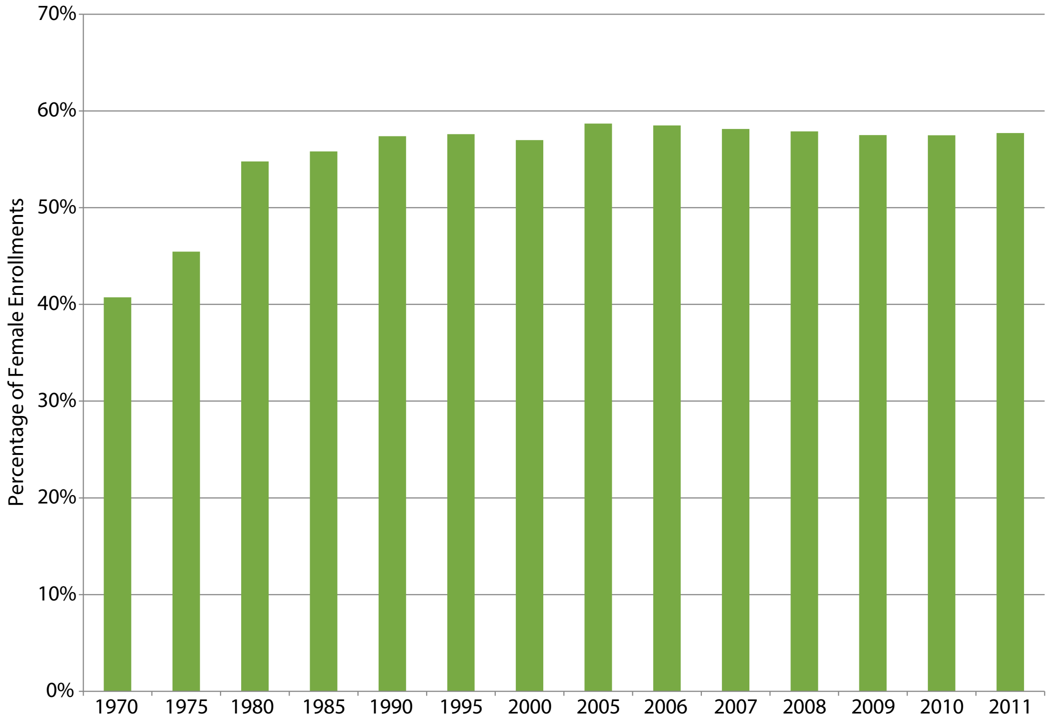
Student enrollments at two-year colleges rose to nearly 7.5 million students in 2011 (Figure 2.5). Female participation remained steady at just under 60%. (Figure 2.6). Enrollment percentages of all underrepresented minority groups also continue to rise at two-year colleges (Figure 2.7). With two-year enrollments steadily rising, particularly among under-represented minorities, more focus needs to turn to recruitment of these students into geoscience majors and career fields.

Figure 2.5: Fall Enrollments at U.S. Two-Year Colleges



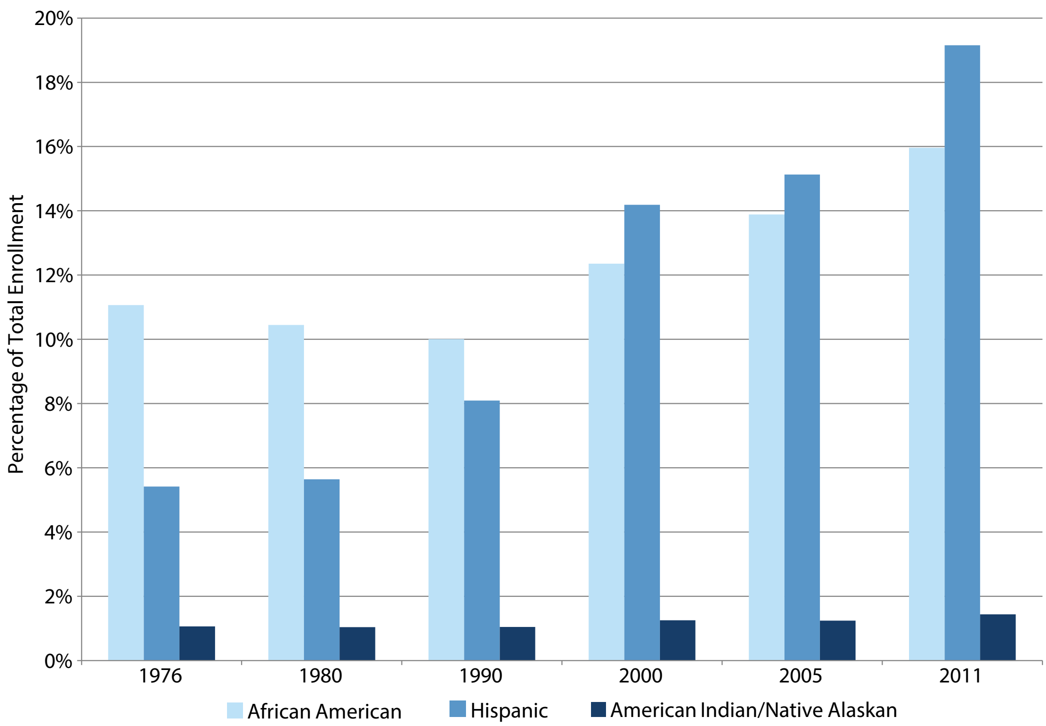
AGI Geoscience Workforce Program; Data derived from NCES Digest of Education Statistics, 2012

Figure 2.6: Participation of Women in Two-Year Colleges



AGI Geoscience Workforce Program; Data derived from NCES Digest of Education Statistics, 2012

Figure 2.7: Underrepresented Minority Enrollments at Two-Year Colleges



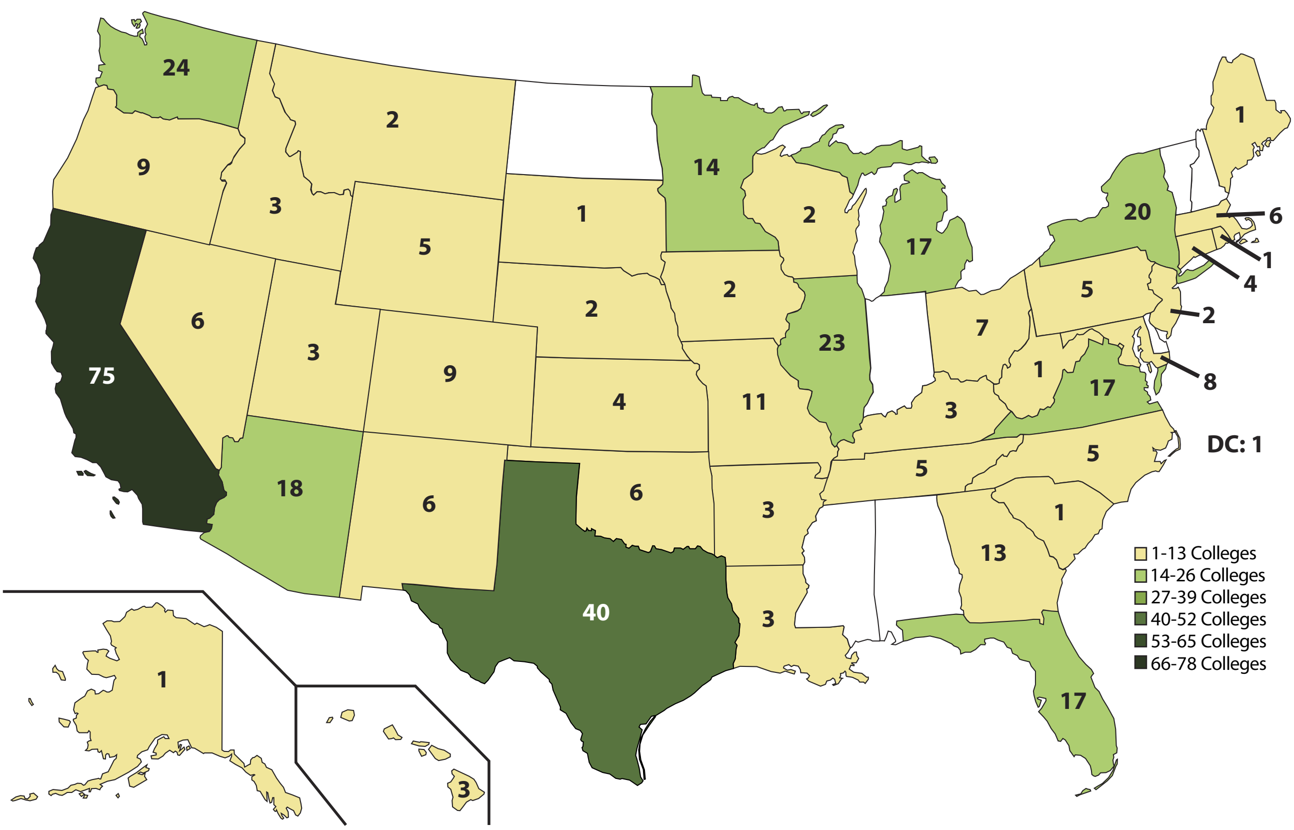
AGI Geoscience Workforce Program; Data derived from NCES Digest of Education Statistics, 2012

Geoscience Departments and Faculty

There are currently 1,721 two-year colleges in the United States, according to the Department of Education, and 409 of these schools have a geoscience program or course available for students (Figure 2.8). California and Texas continue to have the most geoscience programs or courses available at two-year colleges, but Washington has the highest percentage of geoscience programs within all of the two-year colleges in the state (Table 2.1).

However, most schools that provide geoscience courses have very few faculty to teach these classes. Out of the 409 two-year colleges with geosciences, 59% have fewer than five faculty members that teach geoscience coursework and 29% have only one faculty member to represent the geosciences (Figure 2.9). Approximately 30% of the geoscience faculty teaching at two-year colleges are working part-time at these institutions (Figure 2.10). Twenty-eight percent of two-year college geoscience faculty are female, compared to the 17% of four-year university geoscience faculty (Figure 2.11 and 3.5).

Figure 2.8: Number of Geoscience Departments/Programs at Two-Year Colleges by State



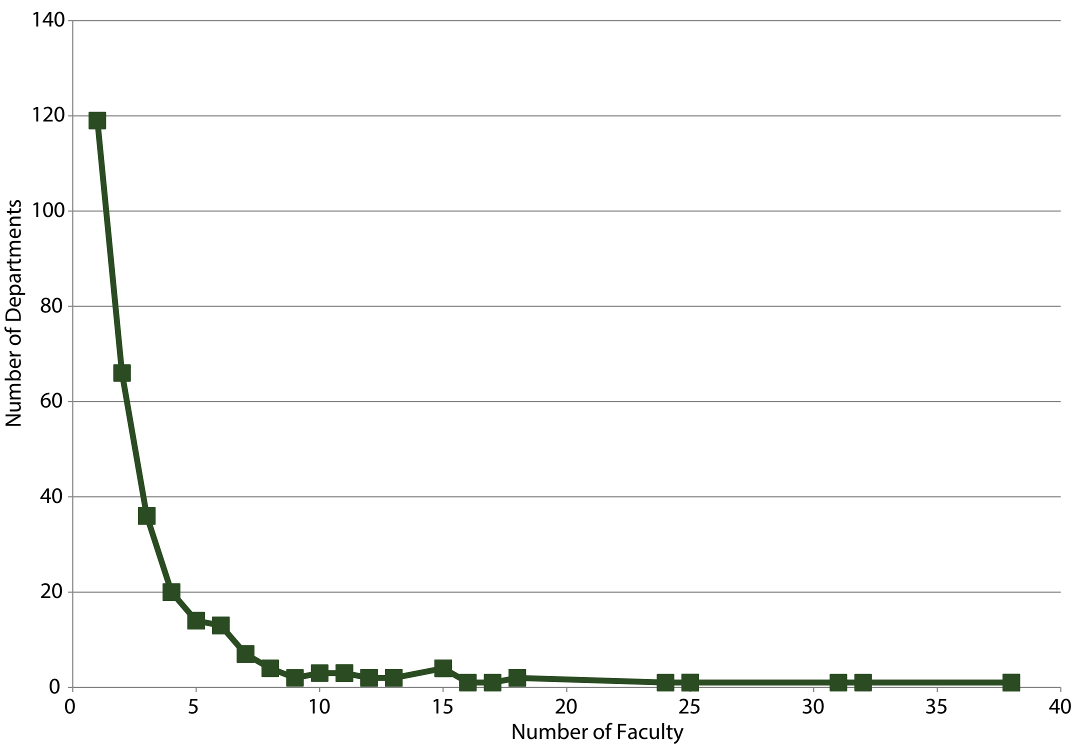
AGI Geoscience Workforce Program; Data derived from AGI's Directory of Geoscience Departments database

Table 2.1: Percentage of Two-Year Colleges with Geoscience Programs for Selected States

State	2-Year Colleges with Geoscience Programs	2-Year Colleges in the State	Percentages of 2-Year Colleges in the State with Geoscience Programs
California	75	289	26%
Texas	40	175	23%
Washington	24	56	43%
Illinois	23	90	26%
New York	20	135	15%
Arizona	18	57	32%
Florida	17	190	9%
Michigan	17	60	28%
Virginia	17	73	23%
Minnesota	14	75	19%

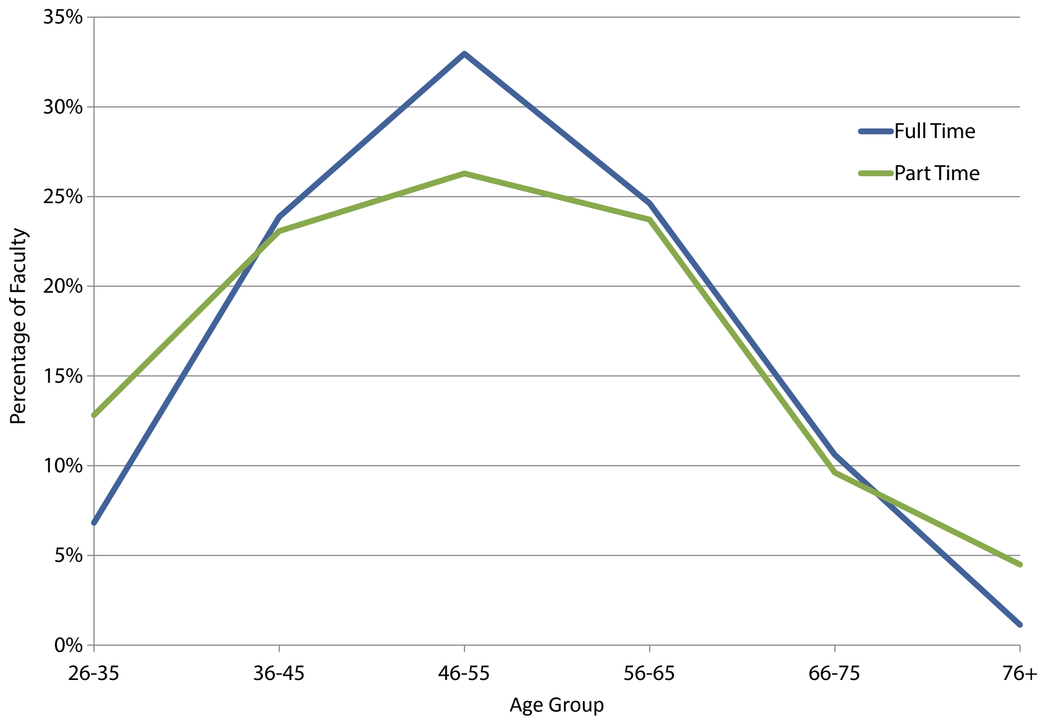
AGI Geoscience Workforce Program; Data derived from AGI's Directory of Geoscience Departments database

Figure 2.9: Number of Faculty per Geoscience Department/Program at Two-Year Colleges



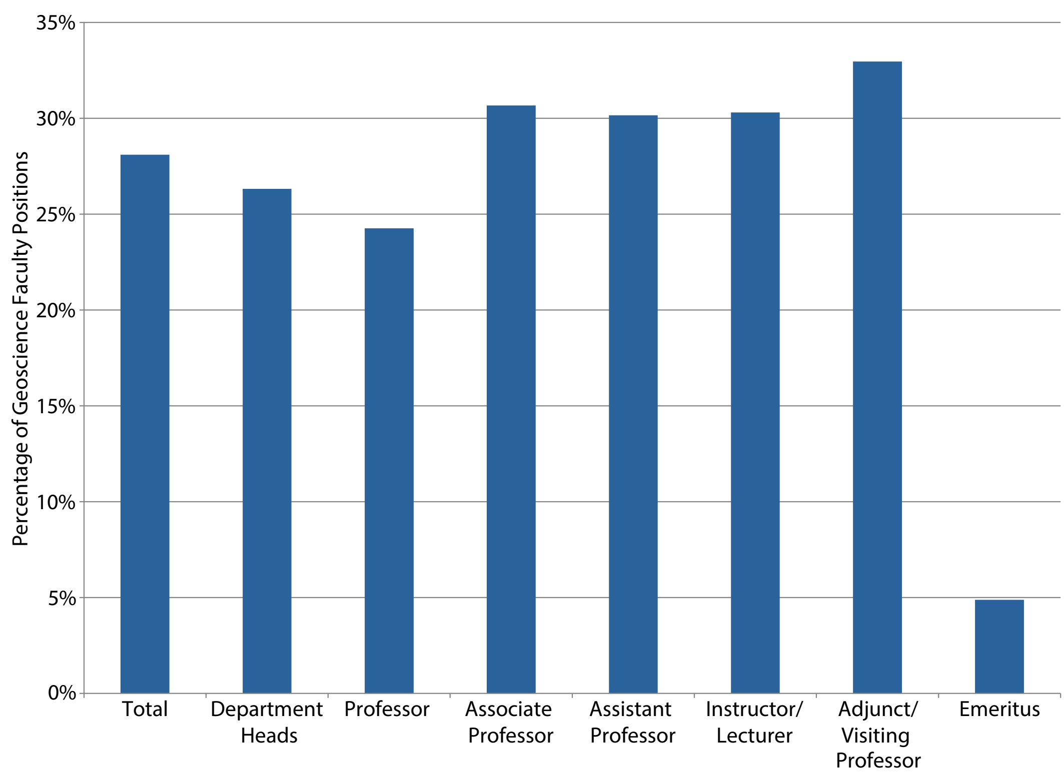
AGI Geoscience Workforce Program; Data derived from AGI's Directory of Geoscience Departments database

Figure 2.10: Age Demographics of Two-Year College Geoscience Faculty



AGI Geoscience Workforce Program; Data derived from AGI's Directory of Geoscience Departments database

Figure 2.11: Percentage of Two-Year Geoscience Faculty Positions Held by Women

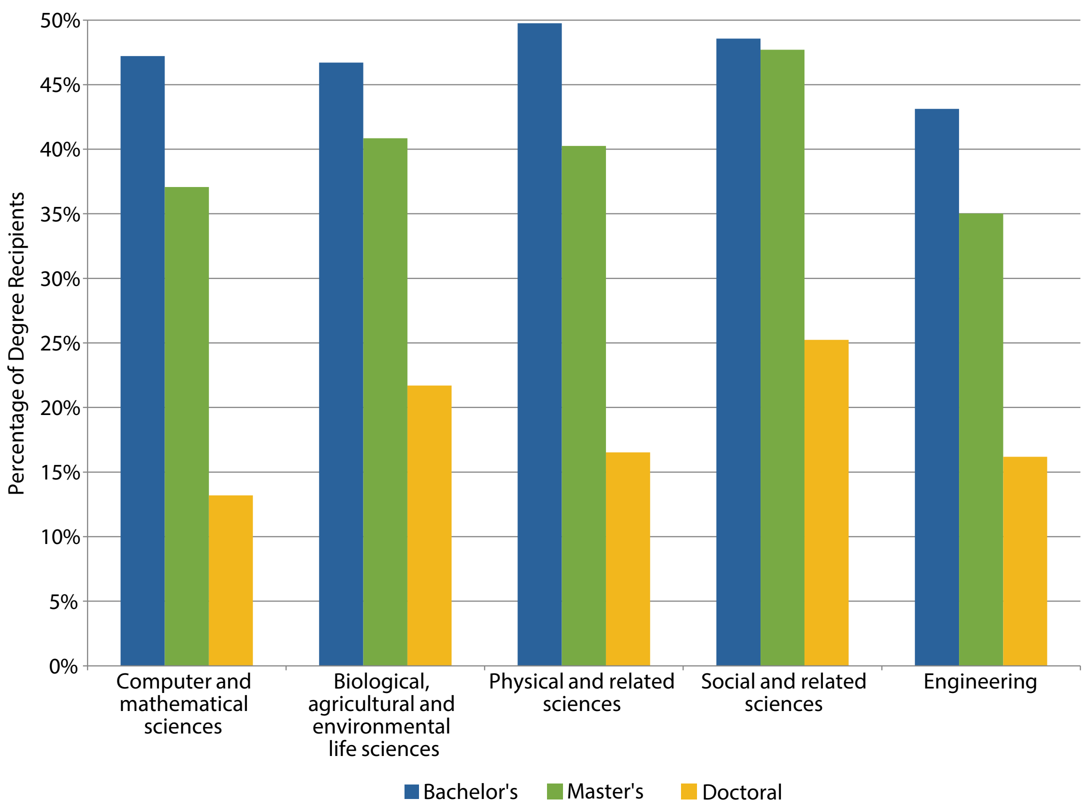


AGI Geoscience Workforce Program; Data derived from AGI's Directory of Geoscience Departments database

Geoscience Students

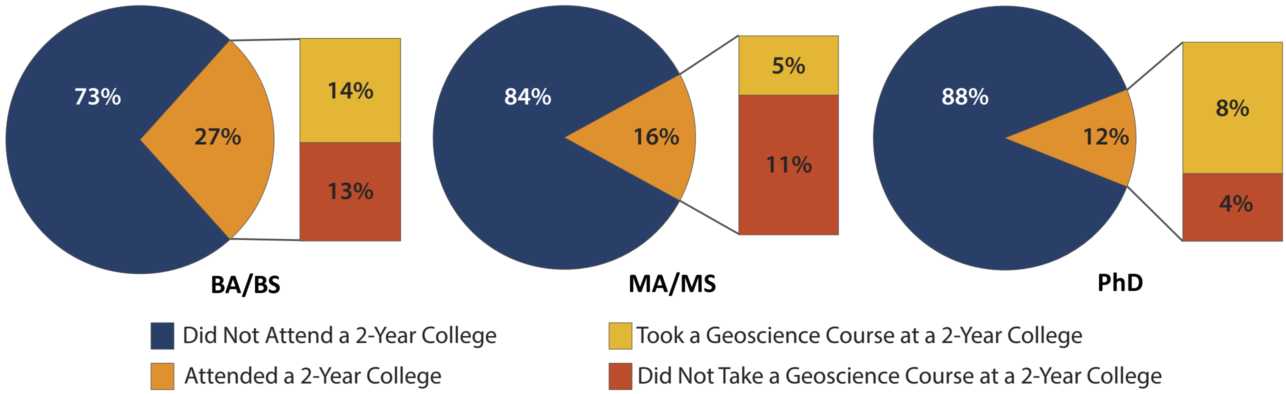
Many of the students that attend a two-year college transfer to four-year universities with or without completing an associate's degree, particularly in the sciences. According to the National Science Foundation, half of the bachelor's graduates with a degree in the physical and related sciences attended a two-year college (Figure 2.12). In the geosciences, slightly more than a quarter of the bachelor's graduates attended a two-year college (Figure 2.13). These figures also reinforce the need to increase recruitment of geoscience majors among two-year college students.

Figure 2.12: Four-Year University Graduates by Degree Field Who Attended a Two-Year College



AGI Geoscience Workforce Program; Data derived from NSF's NSCRG 2010 Public Dataset

Figure 2.13: Geoscience Graduates with at Least One Semester at a Two-Year College



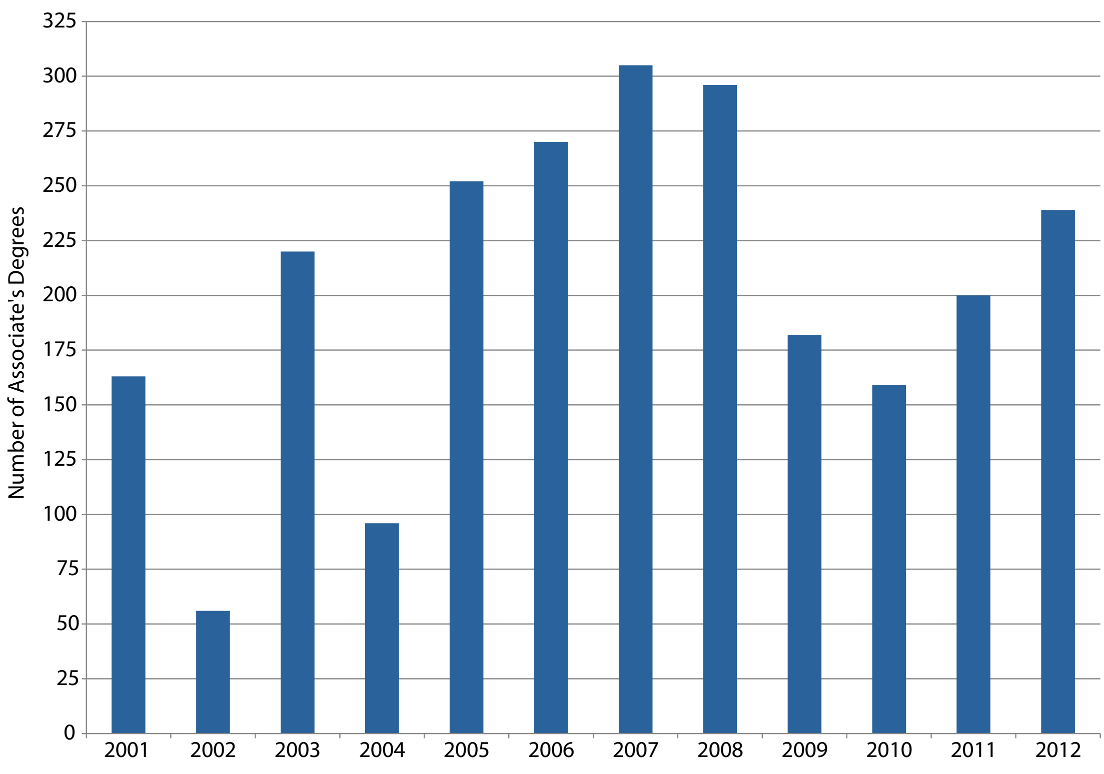
AGI Geoscience Workforce Program; Data derived from AGI's Geoscience Student Exit Survey; Figure created by Kathleen Cantner

Geoscience Associate's Degrees

The number of associate's degrees awarded in the geosciences has varied widely from year to year since 2001. However, this number appears to be rising with 239 associate's degrees awarded in 2012 — a 50% increase since 2010 (Figure 2.14). Of these completed geoscience associate's degrees in 2012, 36% were awarded to women and 18% were awarded to underrepresented minorities (Figure 2.15 and 2.16).

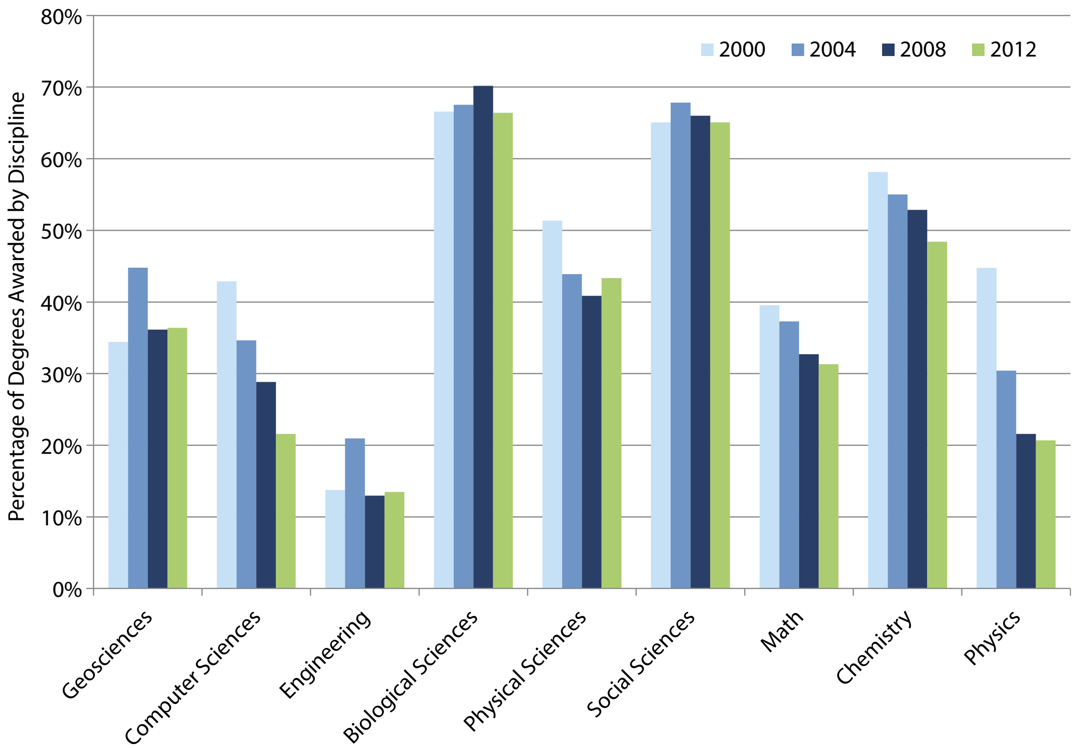
All three figures were derived from data provided by the Department of Education's Integrated Postsecondary Education Database System (IPEDS). When looking at these data, it is important to remember that the information is self-reported by each institution's main administrative office. The information represents the main offices' definitions of geoscience and other fields. This may help explain some of the change and variance in the number of geoscience associate's degrees awarded each year. This information would be more reliable if reported directly from the geoscience programs within the two-year colleges, but with many of these programs consisting of only one or two faculty members, this data collection would be difficult to initiate and sustain.

Figure 2.14: Geoscience Associate's Degrees Awarded Annually



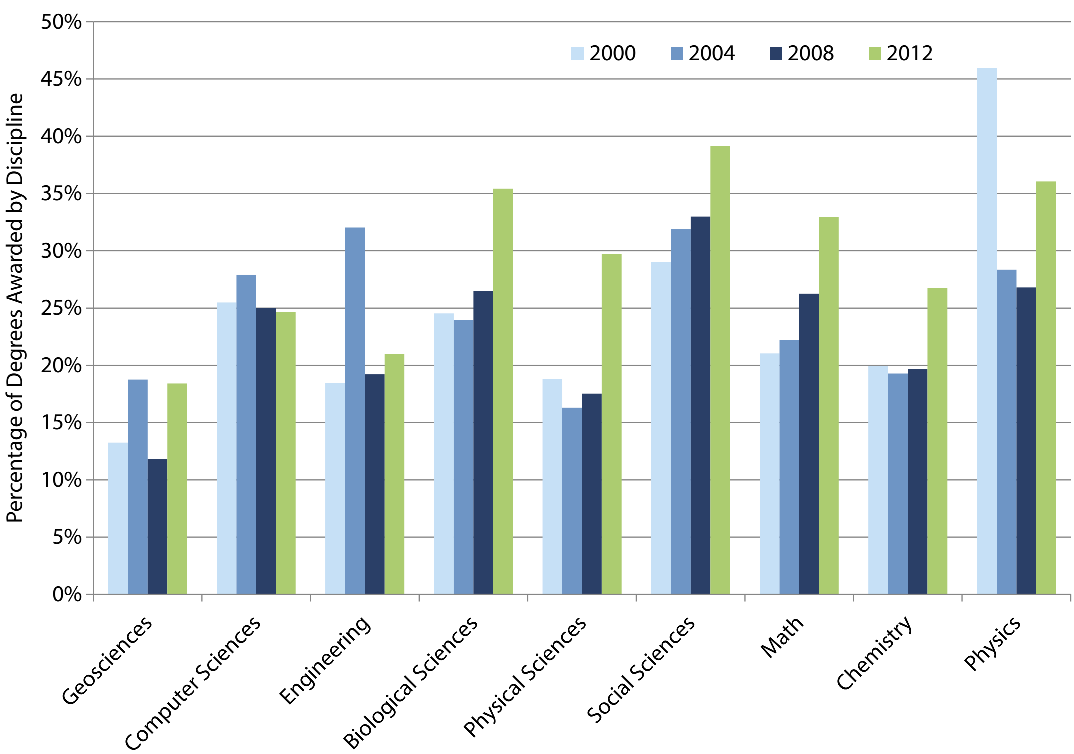
AGI Geoscience Workforce Program; Data derived from IPEDS

Figure 2.15: Percentage of Associate's Degrees Awarded to Women by Discipline



AGI Geoscience Workforce Program; Data derived from IPEDS

Figure 2.16: Percentage of Associate's Degrees Awarded to Underrepresented Minorities by Discipline



AGI Geoscience Workforce Program; Data derived from IPEDS

Chapter 3: Trends in Four-Year Institution Geoscience Programs

A geoscience degree from a four-year institution is essential for developing the necessary knowledge and technical skills to be successful in the workforce. The master's degree in the geosciences historically has been considered the degree of employment for private sector jobs in the geosciences, but recently bachelor recipients are starting to be hired more frequently. Therefore measuring the health of geoscience departments at four-year institutions is essential for tracking the future of the geoscience workforce.

Though the number of geosciences programs in the United States remains relatively steady, some programs begin and others close every year. The student to faculty ratio in programs in most states has increased since 2011. This is attributed to the increases in undergraduate and graduate enrollments with only small increases in the number of faculty members teaching these students. The shift in student to faculty ratios is most pronounced in Texas, Colorado, and California.

Geoscience faculty at four-year institutions tend to enter tenure-track positions 2–4 years after completing their doctorate, and typically take slightly more than 20 years from completion of the doctorate to reach full professor. Since 2011, the number of emeritus faculty has increased from just over 900 to over 1100. Approximately 37% of geoscience faculty are above federal retirement age, and 17% of all geoscience faculty are listed as emeritus. The percentages of females in geoscience faculty and researcher positions continue to slowly increase to 17% of the entire geoscience workforce at four-year institutions. This slow upward trend of women in academia is expected to continue due to the relatively high percentage of women currently in assistant professor positions.

Student enrollments in geoscience departments tend to follow the economic trends of the geosciences. Since 2007, enrollments have been increasing due to the high job availability in many of the geoscience industries. Interestingly, this acceleration in enrollments is largely accommodated by new male students. Female enrollments are also increasing in geoscience departments, but not at the same rate as males. This upward trend is also seen in the rate of bachelor's degrees awarded. Students from underrepresented minorities are harder to track through enrollments; however data collection efforts by AGI and NSF provide a better understanding of the graduation rates of minorities with geoscience degrees. Approximately 7–8% of degrees awarded in the geosciences are to underrepresented minorities; the majority of these students tend to be Hispanic. These percentages are the lowest of all science disciplines according to NSF.

The core skill sets for new geosciences graduates is a common concern. Quantitative skills in particular are considered a major concern. Most geoscience students complete Calculus I and II while working towards their degree, but participation in higher-level quantitative courses is well below half of all graduates. Many industries continue to indicate these higher math skills are requirements for success and thus struggle to find enough qualified graduates.

Nearly every geoscience student participates in a field experience, whether it is field camp, a field course, or a field component during a trip or outing. Field camp attendance continues to rapidly increase since 2006, with emerging evidence that available field camps are at capacity. Field camp access may become a limiting factor for some graduates' employability. Most geoscience students recognize the importance of research in the geosciences and participate in at least one research experience before graduation. However, the number of master's theses, in particular, reported to GeoRef since the 1980s has decreased dramatically. Student internships do not seem to be as emphasized within geosciences programs, as seen by the low participation rates, particularly at the bachelor's and doctoral degree levels. Over 60% of master's graduates participated in at least one internship, and as a result, almost half of those students found a job when they graduated at the same company where they interned.

Much of the data presented in this report on geoscience students at four-year institutions originated from AGI's Geoscience Student Exit Survey. This study was developed to understand the preparation of students for entering the workforce and their immediate plans after graduation. For more information about this study, please visit http://www.americangeosciences.org/workforce/exit-survey.

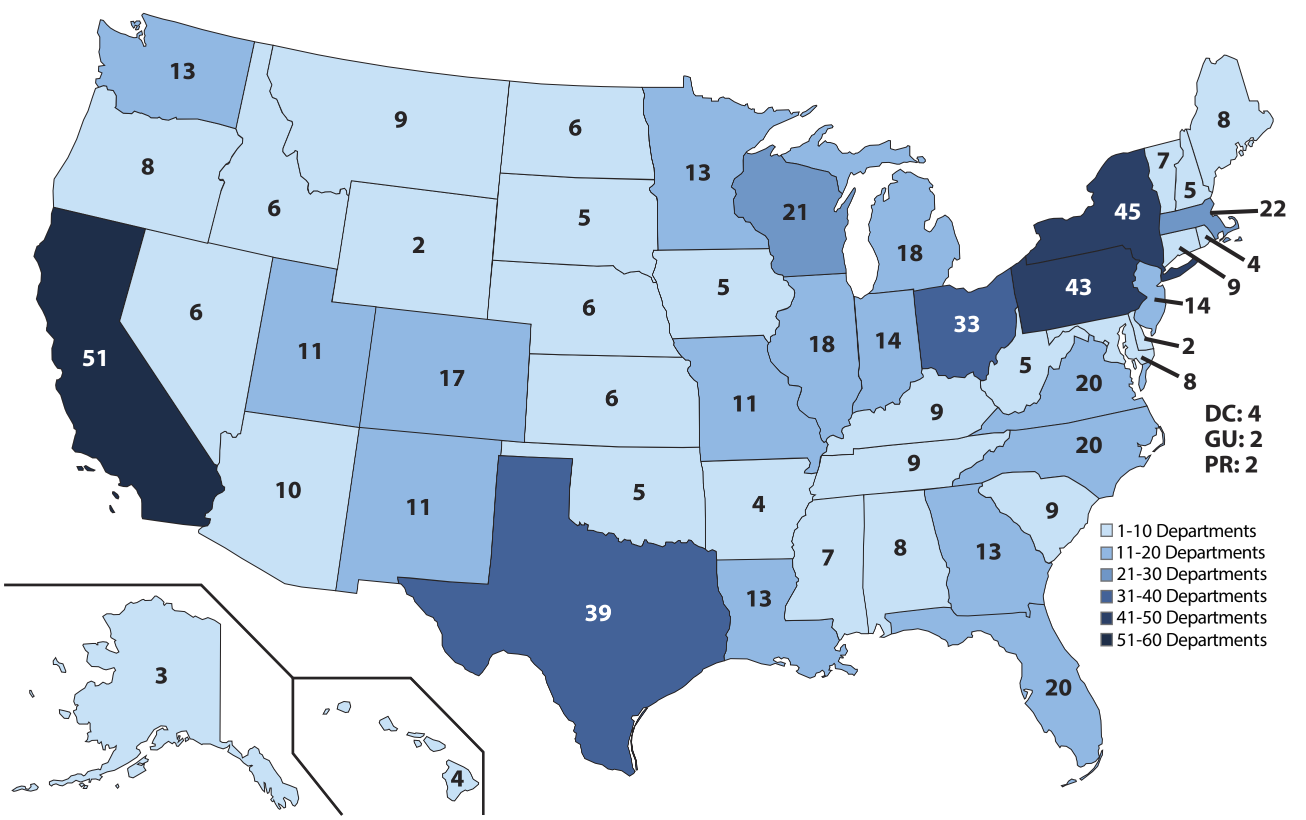
Geoscience Departments

According to AGI's Directory of Geoscience Departments, there are currently 661 geoscience departments at four-year universities (Figure 3.1). Since 2011, six states saw reductions in the number of geoscience departments and fifteen states saw increases in the number of geoscience departments.

Changes in faculty appointments and student enrollments have really changed the student to faculty ratio compared to the 2011 (Figure 3.2). In the U.S., the average number of geoscience tenure-track faculty within a geoscience department is approximately ten faculty members, and the average enrollment within geoscience departments is 88 students. Texas leads the nation in the number of geoscience undergraduate and graduate students enrolled within geoscience departments, followed closely by Colorado and California (Tables 3.1 and 3.2).

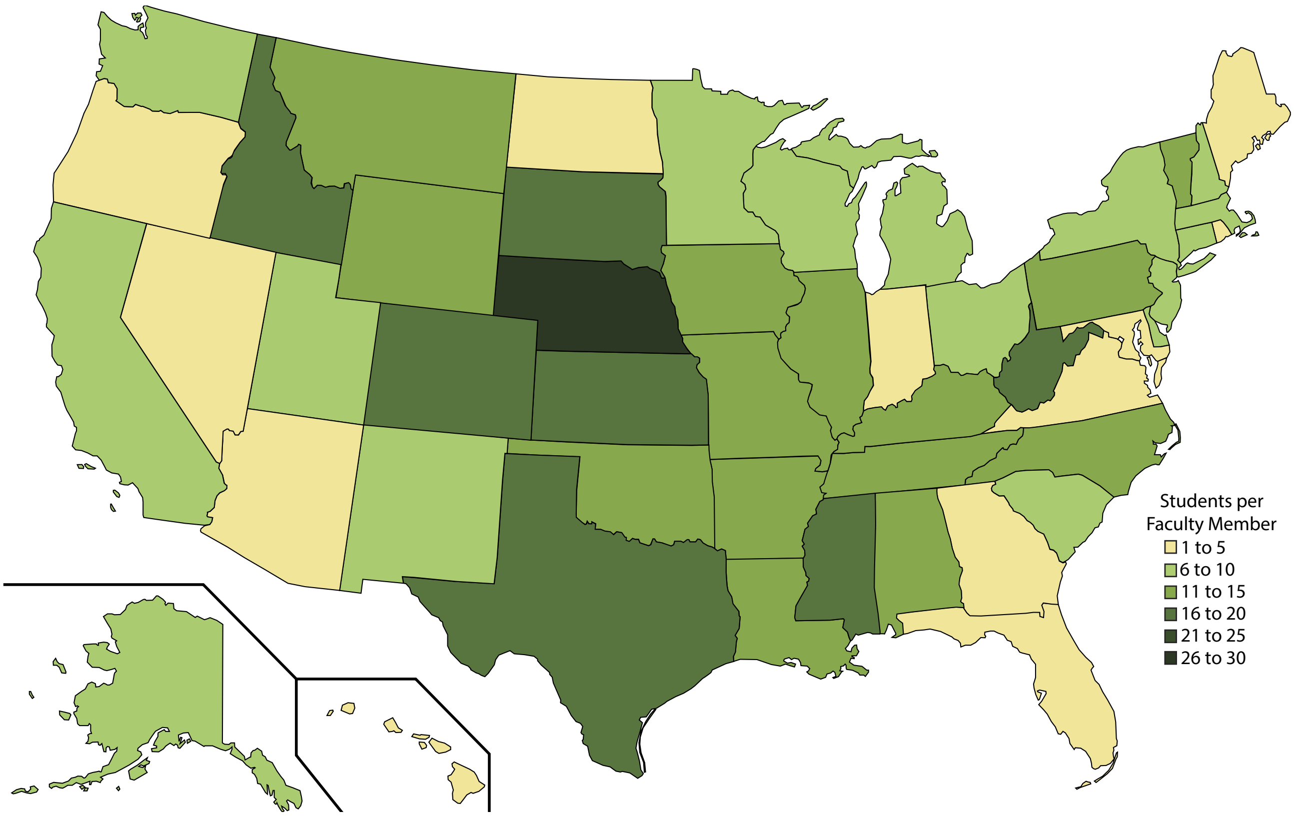
The data provided to AGI's Directory of Geoscience Departments is self-reported by representatives within each department on a near annual basis. Over the past two years, AGI has actually increased the number of departments that are regularly updating their listings on a yearly basis, which lends more reliability to the presented data.

Figure 3.1: Number of Geoscience Departments by State



AGI Geoscience Workforce Program; Data derived from AGI's Directory of Geoscience Departments database

Figure 3.2: Number of Students per Tenure Track Faculty Member by State



AGI Geoscience Workforce Program; Data derived from AGI's Directory of Geoscience Departments database

Table 3.1: Percentage of All U.S. Geoscience Undergraduate Students Enrolled in 2012–2013

State	Percentage of All Undergraduate Geoscience Students
Texas	9.0%
Colorado	7.7%
California	7.5%
New York	5.9%
Ohio	5.8%
Pennsylvania	5.6%

AGI Geoscience Workforce Program; Data derived from AGI's Directory of Geoscience Departments database

Table 3.2: Percentage of All U.S. Geoscience Graduate Students Enrolled in 2012–2013

State	Percentage of All Graduate Geoscience Students
Texas	19.2%
California	11.6%
Colorado	8.6%
Nebraska	4.2%
Pennsylvania	4.2%
Kansas	3.1%

AGI Geoscience Workforce Program; Data derived from AGI's Directory of Geoscience Departments database

Geoscience Faculty

In 2013, there were 10,265 geoscience faculty and researchers employed at four-year universities, compared to 10,213 in 2011 and 10,051 in 2008. Approximately 70% of the geoscience faculty are tenured and 14% are untenured but in tenure-track positions.

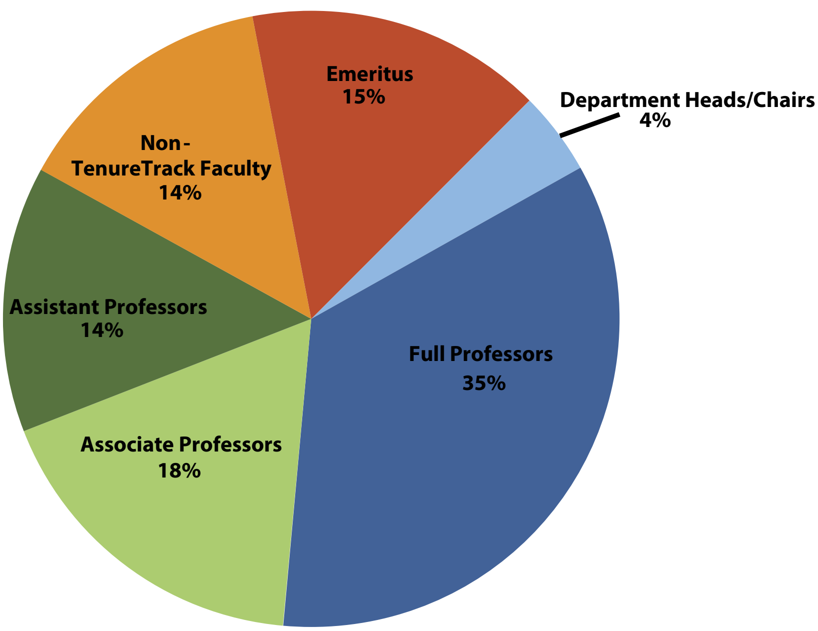
The age distribution of geoscience faculty has shifted to an average age of 60 years old in 2013. Since 2011, the ages of the majority of faculty ranked as professor has shifted from 56–60 years old to 61–65 years old (Figure 3.4). Also the number of emeritus faculty has rocketed up to 1160 people, compared to 900 in 2011.

The overall percentage of women in geoscience faculty positions at four-year universities continues to slowly rise from 16% in 2010 to 17% in 2013. This increase is also seen among all the different ranks given to faculty, except the overall percentage of tenure/tenure-track faculty (Figure 3.5).

According to AGI's GeoRef database, over the past several decades, there has been a 78% increase in the number of geoscience publications produced, from 156,274 in the 1970s to 278,184 in the 2000s (Figure 3.6). There have been rapid increases in the number of publications in the environmental geology, quaternary geology, and hydrogeology subject areas in particular. However, economic geology still maintains a high number of publications, only surpassed by environmental geology within the past decade. Publication rates within journals sponsored by geoscience societies show increases in the number of articles published about atmospheric sciences and climatology in particular (Figure 3.7).

Since 1999, there has been a decrease in the overall number of faculty specializing in major geoscience fields, except for geochemistry, and a slight increase in the number of faculty specializing in other geoscience fields, such as the atmospheric sciences, earth science education, and geographic information systems fields (Figure 3.8).

Figure 3.3: Percentage of Geoscience Faculty by Rank in Four-Year Institutions



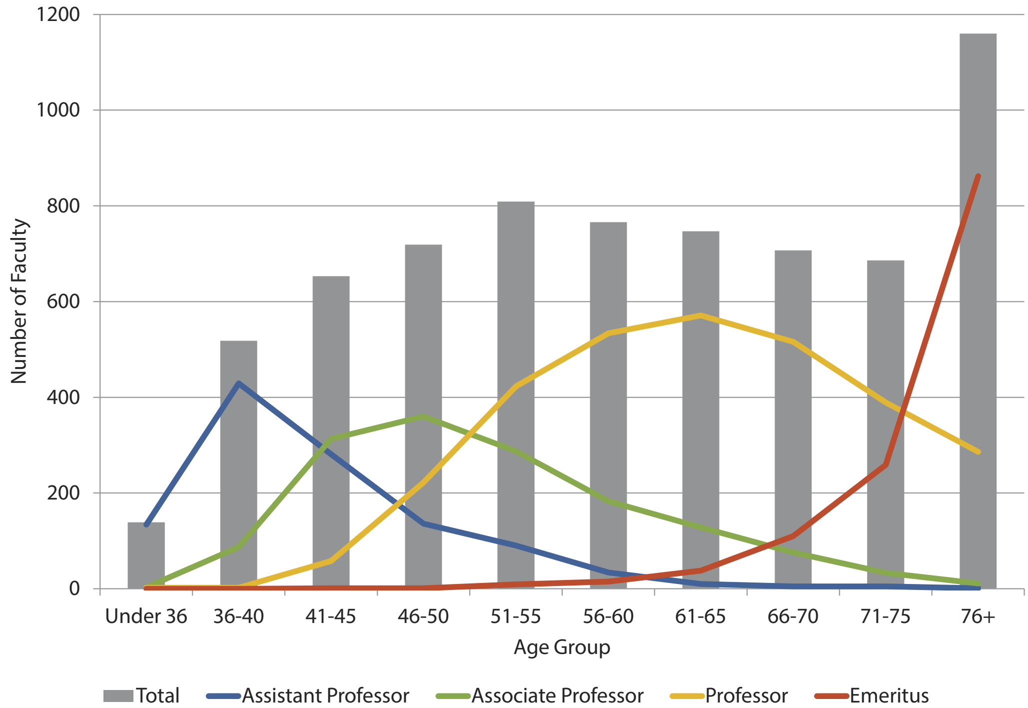
AGI Geoscience Workforce Program; Data derived from AGI's Directory of Geoscience Departments database

Table 3.3: Top Ten Degree Granting Institutions of U.S. Geoscience Tenure-Track or Tenured Faculty

School where Faculty Earned Highest Degree	Total Number of Tenure or Tenure-Track Faculty Graduates
Massachusetts Institute of Technology	288
University of California–Berkeley	228
University of Wisconsin–Madison	215
University of Washington	206
Stanford University	204
Harvard University	173
Columbia University	169
California Institute of Technology	161
Pennsylvania State University	151
University of Arizona	140

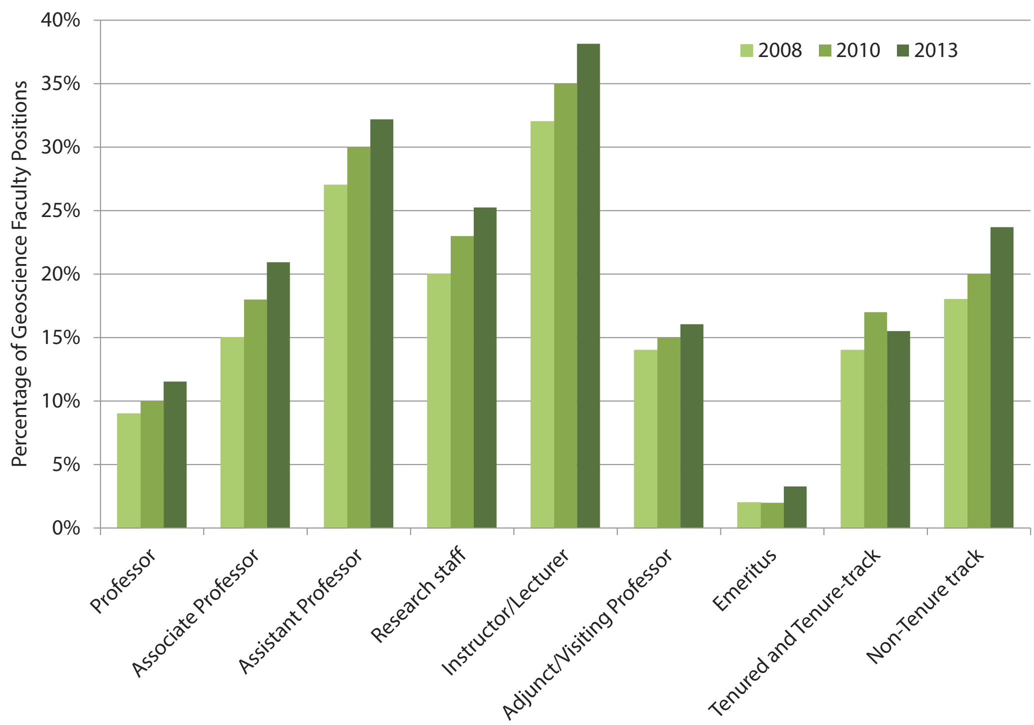
AGI Geoscience Workforce Program; Data derived from AGI's Directory of Geoscience Departments database

Figure 3.4: Number of Geoscience Faculty by Age Group and Rank



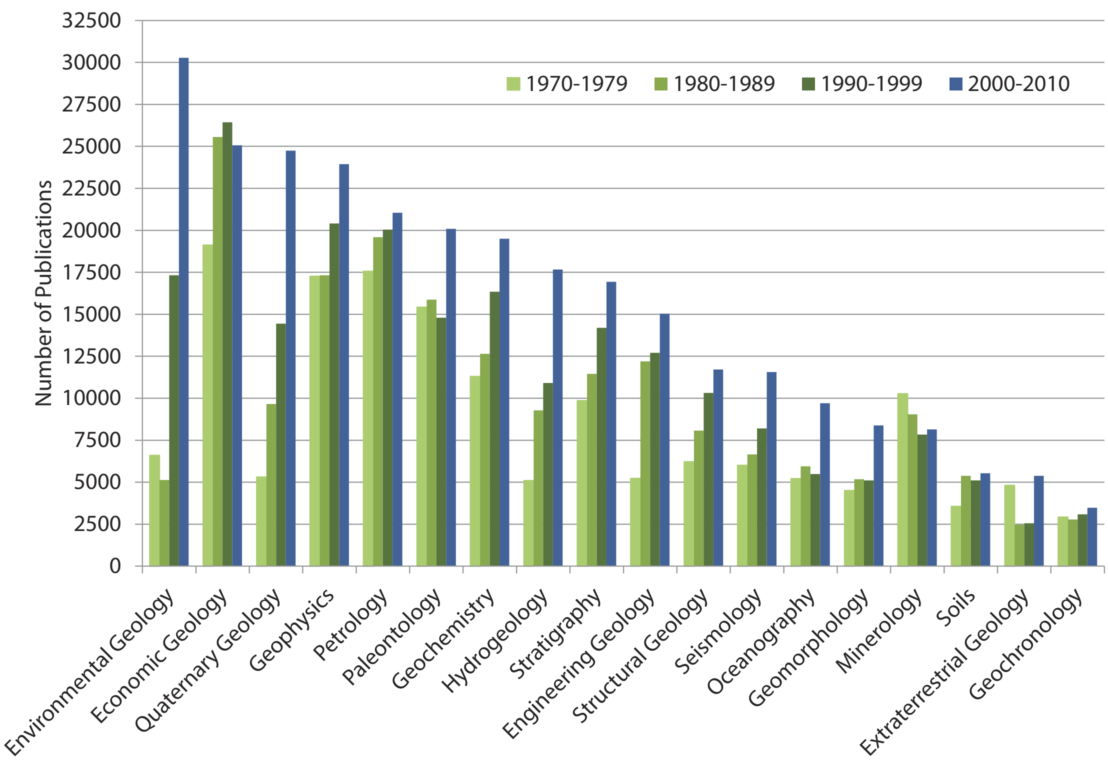
AGI Geoscience Workforce Program; Data derived from AGI's Directory of Geoscience Departments database

Figure 3.5: Percentage of Female Geoscience Faculty by Rank



AGI Geoscience Workforce Program; Data derived from AGI's Directory of Geoscience Departments database

Figure 3.6: Trends in Geoscience Publications



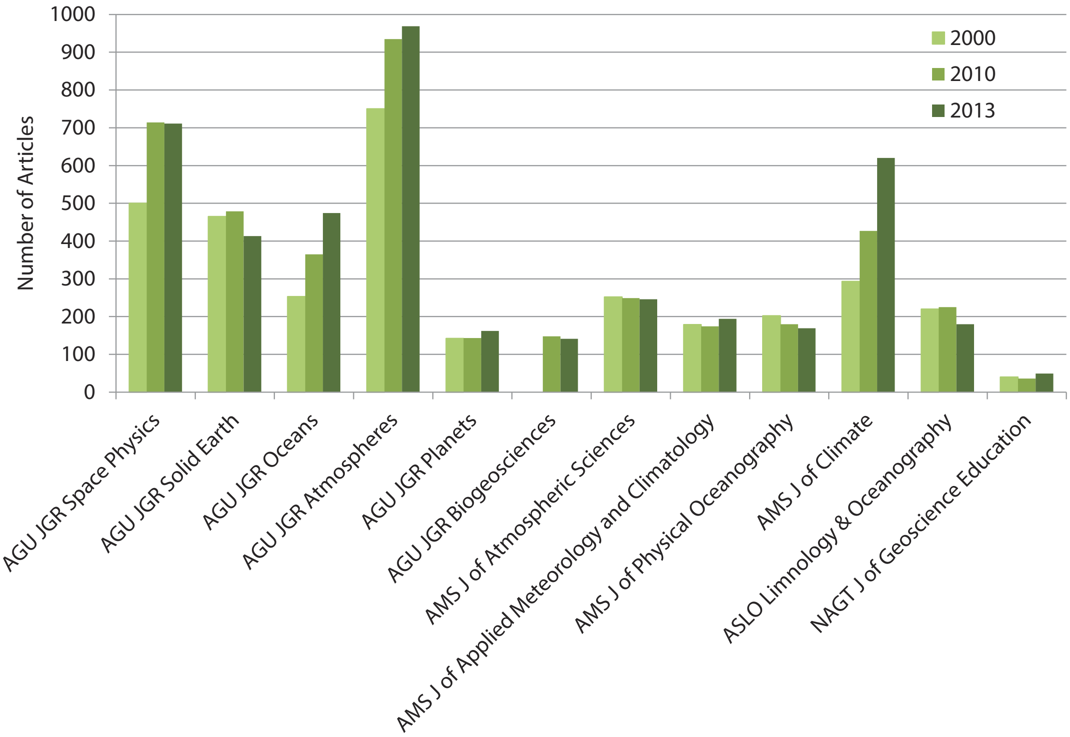
AGI Geoscience Workforce Program; Data derived from AGI's GeoRef database

Table 3.4: Top Five Geoscience Publication Topics, 1970-2010

1970-1979	1980-1989	1990-1999	2000-2010
Economic Geology	Economic Geology	Economic Geology	Environmental Geology
Petrology	Petrology	Geophysics	Economic Geology
Geophysics	Geophysics	Petrology	Quaternary Geology
Paleontology	Paleontology	Environmental Geology	Geophysics
Geochemistry	Geochemistry	Geochemistry	Petrology

AGI Geoscience Workforce Program; Data derived from AGI's GeoRef database

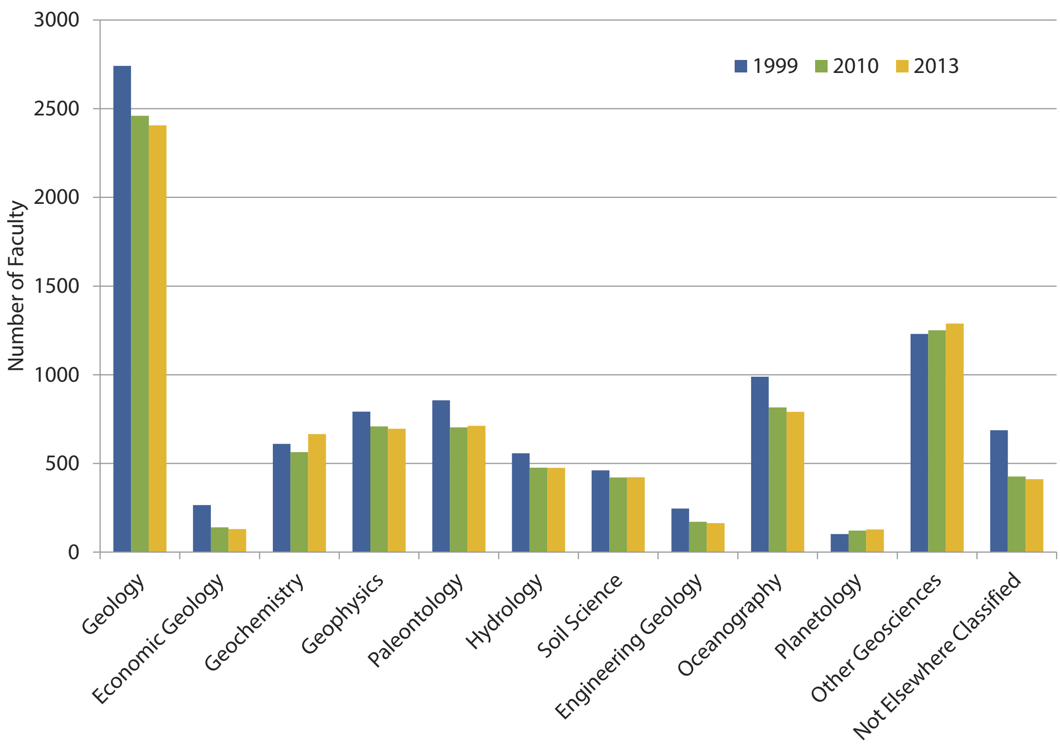
Figure 3.7: Publication Trends in Selected Geoscience Journals



Acromyns: American Geophysical Union (AGU) Journal of Geophysical Research (JGR); American Meteorological Union (AMS); Association for the Sciences of Limnology and Oceanography (ASLO); National Association of Geoscience Teachers (NAGT)

AGI Geoscience Workforce Program; Data derived from the AGU, AMS, ASLO, and NAGT journal publication websites

Figure 3.8: Trends in Geoscience Faculty Specialties (1999-2013)



AGI Geoscience Workforce Program; Data derived from AGI's Directory of Geoscience Departments database

Table 3.5: Research and Teaching Specialties of Geoscience Faculty, 2013

Faculty Specialties	Faculty (2013)
GEOLOGY	
General Geology	212
Archaeological Geology	47
Environmental Geology	112
Geomorphology	240
Glacial Geology	74
Marine Geology	88
Mineralogy and Crystallography	140
Paleolimnology	17
Petroleum Geology	42
General Petrology	74
Igneous Petrology	205
Metamorphic Petrology	104
Sedimentary Petrology	73
Sedimentology	308
Physical Stratigraphy	86
Structural Geology	337
Tectonics	122
Volcanology	69
Mathematical Geology	20
Mineral Physics	26
History of Geology	6
Geomedicine	3
Forensic Geology	1
ECONOMIC GEOLOGY	
General Economic Geology	60
Coal	17
Metals	40
Non-Metals	5
Oil and Gas	8
GEOCHEMISTRY	
General Geochemistry	146
Analytical Geochemistry	30
Experimental Petrology/Phase Equilibria	45
Exploration Geochemistry	6
Geochronology and Radioisotopes	89
Low-Temperature Geochemistry	141

Faculty Specialties	Faculty (2013)
Marine Geochemistry	62
Organic Geochemistry	50
Stable Isotopes	81
Trace Element Distribution	16
GEOPHYSICS	
General Geophysics	195
Experimental Geophysics	30
Exploration Geophysics	83
Geodesy	19
Geomagnetism and Paleomagnetism	54
Gravity	8
Heat Flow	13
Seismology	205
Marine Geophysics	89
PALEONTOLOGY	
General Paleontology	91
Paleostratigraphy	47
Micropaleontology	64
Paleobotany	28
Palynology	23
Quantitative Paleontology	2
Vertebrate Paleontology	107
Invertebrate Paleontology	111
Paleobiology	66
Paleoecology and Paleoclimatology	120
Geobiology	53
HYDROLOGY	
General Hydrology	102
Ground Water/Hydrogeology	259
Quantitative Hydrology	33
Surface Water	49
Geohydrology	32
SOIL SCIENCE	
Soil Physics/Hydrology	63
Soil Chemistry/Mineralogy	123
Pedology/Classification/ Morphology	58
Forest Soils/Rangelands/ Wetlands	29

Faculty Specialties	Faculty (2013)
Soil Biology/Biochemistry	59
Paleopedology/Archeology	8
Other Soil Science	82
ENGINEERING GEOLOGY	
General Engineering Geology	61
Earthquake Engineering	5
Mining Tech/Extractive Metallurgy	14
Mining Engineering	35
Petroleum Engineering	21
Rock Mechanics	28
OCEANOGRAPHY	
General Oceanography	47
Biological Oceanography	286
Chemical Oceanography	114
Geological Oceanography	80
Physical Oceanography	214
Shore and Nearshore Processes	50
PLANETOLOGY	
Cosmochemistry	24
Extraterrestrial Geology	49
Extraterrestrial Geophysics	41
Meteorites and Tektites	14
OTHER	
General Earth Sciences	70
Atmospheric Sciences	489
Earth Science Education	76
Physical Geography	132
Ocean Engineering/Mining	12
Remote Sensing	123
Soil Science	18
Meteorology	169
Material Science	22
Land Use/Urban Geology	46
Geographic Information Systems	121
Glaciology	11
Not Elsewhere Classified	411

AGI Geoscience Workforce Program; Data derived from AGI's Directory of Geoscience Departments database

Table 3.6: Top Geoscience Specialities with the Most Change in Faculty Since 2010

Positive Change in Faculty	Negative Change in Faculty
GEOLOGY	
Structural Geology	Petroleum Geology
Sedimentology	Sedimentary Petrology
Igneous Petrology	Glacial Geology
ECONOMIC GEOLOGY	
Metals	Coal
Oil and Gas	Non-Metals
GEOCHEMISTRY	
Low-Temperature Geochemistry	Trace Element Distribution
Experimental Petrology	Organic Geochemistry
GEOPHYSICS	
Geodesy	Geomagnetism and Paleomagnetism
Seismology	Exploration Geophysics
PALEONTOLOGY	
Geobiology	Micropaleontology
General Paleontology	Paleostratigraphy
HYDROLOGY	
Ground Water/Hydrogeology	Geohydrology
Surface Waters	Quantitative Hydrology
SOIL SCIENCE	
Soil Chemistry/Mineralogy	Other Soil Science
Pedology/Classification/Morphology	Soil Physics/Hydrology
ENGINEERING GEOLOGY	
Petroleum Engineering	General Engineering Geology
Mining Tech/Extractive Metallurgy	Rock Mechanics
OCEANOGRAPHY	
Shore and Nearshore Processes	Physical Oceanography
General Oceanography	Geological Oceanography
PLANETOLOGY	
Extraterrestrial Geology	Extraterrestrial Geophysics
Cosmochemistry	Meteorites and Tektites
OTHER GEOSCIENCES	
Atmospheric Sciences	Physical Geography
Geographic Information Sciences	Remote Sensing

AGI Geoscience Workforce Program; Data derived from AGI's Directory of Geoscience Departments database

Geoscience University Students

Enrollments at four-year universities have increased by 39% between 2001 and 2011 to 13,494,131 students, and they are projected to continue increasing to 15,203,399 students in 2021 (Figure 3.9). Enrollments of female students at four-year universities have hovered at 57% of the total enrollments since 2005 (Figure 3.10). The percentage of women enrolled at four-year universities is about the same as the percentage of women enrolled at two-year colleges. Also, as in two-year colleges, the percentages of underrepresented minorities enrolled at four-year universities continue to increase (Figure 3.11). However, the percentage of enrolled underrepresented minorities is actually higher at the two-year college level, particularly among Hispanics.

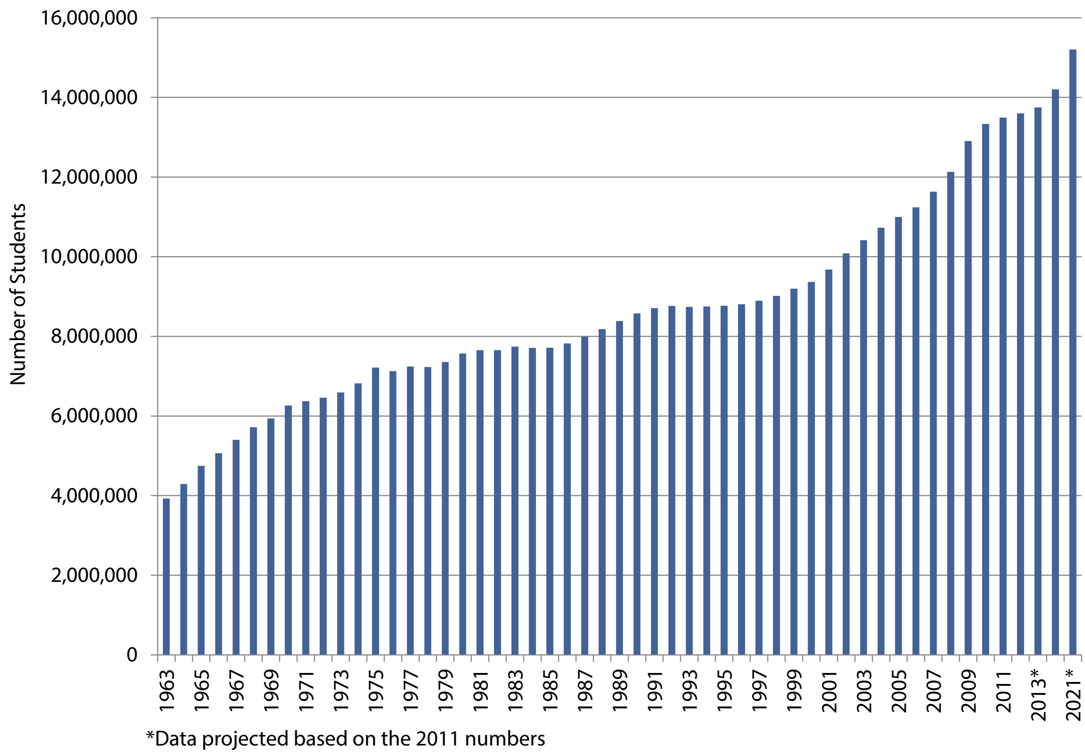
For the geosciences, undergraduate enrollments were increasing steadily from 2007 to 2012 reaching 28,570 students. In 2013, the number of undergraduates students enrolled in geoscience departments dropped to 27,591 students. Graduate enrollments continue to fluctuate around 10,000 students each year (Figure 3.12). Geoscience graduation rates for bachelor's and master's students are currently trending upward and should continue to increase due to the increases in enrollments. Graduation rates for doctoral students remain steady hovering between 600–700 students a year (Figure 3.13). While it appears in Figure 3.14 that enrollments and awarded degrees in the geosciences among women are decreasing, the actual numbers of female students in geoscience departments is increasing. However, the recent rapid increases in enrollments and increases in awarded degrees have been largely driven by male students.

Figures 3.15–3.19 show the percentages of science and geoscience degrees awarded to underrepresented minorities from three different sources—the National Science Foundation, the Department of Education's IPEDS database, and AGI's Geoscience Student Exit Survey. Reliable data on the enrollments and completions of underrepresented minorities in geoscience degree programs is difficult to acquire. Figures 3.16–3.18 show the data provided by the Department of Education. While there is an apparent increase in the recruitment of minority students to the geosciences, this increase is actually caused by changes in the Department of Education's definitions for the different racial groups. The changes included creating a new category for Pacific Islander/Native Hawaiian students and the introduction of multi-racial responses. However, with the new multi-racial approach, individual students can be counted within multiple categories, or more specifically, select a given racial category that they may not have been previously disposed, which can inflate the reported percentages. In addition, the source of IPEDS data varies by institution, including from departments, colleges, and offices of institutional research, which can lead to varying definitions of the degree programs compared to how they would be defined by the individual departments or students. Figure 3.15 presents data from NSF, which appears to be more consistent in their percentages of completions by underrepresented minorities in the geosciences because it is similar to the data from AGI's Geoscience Exit Survey in Figure 3.19, which asks the students for this information directly. Regardless of which data source is used for completion rates of underrepresented minorities in the geosciences, it's clear these populations are quite a bit lower than the overall completion rates at four-year universities, and the NSF data shows the geosciences with the lowest completion rates by underrepresented minorities compared to other science and engineering degrees.

Not surprisingly, the majority of geoscience students are U.S. citizens. Geoscience departments are beginning to see a larger population of non-permanent residents in graduate programs, particularly doctoral programs, where more than a quarter of the graduates are from outside the U.S. (Figure 3.20).

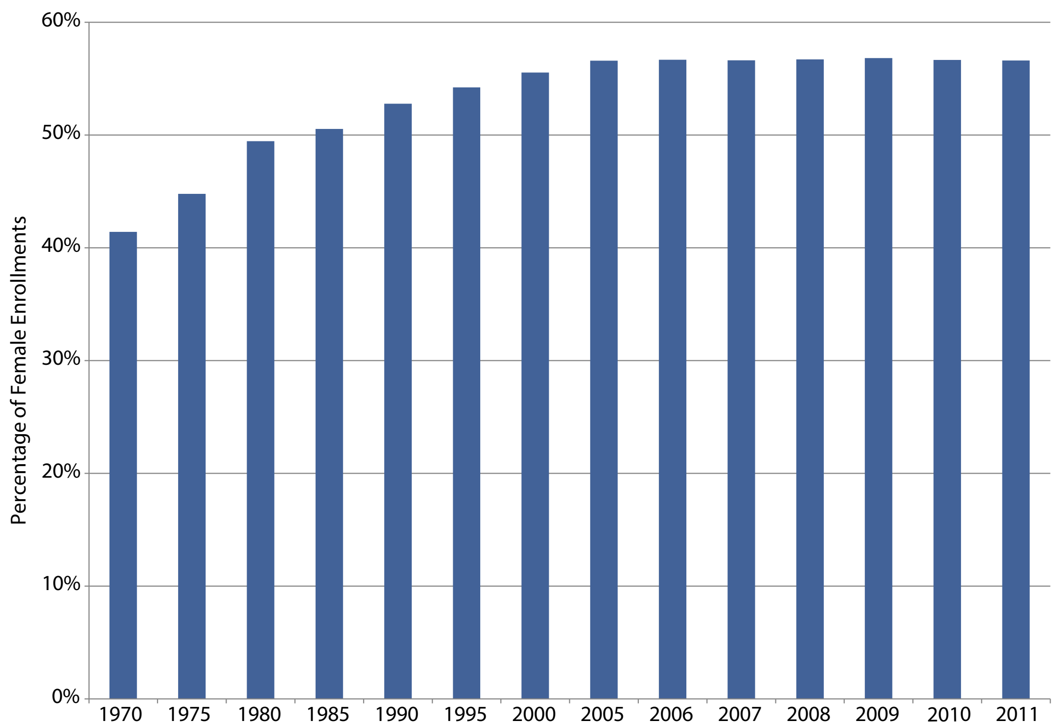
While geoscience students at four-year universities are working toward their degrees, over 70% complete Calculus I, but the percentages of bachelor's and master's graduates with experience in higher-level quantitative courses drops from there (Figure 3.21). Students are receiving instruction in chemistry and physics during their geoscience degrees as well, with 80–90% of graduates at the differing degree-levels taking at least one course in chemistry and either calculus or algebra-based physics (Figure 3.22).

Figure 3.9: Fall Enrollments at Four-Year Institutions



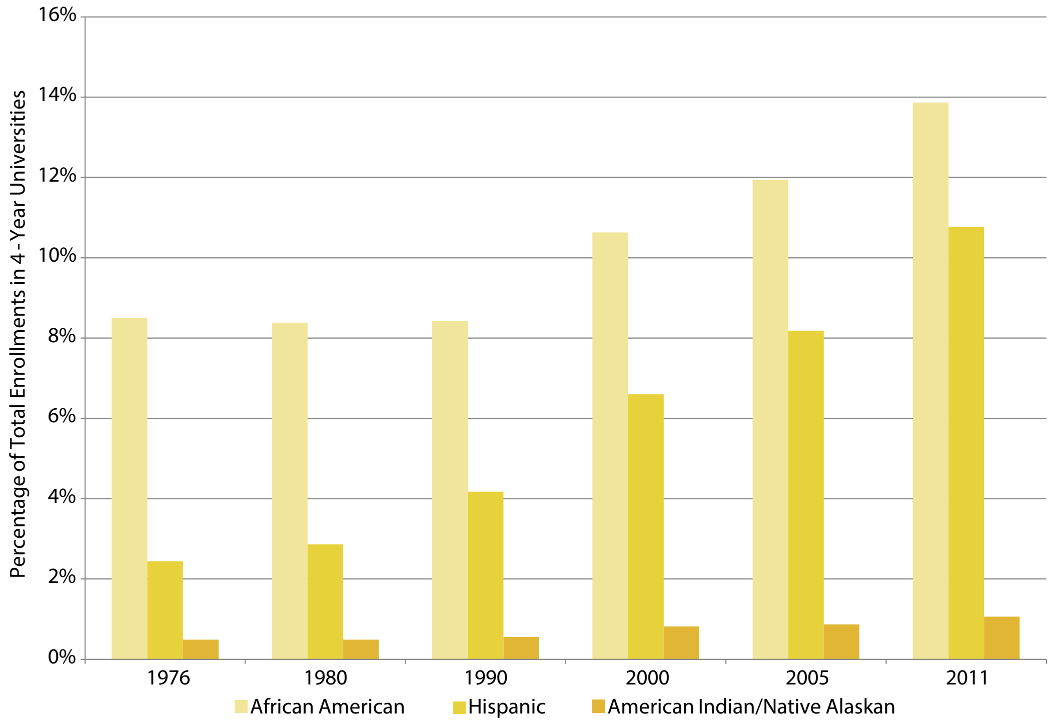
AGI Geoscience Workforce Program; Data derived from NCES Digest of Education Statistics, 2012

Figure 3.10: Participation of Women in Four-Year Institutions



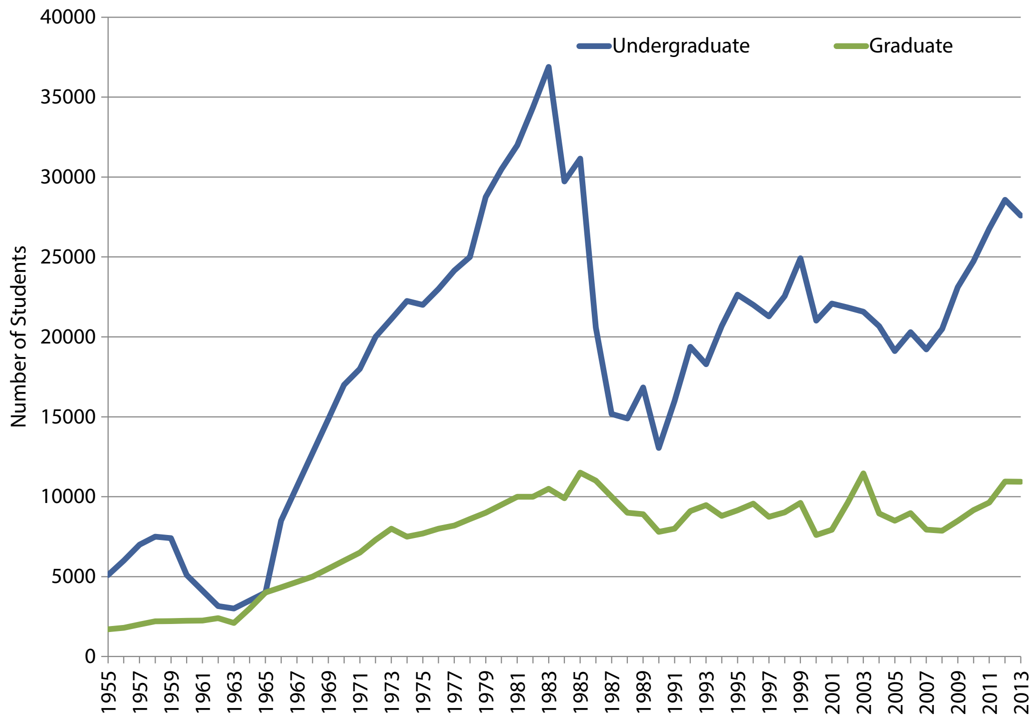
AGI Geoscience Workforce Program; Data derived from NCES Digest of Education Statistics, 2012

Figure 3.11: Underrepresented Minority Enrollments at Four-Year Institutions



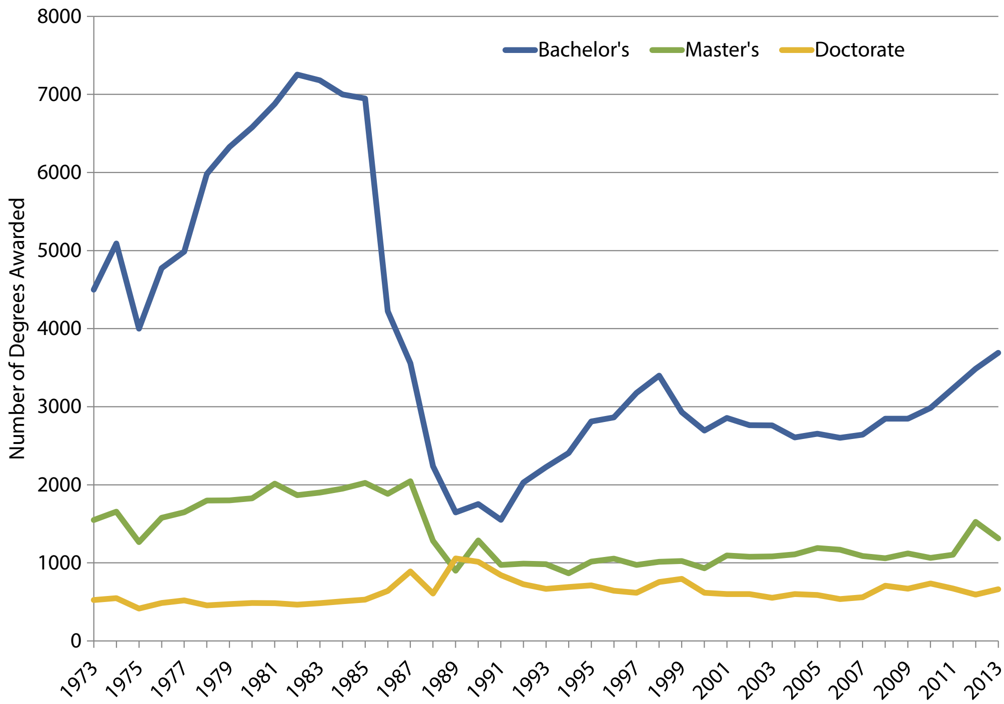
AGI Geoscience Workforce Program; Data derived from NCES Digest of Education Statistics, 2012

Figure 3.12: Geoscience Enrollments at U.S. Four-Year Institutions, 1955-2013



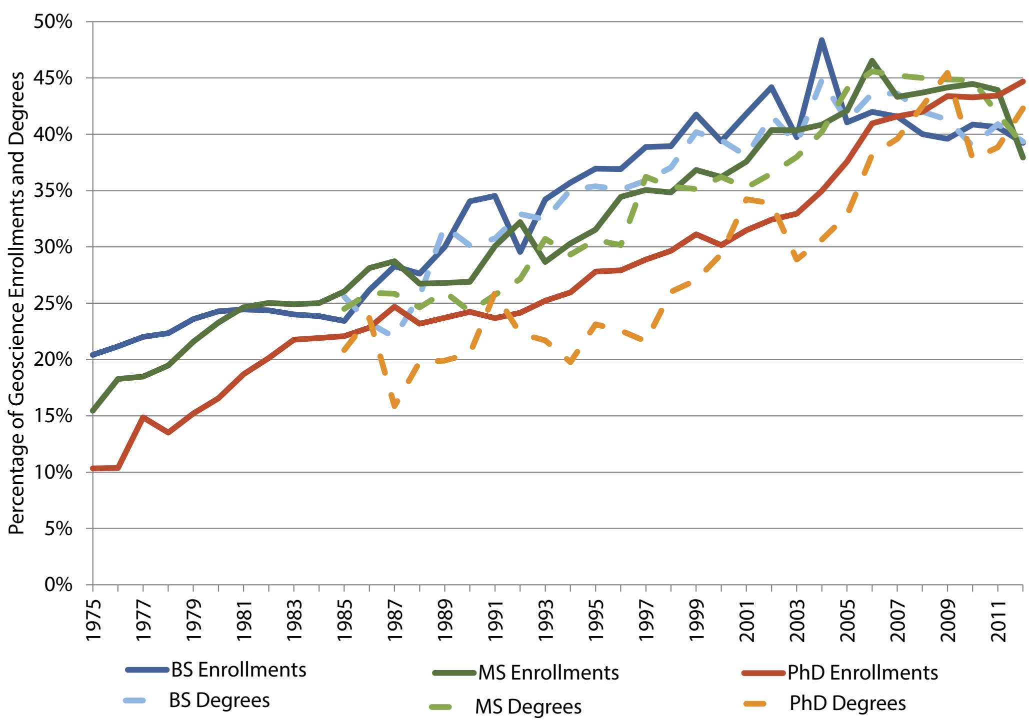
AGI Geoscience Workforce Program; Data derived from AGI's Directory of Geoscience Departments database

Figure 3.13: Geoscience Degrees Awarded at U.S. Four-Year Institutions, 1973-2013



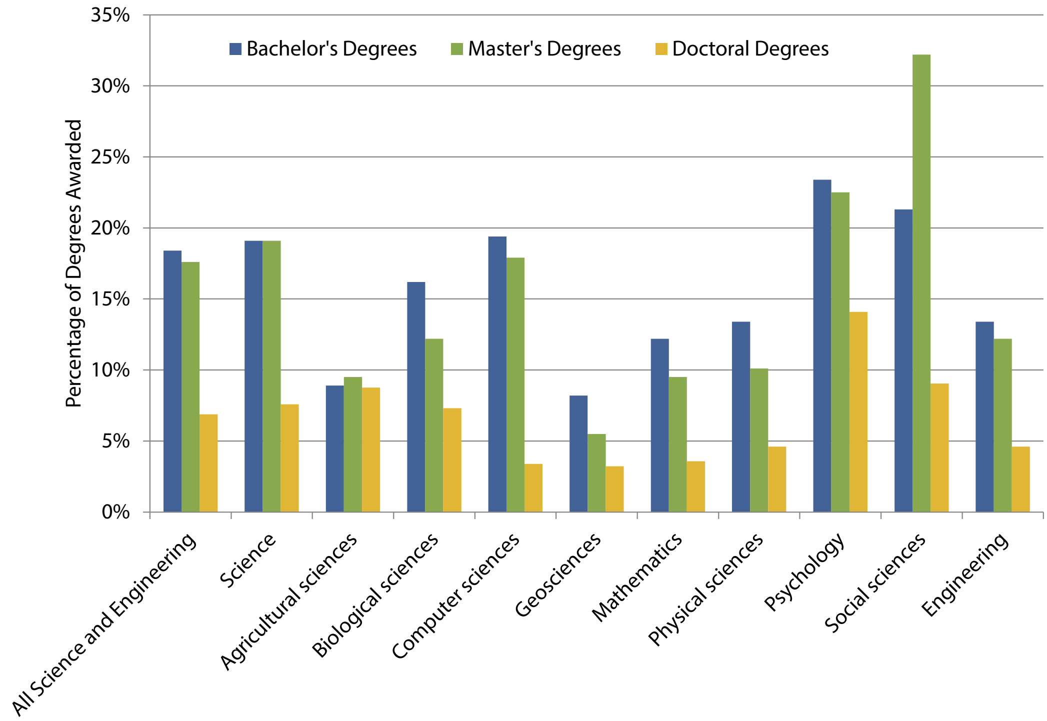
AGI Geoscience Workforce Program; Data derived from AGI's Directory of Geoscience Departments database

Figure 3.14: Participation of Women in Geoscience Programs



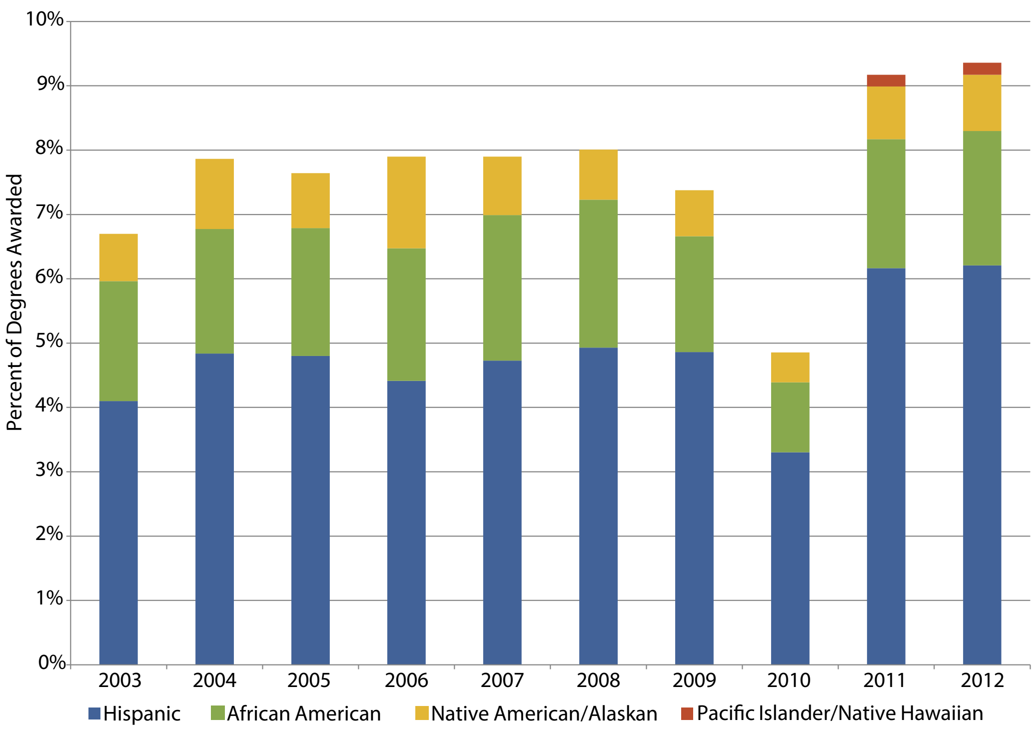
AGI Geoscience Workforce Program; Data derived from AGI's Directory of Geoscience Departments database

Figure 3.15: Percentage of Science and Engineering Degrees Awarded to Underrepresented Minorities



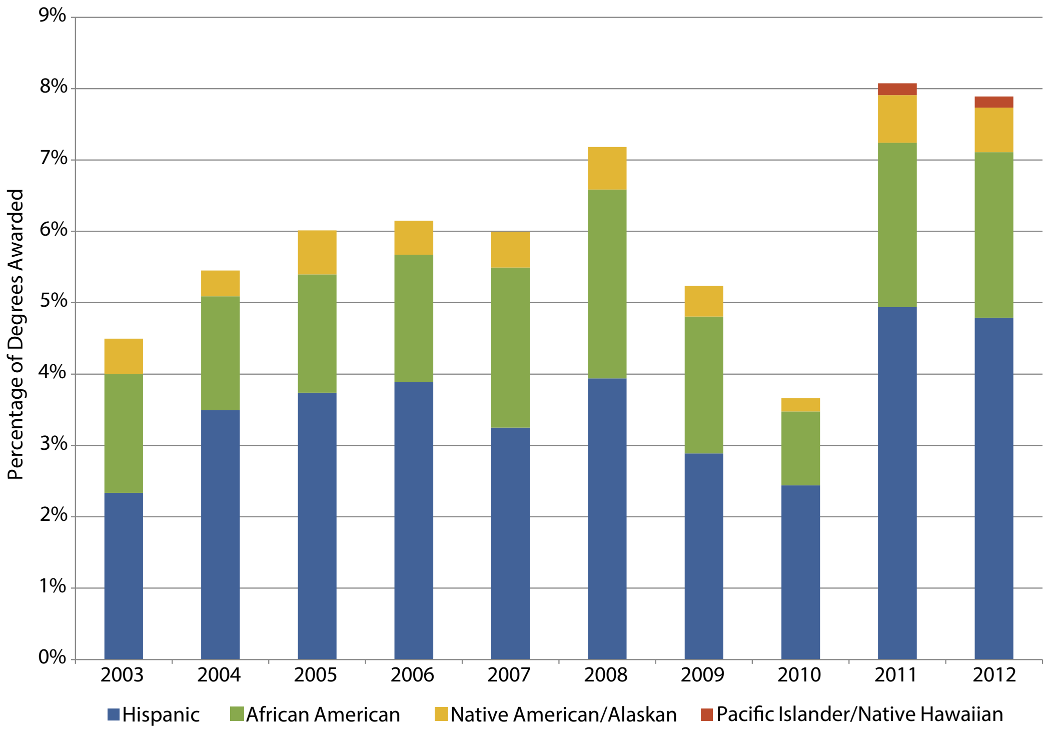
AGI Geoscience Workforce Program; Data derived from NSF's Women, Minorities, and Persons with Disabilities report

Figure 3.16: Percentage of Geoscience Bachelor's Degrees Awarded to Underrepresented Minorities



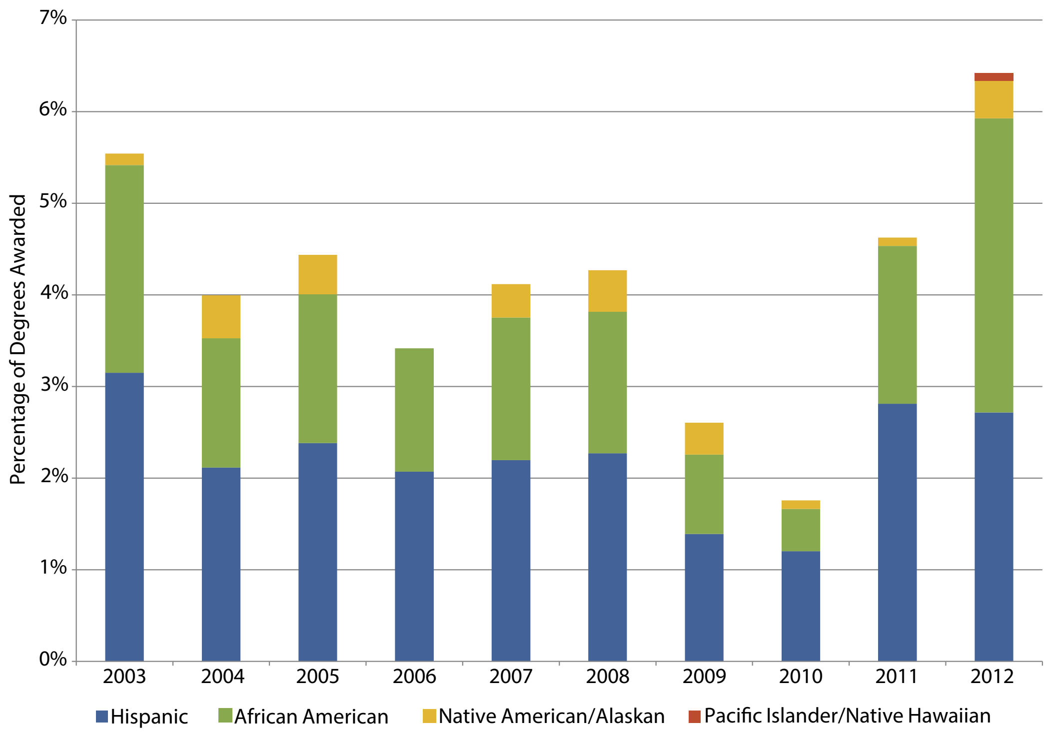
AGI Geoscience Workforce Program; Data derived from IPEDS

Figure 3.17: Percentage of Geoscience Master's Degrees Awarded to Underrepresented Minorities



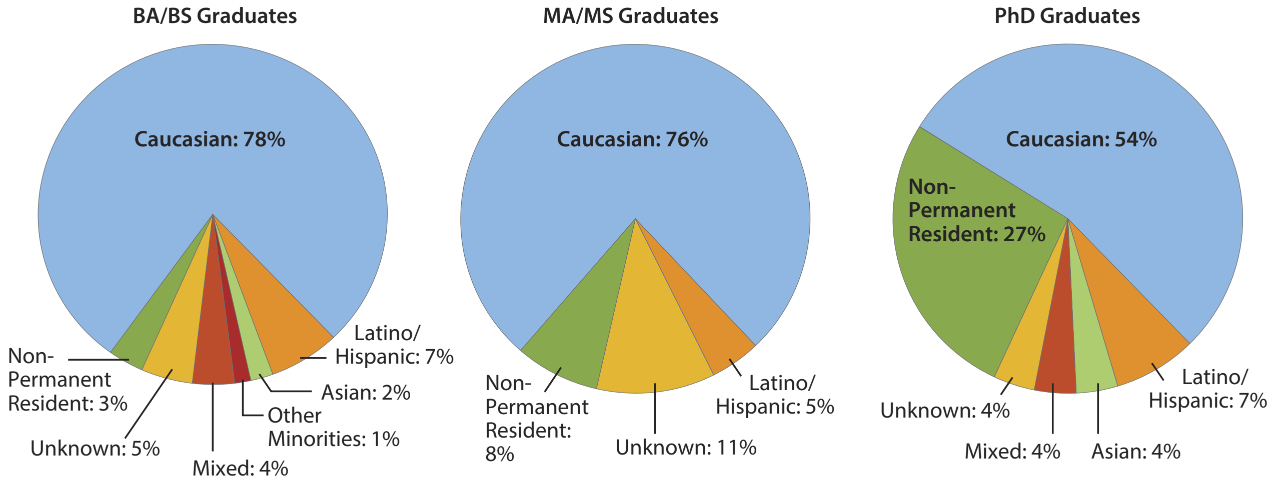
AGI Geoscience Workforce Program; Data derived from IPEDS

Figure 3.18: Percentage of Geoscience Doctoral Degrees Awarded to Underrepresented Minorities



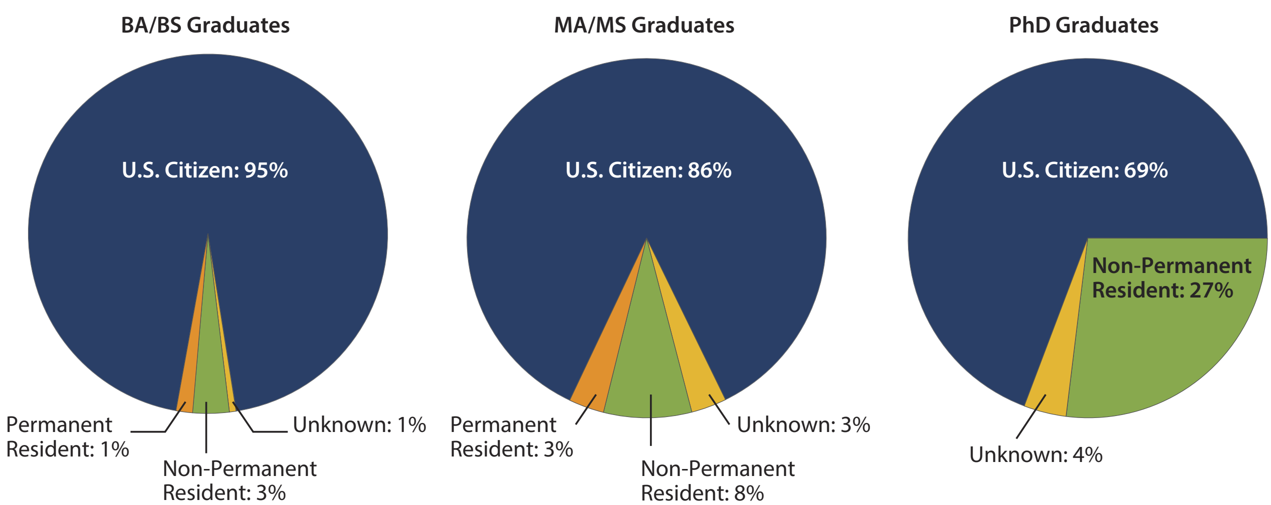
AGI Geoscience Workforce Program; Data derived from IPEDS

Figure 3.19: Race and Ethnicity of Geoscience Graduates



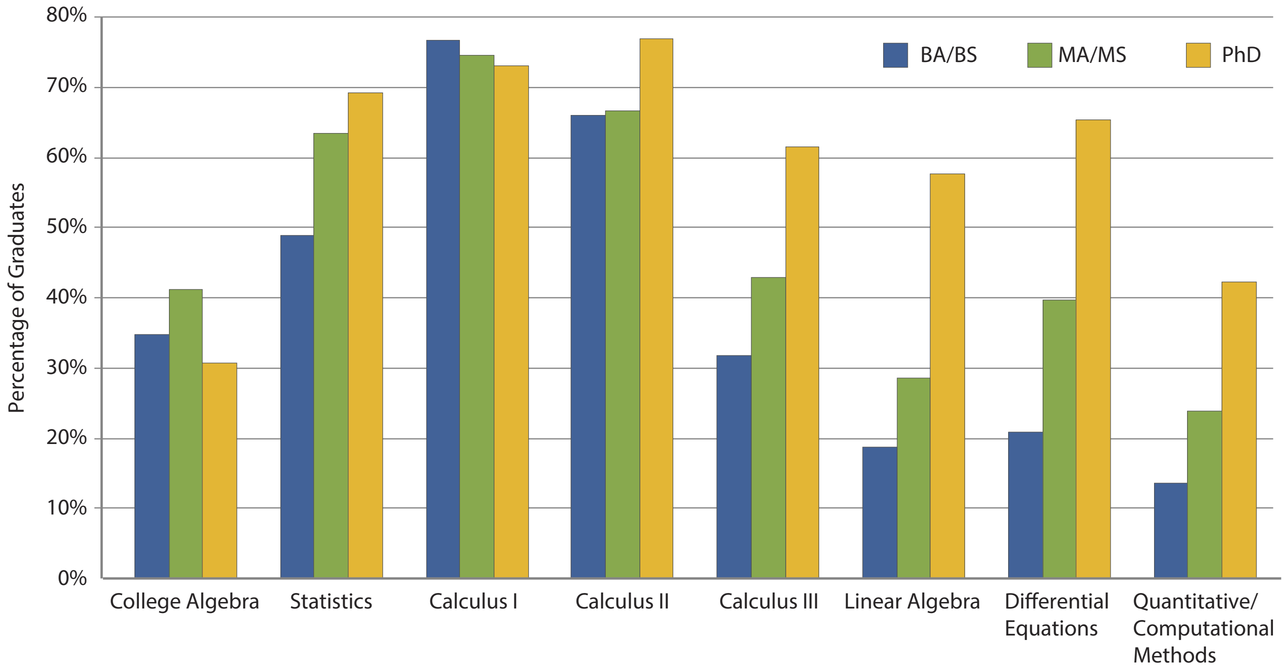
AGI Geoscience Workforce Program; Data derived from AGI's Geoscience Student Exit Survey; Figure created by Kathleen Cantner

Figure 3.20: Citizenship of Geoscience Graduates



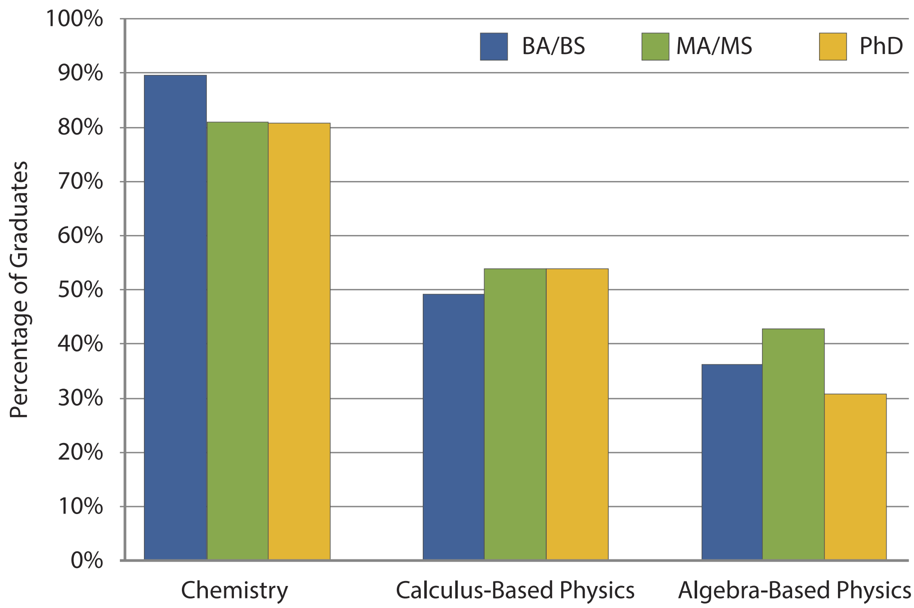
AGI Geoscience Workforce Program; Data derived from AGI's Geoscience Student Exit Survey; Figure created by Kathleen Cantner

Figure 3.21: Quantitative Skills and Knowledge Gained by Geoscience Graduates



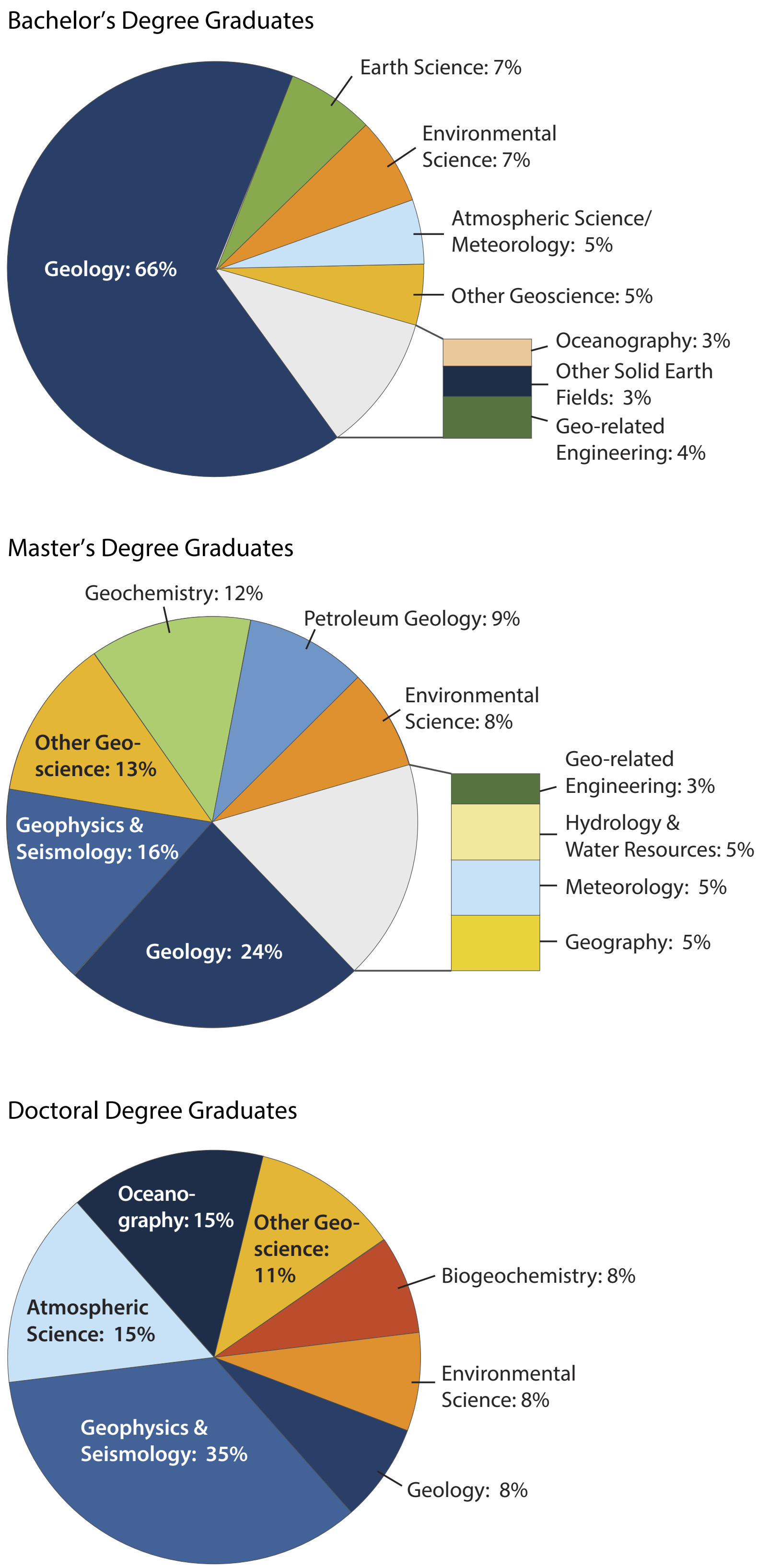
AGI Geoscience Workforce Program; Data derived from AGI's Geoscience Student Exit Survey; Figure created by Kathleen Cantner

Figure 3.22: Supplemental Science Courses Taken by Geoscience Graduates



AGI Geoscience Workforce Program; Data derived from AGI's Geoscience Student Exit Survey; Figure created by Kathleen Cantner

Figure 3.23: The Chosen Degree Fields of Geoscience Graduates



AGI Geoscience Workforce Program; Data derived from AGI's Geoscience Student Exit Survey; Figure created by Kathleen Cantner

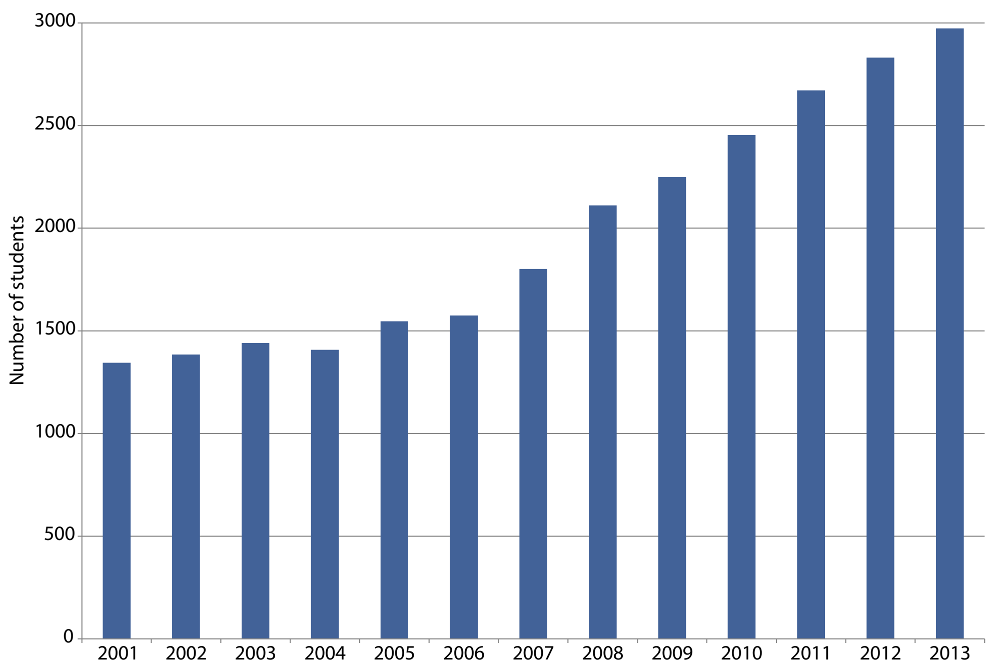
Co-Curricular Activities

Field camp attendance continues to steadily grow with 2,973 students participating in 2013 — a 92% increase since 2006 (Figure 3.24). There is growing concern that the available field camps are at or reaching their capacity for students because 21% of geoscience bachelor's graduates did not attend a field camp while working on their degree but still plan to attend one (Figure 3.25). Most states in the United States either have at least one field camp held within the state or at least one department that hosts a field camp in a different location outside of the state (Figure 3.26). International field camps are also becoming more popular for departments to host with eight different international destinations recently visited by geoscience students. If a geoscience student did not participate in a field camp, then it is extremely likely that student participated in at least one field course and/or one field experience before graduating (Figure 3.27 and 3.28).

Research experiences were not as common as field experiences, particularly among bachelor's graduates with 24% completing their degree without participating in a faculty-directed or individual research project (Figure 3.29). Among those students that participated in individual research projects, there are clear differences in how the research was conducted between undergraduate and graduate students. Specifically, graduate students participate in literature-based research and computer-based research more often than undergraduates and participate in field-based research less often than undergraduate students (Figure 3.30). However, research methods can differ in different geoscience fields. While 89% of master's graduates do participate in individual research projects while working towards their degree, the overall number of theses attributed to these students has decreased from 12,431 in the 1980s to 3,711 in the 2000s (Figure 3.31). Due to the large number of students conducting research at the master's level, this decrease is most likely due to a decrease in the number of departments reporting the theses produced each year to AGI's GeoRef Information Services. For doctoral dissertations, GeoRef reported 9,291 published during the 2000s—a small decrease from the 1990s when 9,862 dissertations were published (Figure 3.32). This information is also provided by departments, and does change with time due to departments not always reporting their yearly thesis and dissertation numbers in a timely fashion.

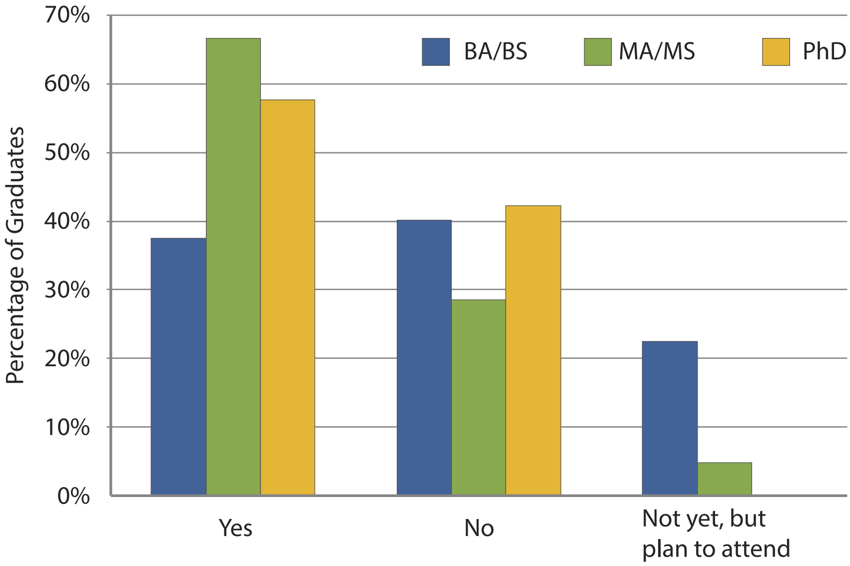
Internships are recognized by many industries as a good recruitment tool for future employees, so it is surprising that in 2013, 60% of bachelor's graduates, 37% of master's graduates, and 65% of doctoral graduates did not participate in an internship while working towards their degree.

Figure 3.24: Field Camp Attendance, 2001-2013



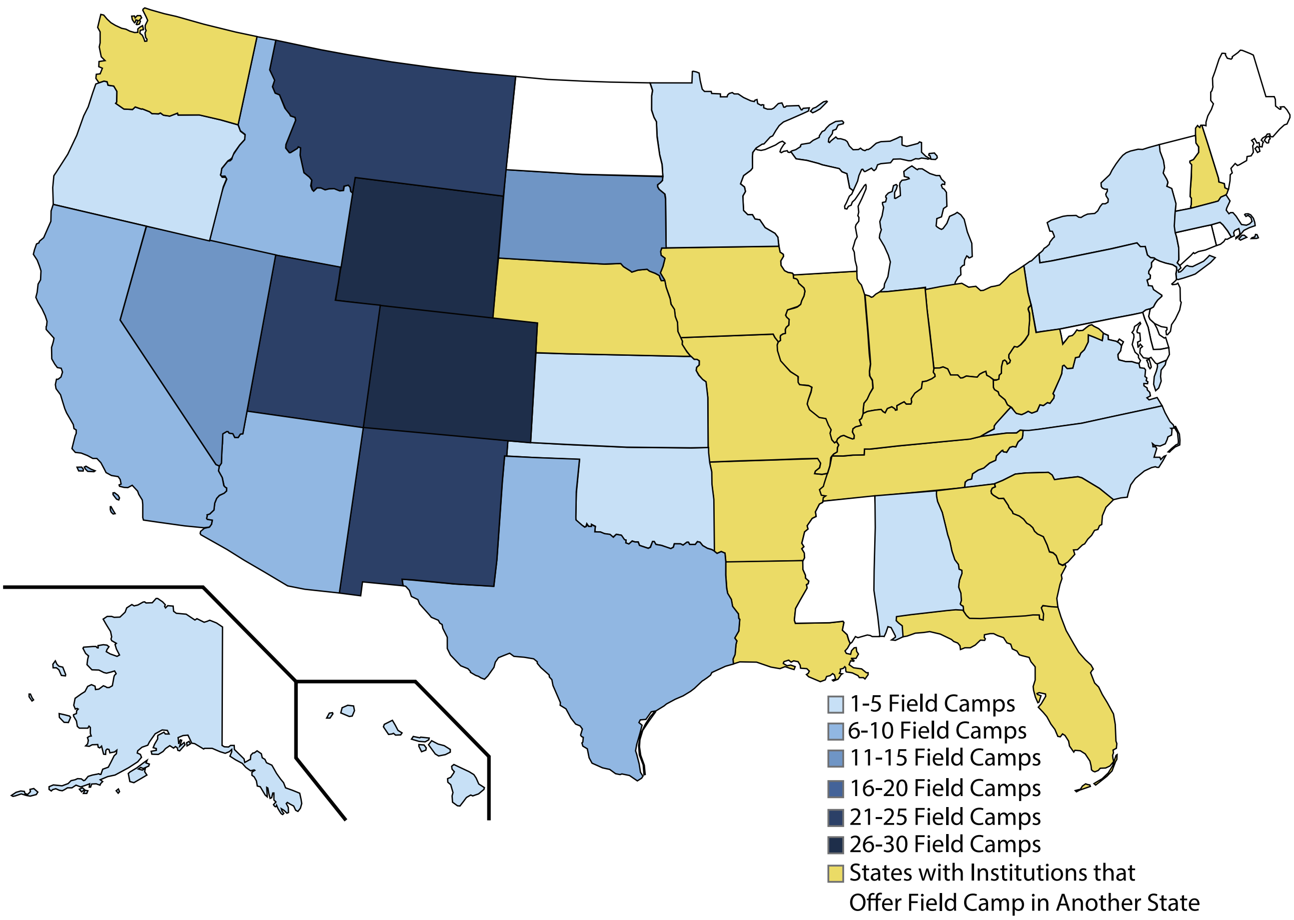
Data provided by Dr. Penelope Morton, UMN-Duluth

Figure 3.25: Geoscience Graduates That Have Participated in a Field Camp



AGI Geoscience Workforce Program; Data derived from AGI's Geoscience Student Exit Survey; Figure created by Kathleen Cantner

Figure 3.26: Locations of Geoscience Field Camps by State



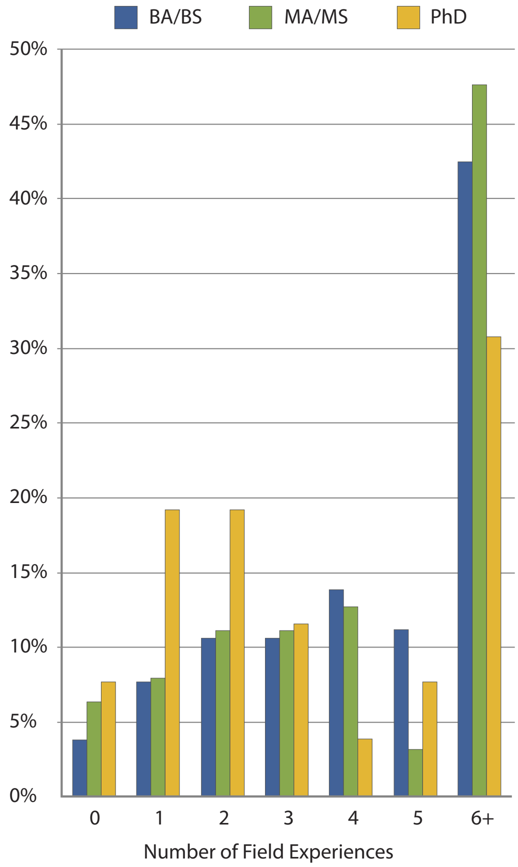
Data provided by Dr. Penelope Morton, UMN-Duluth

Table 3.7: U.S. Universities Hosting Geoscience Field Camps

University Hosting Field Camp	State
University of Alaska–Anchorage	AK
University of Alaska–Fairbanks	AK
Auburn University	AL
University of Alabama	AL
University of South Alabama	AL
University of Arkansas	AR
Arizona State University	AZ
Northern Arizona University	AZ
University of Arizona	AZ
California State University–Fullerton	CA
California State University–Long Beach	CA
Humboldt State University	CA
San Diego State University	CA
San Jose State University	CA
University of California–Davis	CA
University of California–Santa Barbara	CA
University of California–Santa Cruz	CA
Adams State College	CO
Colorado Mesa University	CO
Colorado School of Mines	CO
Colorado State University	CO
Fort Lewis College	CO
Western State College of Colorado	CO
Florida Atlantic University	FL
Florida State University	FL
Miami University	FL
University of Florida	FL
Georgia State University	GA
University of Georgia	GA
Iowa State University	IA
Boise State University	ID
Brigham Young University–Idaho	ID
Idaho State University	ID
University of Idaho	ID
Eastern Illinois University	IL
Illinois State University	IL
Northern Illinois University	IL
Southern Illinois University	IL
Western Illinois University	IL
Wheaton College	IL
Ball State University	IN
University of Michigan	MI
Western Michigan University	MI
University of Minnesota–Duluth	MN
University of Minnesota–Twin Cities	MN
Missouri University of Science & Technology	MO
University of Missouri–Columbia	MO
University of Missouri–Kansas City	MO
Montana State University	MT
Montana Tech of the University of Montana	MT
University of Montana	MT
North Carolina State University	NC
University of North Carolina	NC
University of North Carolina–Wilmington	NC
University of Nebraska	NE
Dartmouth College	NH
New Mexico Institute of Mining and Technology	NM
New Mexico State University	NM
University of New Mexico	NM
University of Nevada–Las Vegas	NV
University of Nevada–Reno	NV
Colgate University	NY
Cornell University	NY
State University of New York–Cortland	NY
State University of New York–Oswego	NY
University of Buffalo	NY
Bowling Green State University	OH
Kent State University	OH
Ohio State University	OH
University of Akron	OH
Wright State University	OH
Oklahoma State University	OK
University of Oklahoma	OK
Oregon State University	OR
Southern Oregon University	OR
University of Oregon	OR
Lehigh University	PA
Penn State University	PA
Clemson University	SC
Black Hills Natural Sciences Field Station	SD
University of Memphis	TN
Baylor University	TX
Stephen F. Austin State University	TX
Sull Ross State University	TX
Texas A&M University	TX
University of Houston	TX
University of Texas–Arlington	TX
University of Texas–Austin	TX
University of Texas–Dallas	TX
University of Texas–El Paso	TX
Brigham Young University	UT
Southern Utah University	UT
Utah State University	UT
Wasatch Uinta Field Camp	UT
Weber State University	UT
George Mason University	VA
James Madison University	VA
West Virginia University	VA
Central Washington University	WA
Eastern Washington University	WA
University of Washington	WA
Washington State University	WA
Western Washington University	WA
Beloit College	WI
Northland College	WI
University of Wisconsin–Eau Claire	WI
University of Wisconsin–Oshkosh	WI
Concord University	WV
University of Wyoming	WY

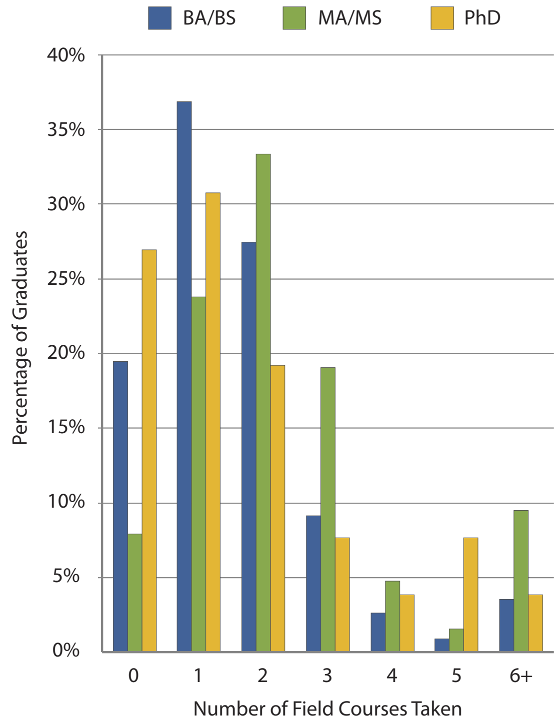
Data provided by Dr. Penelope Morton, UMN-Duluth

Figure 3.27: Geoscience Graduates with One or More Field Experiences



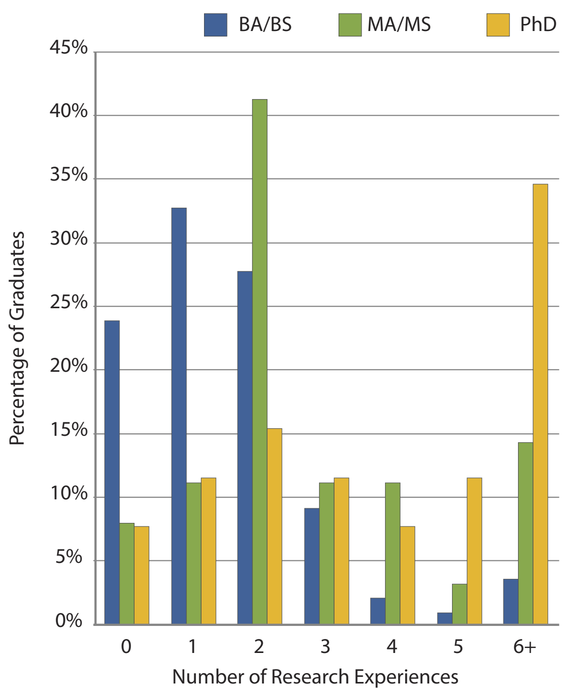
AGI Geoscience Workforce Program; Data derived from AGI's Geoscience Student Exit Survey; Figure created by Kathleen Cantner

Figure 3.28: Geoscience Graduates that Have Taken One or More Field Courses



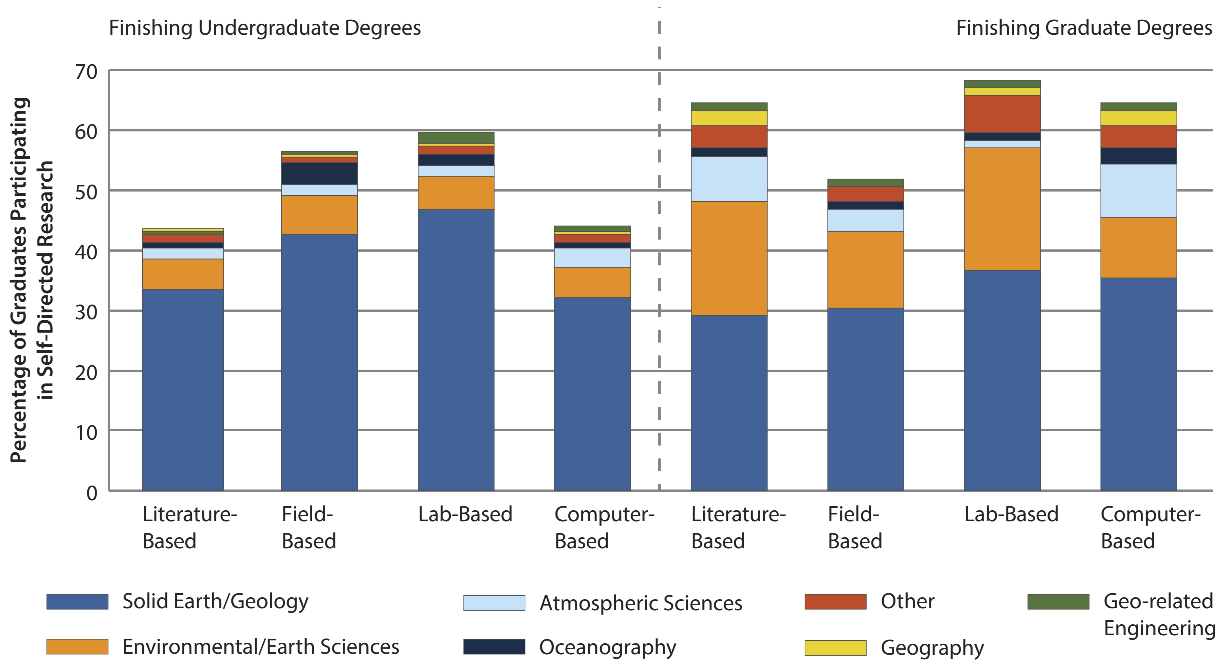
AGI Geoscience Workforce Program; Data derived from AGI's Geoscience Student Exit Survey; Figure created by Kathleen Cantner

Figure 3.29: Geoscience Graduates with One or More Research Experiences



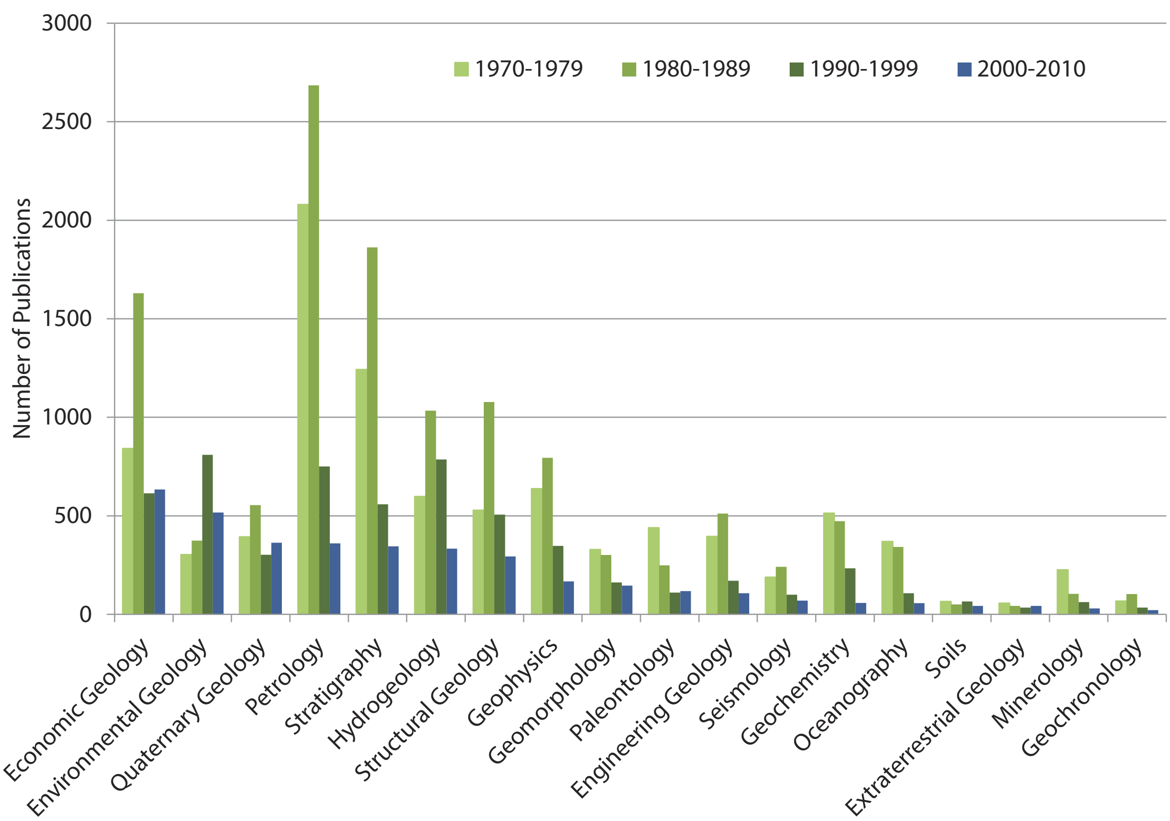
AGI Geoscience Workforce Program; Data derived from AGI's Geoscience Student Exit Survey; Figure created by Kathleen Cantner

Figure 3.30: Research Methods Utilized by Geoscience Graduates for Their Individual Research Projects



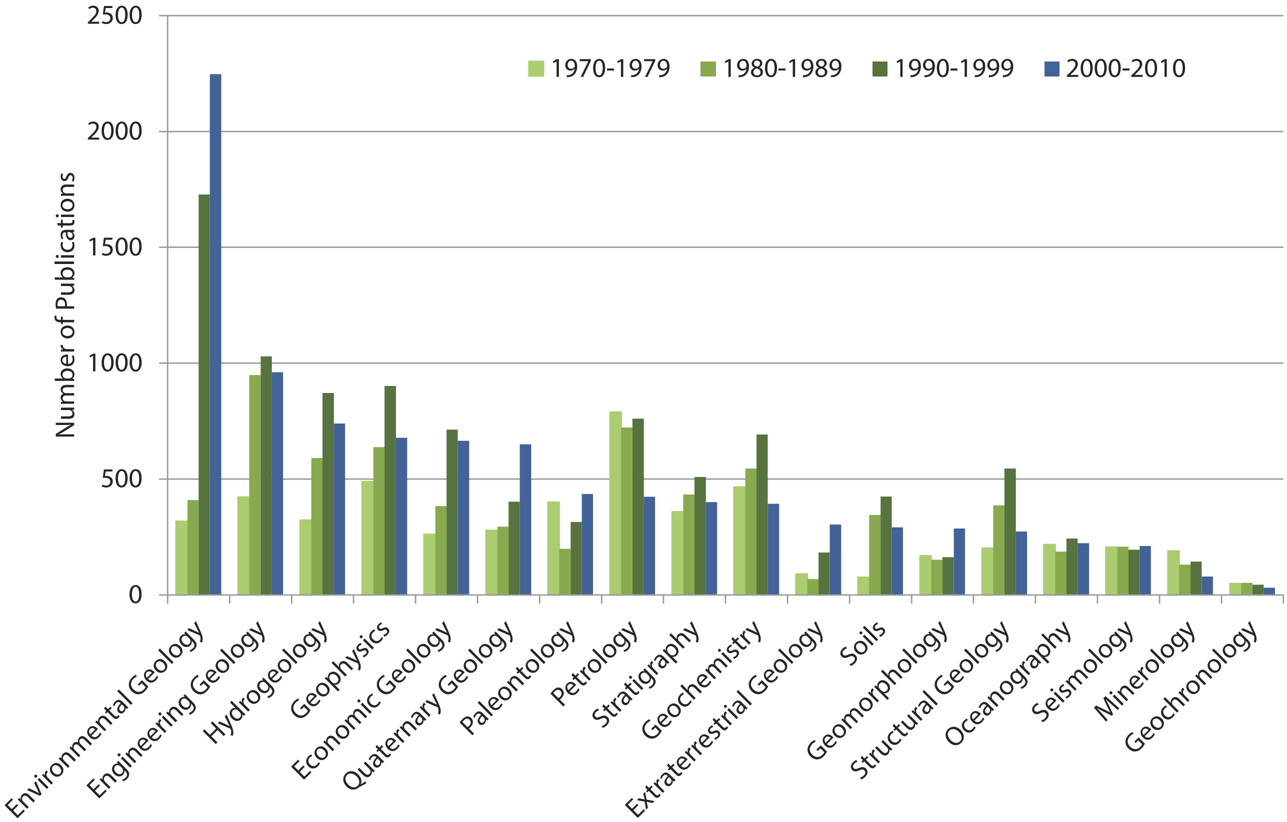
AGI Geoscience Workforce Program; Data derived from AGI's Geoscience Student Exit Survey; Figure created by Kathleen Cantner

Figure 3.31: Trends in Geoscience Master's Thesis Topics



AGI Geoscience Workforce Program; Data derived from AGI's GeoRef database

Figure 3.32: Trends in Geoscience Doctoral Dissertation Topics



AGI Geoscience Workforce Program; Data derived from AGI's GeoRef database

Table 3.8: Top Five Geoscience Master's Theses Topics

1970-1979	1980-1989	1990-1999	2000-2010
Petrology	Petrology	Environmental Geology	Economic Geology
Stratigraphy	Stratigraphy	Hydrogeology	Environmental Geology
Economic Geology	Economic Geology	Petrology	Quaternary Geology
Geophysics	Structural Geology	Economic Geology	Petrology
Hydrogeology	Hydrogeology	Stratigraphy	Stratigraphy

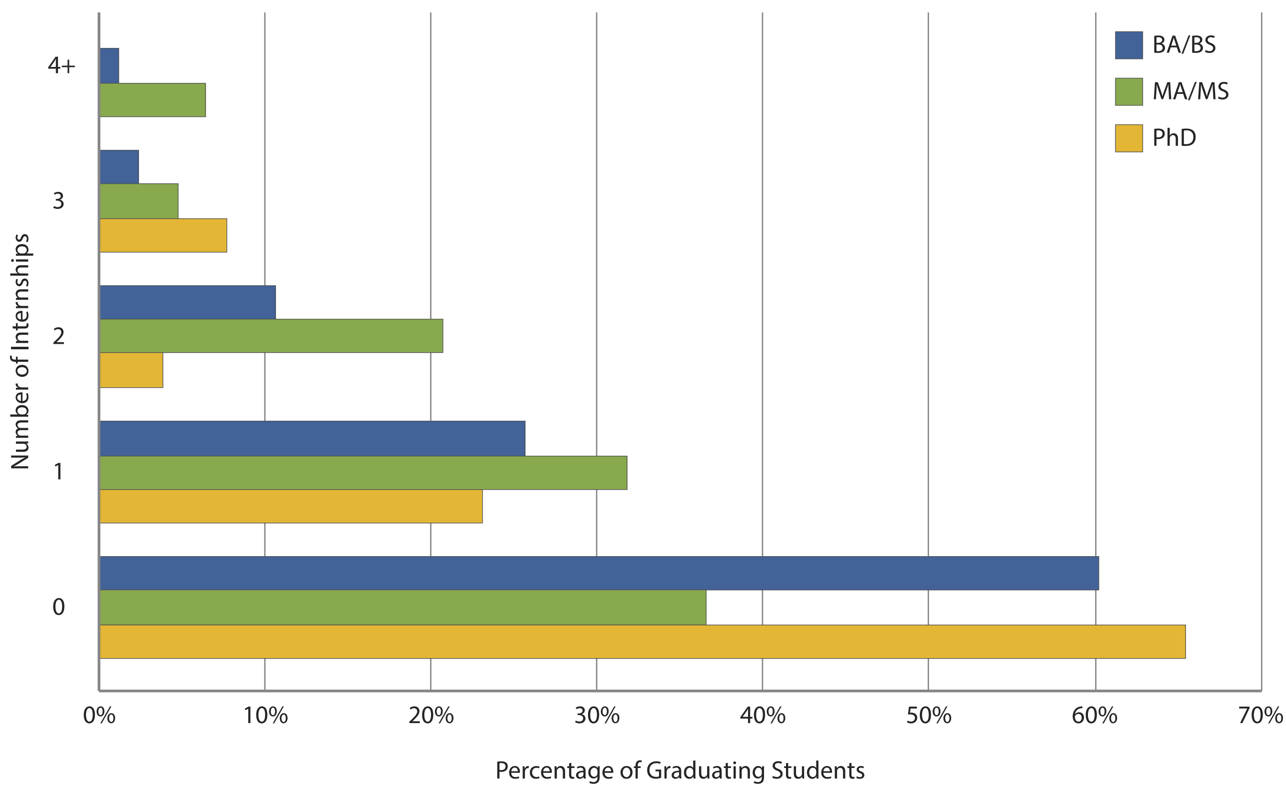
AGI Geoscience Workforce Program; Data derived from AGI's GeoRef database

Table 3.9: Top Five Geoscience Doctoral Dissertation Topics

1970-1979	1980-1989	1990-1999	2000-2010
Petrology	Engineering Geology	Environmental Geology	Environmental Geology
Geophysics	Petrology	Engineering Geology	Engineering Geology
Geochemistry	Geophysics	Geophysics	Hydrogeology
Engineering Geology	Hydrogeology	Hydrogeology	Geophysics
Paleontology	Geochemistry	Petrology	Economic Geology

AGI Geoscience Workforce Program; Data derived from AGI's GeoRef database

Figure 3.33: Number of Internships Held by Geoscience Graduates

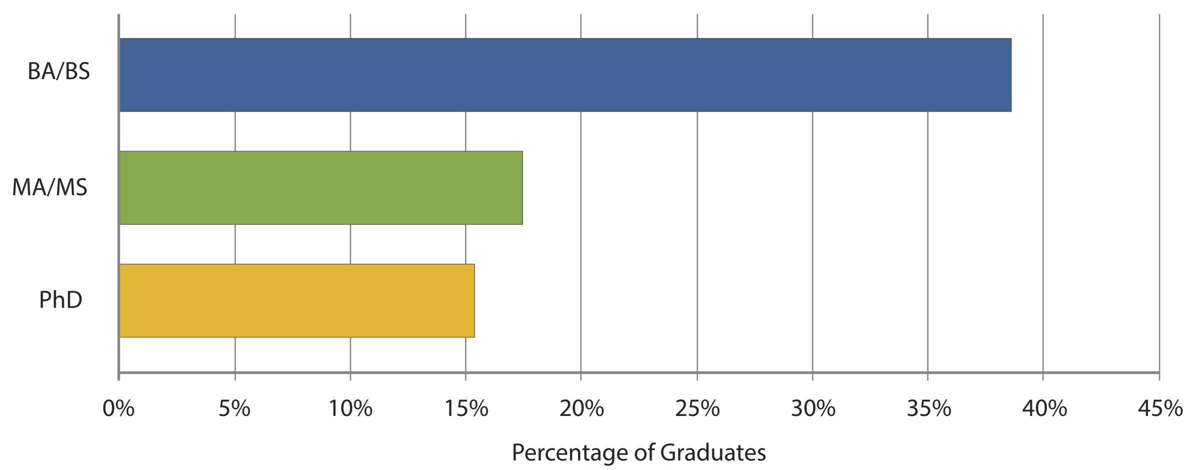


AGI Geoscience Workforce Program; Data derived from AGI's Geoscience Student Exit Survey; Figure created by Kathleen Cantner

Students Plans for Graduate School

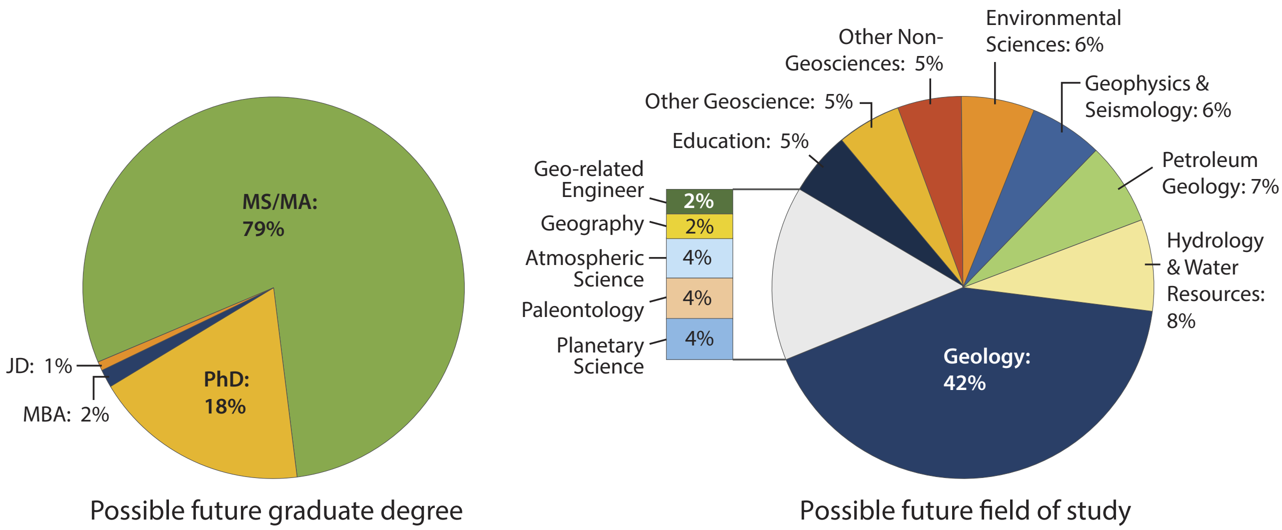
Among recent geoscience graduates, 39% of bachelor's graduates, 17% of master's graduates, and 15% of doctoral graduates planned to immediately return to school for a graduate degree (Figure 3.34). Most of the bachelor's graduates planned to obtain a master's degree in a wide range of geoscience fields, compared to the master's and doctoral graduates (Figure 3.35 and 3.36).

Figure 3.34: Geoscience Students Planning to Attend Graduate School Immediately After Graduation



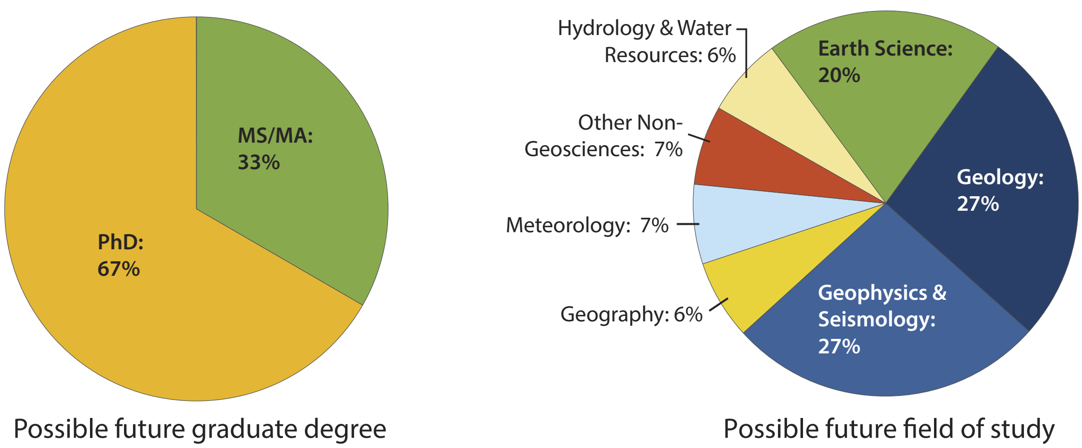
AGI Geoscience Workforce Program; Data derived from AGI's Geoscience Student Exit Survey; Figure created by Kathleen Cantner

Figure 3.35: Geoscience Undergraduate Students Planning to Pursue a Graduate Degree



AGI Geoscience Workforce Program; Data derived from AGI's Geoscience Student Exit Survey; Figure created by Kathleen Cantner

Figure 3.36: Geoscience Graduate Students Planning to Pursue Another Graduate Degree



AGI Geoscience Workforce Program; Data derived from AGI's Geoscience Student Exit Survey; Figure created by Kathleen Cantner

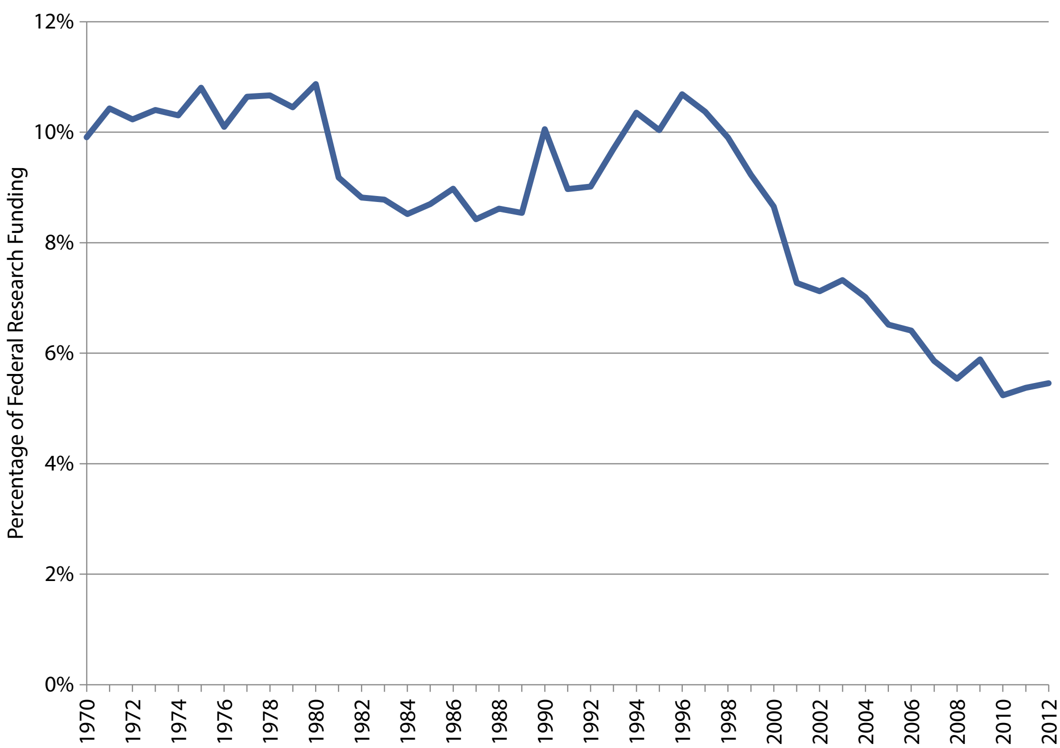
Funding of the Geosciences at the University Level

The percentage of federal research funding applied to the geosciences has decreased from a high of 11% in 1996 to a low of 5% in 2012 (Figure 3.37). However, the overall amount of federal research funds awarded to universities has steadily risen, which highlights the overall increases in total federal research funding since the 1970s (Figure 3.38). The majority of the research funds for geoscience given to universities overwhelmingly came from the National Science Foundation (NSF) reaching $537 million (Figure 3.43). In general, the geoscience research funds given to universities have increased within the major science research agencies, except for NASA and Department of Energy funding (Figures 3.39–3.43).

At NSF, the funding rate of geoscience proposals has been on a downward trend since 2009 (Figure 3.44). This downward trend can also be seen for the funding rates within the different geoscience divisions (Figure 3.45). In 2009 and 2010, the United States government introduced the American Recovery and Reinvestment Act (ARRA), and the money from this stimulus program given to NSF allowed for a higher percentage of proposals to receive funding. As a result, the NSF Geoscience Directorate awarded 804 ARRA proposals, which inflated the overall funding rate and the funding rates within the divisions. However the overall funding rate in 2013 is lower than the fairly steady rate seen from 2004–2008 and the number of proposals submitted to the Geoscience Directorate continued to rise after 2009, which lends to speculation that the ARRA funding may have lead to unrealistic expectations on the part of the proposal writers on their chances for funding. While the funding rate has been decreasing, the median award size continues to increase (Figure 3.46).

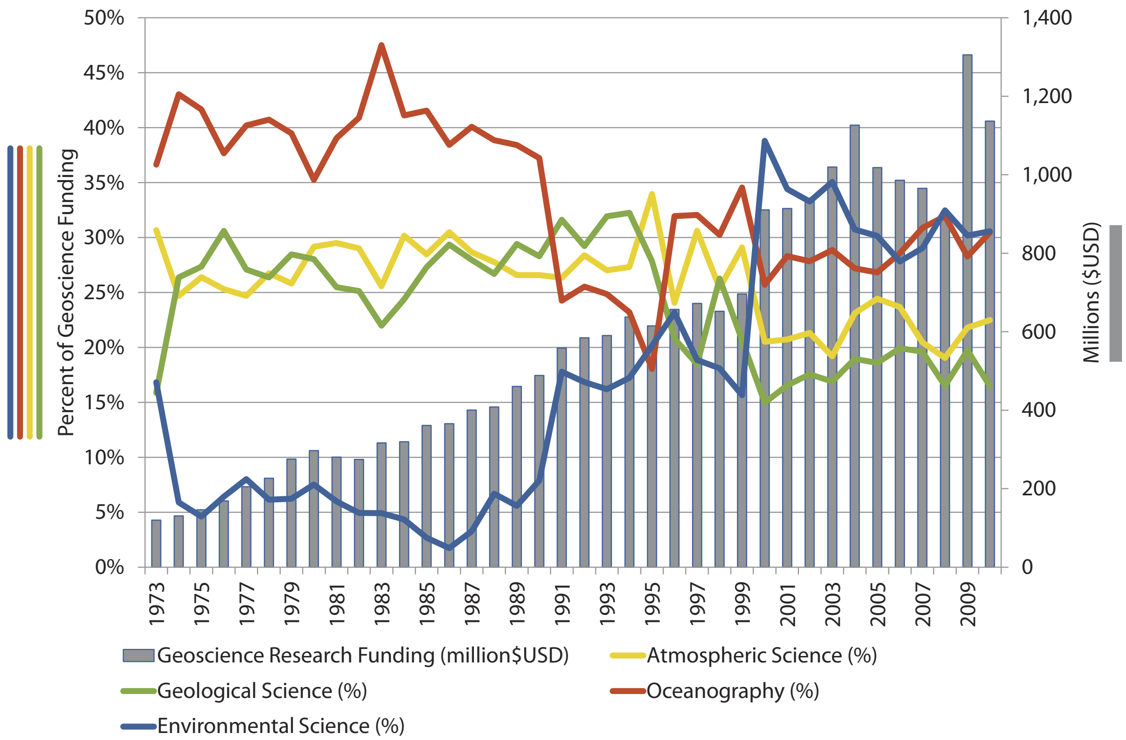
The Office of Polar Programs at NSF was integrated into the Geoscience Directorate in 2013 as a new division. This edition of the report does not have as much information on the funding rates within this division, but future editions will most likely begin to include more data about the Polar Programs division.

Figure 3.37: Percentage of Total Federal Research Funding Applied to the Geosciences



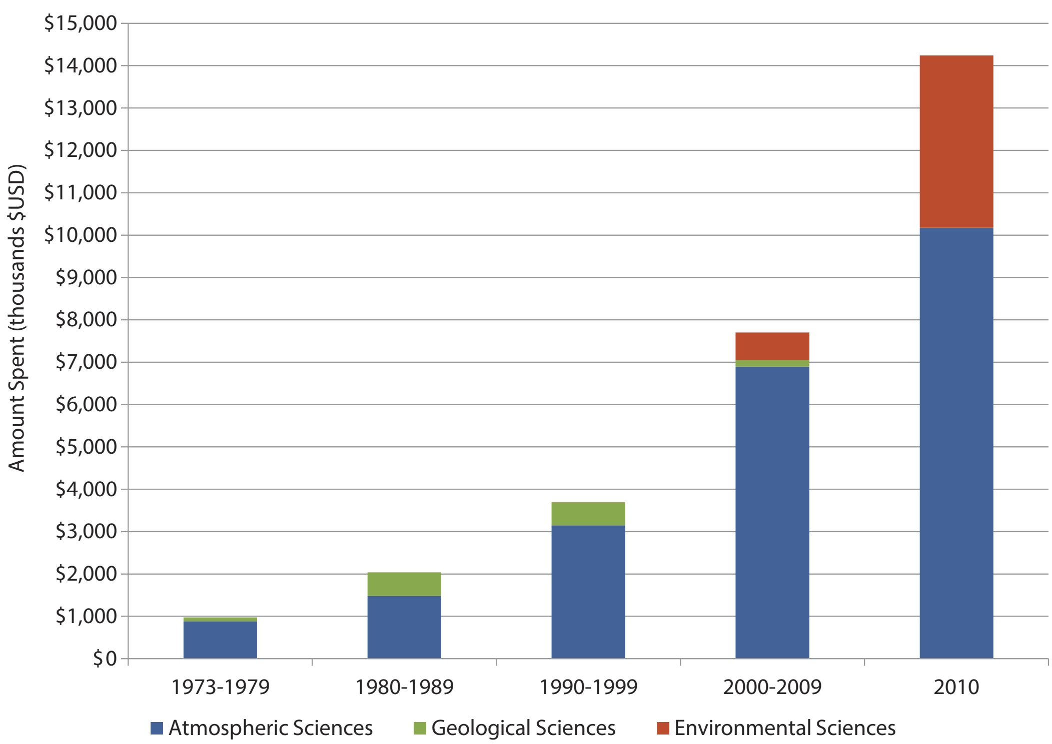
AGI Geoscience Workforce Program; Data derived from NSF/SRS Survey of Federal Funds for Research & Development

Figure 3.38: Percentage of University Geoscience Research Funding per Subdiscipline from Selected Federal Agencies



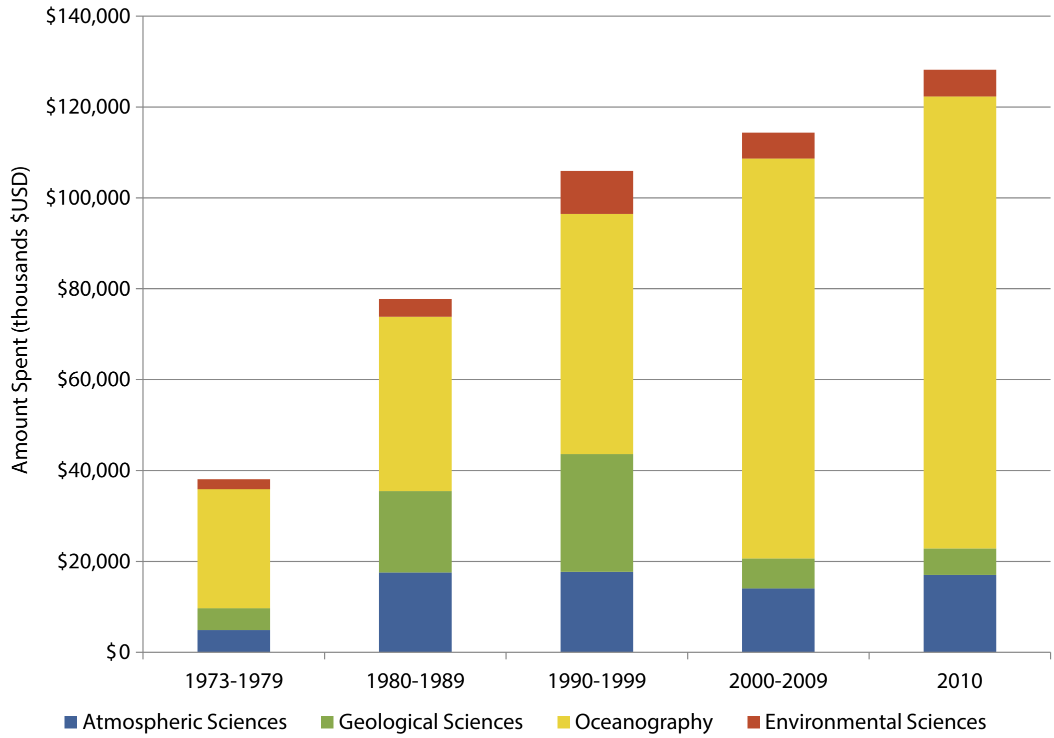
AGI Geoscience Workforce Program; Data derived from NSF/SRS Survey of Federal Funds for Research & Development

Figure 3.39: Average Annual University Geoscience Research Funding by the Department of Agriculture



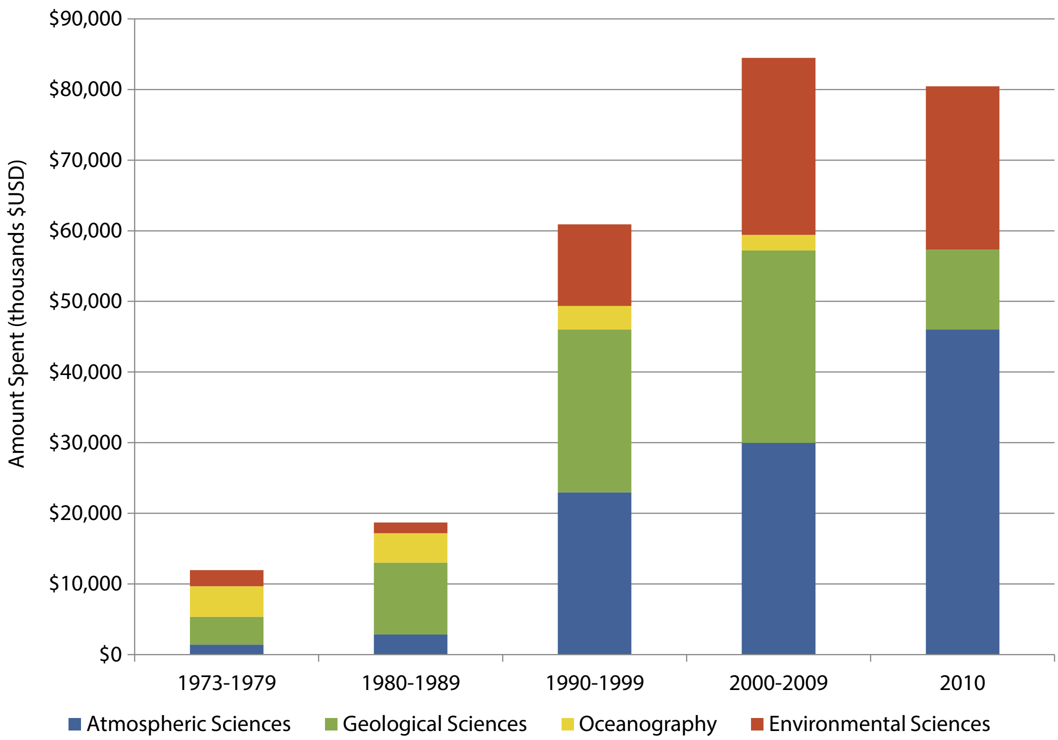
AGI Geoscience Workforce Program; Data derived from NSF/SRS Survey of Federal Funds for Research & Development

Figure 3.40: Average Annual University Geoscience Research Funding by the Department of Defense



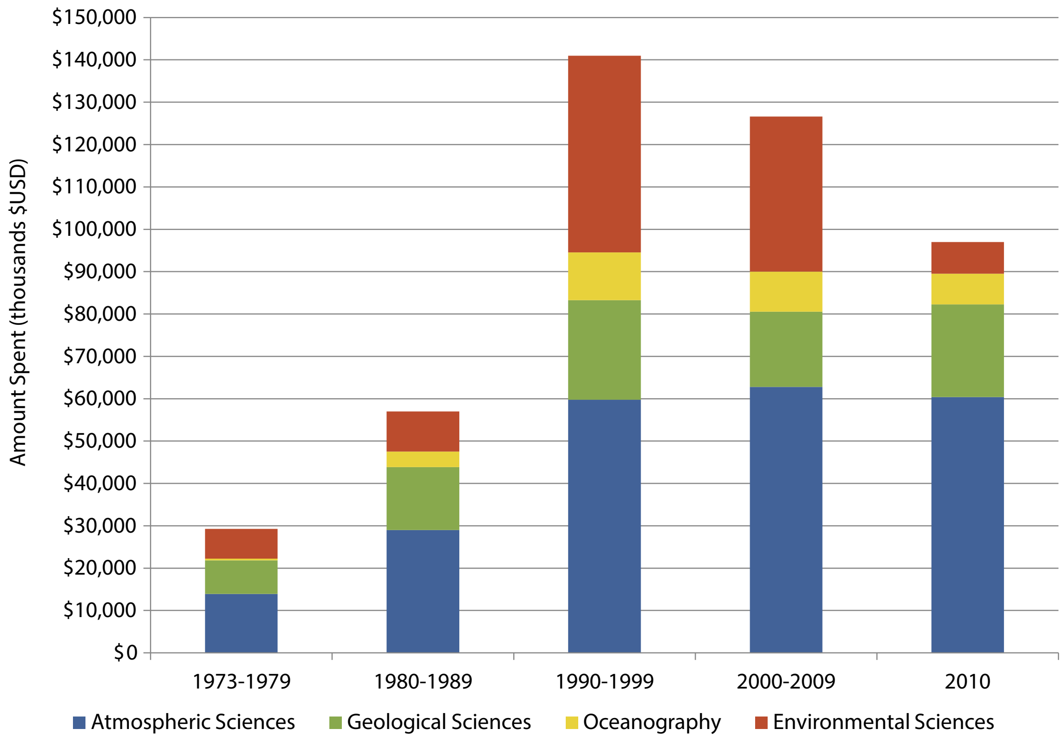
AGI Geoscience Workforce Program; Data derived from NSF/SRS Survey of Federal Funds for Research & Development

Figure 3.41: Average Annual University Geoscience Research Funding by the Department of Energy



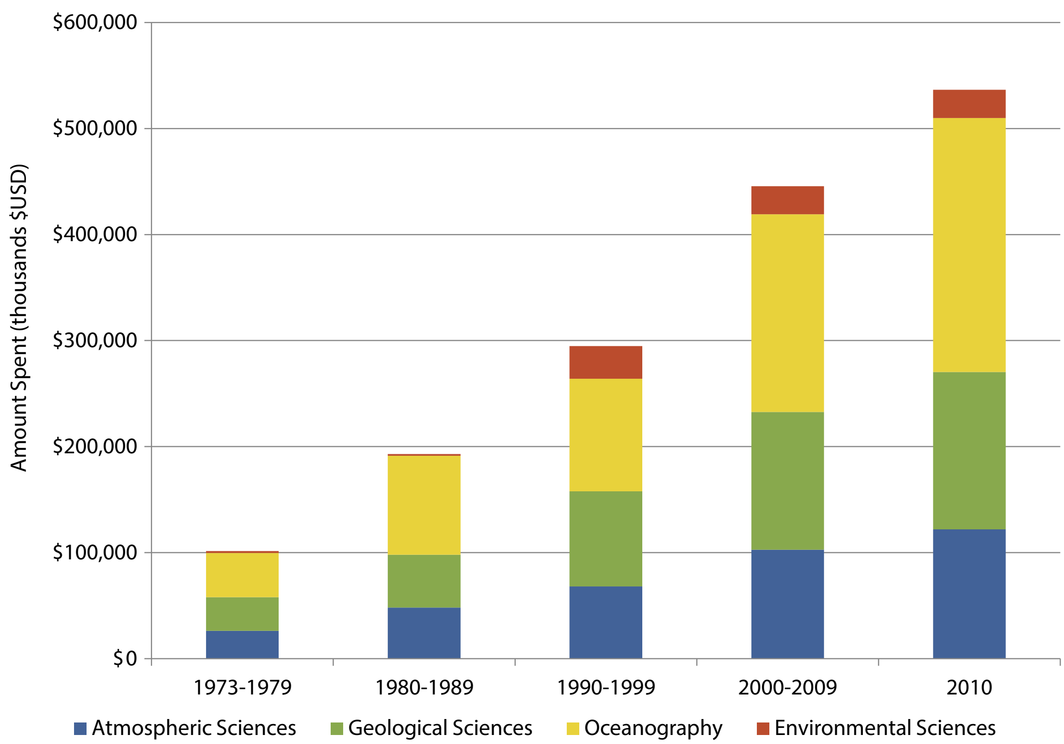
AGI Geoscience Workforce Program; Data derived from NSF/SRS Survey of Federal Funds for Research & Development

Figure 3.42: Average Annual University Geoscience Research Funding by NASA



AGI Geoscience Workforce Program; Data derived from NSF/SRS Survey of Federal Funds for Research & Development

Figure 3.43: Average Annual University Geoscience Research Funding by NSF

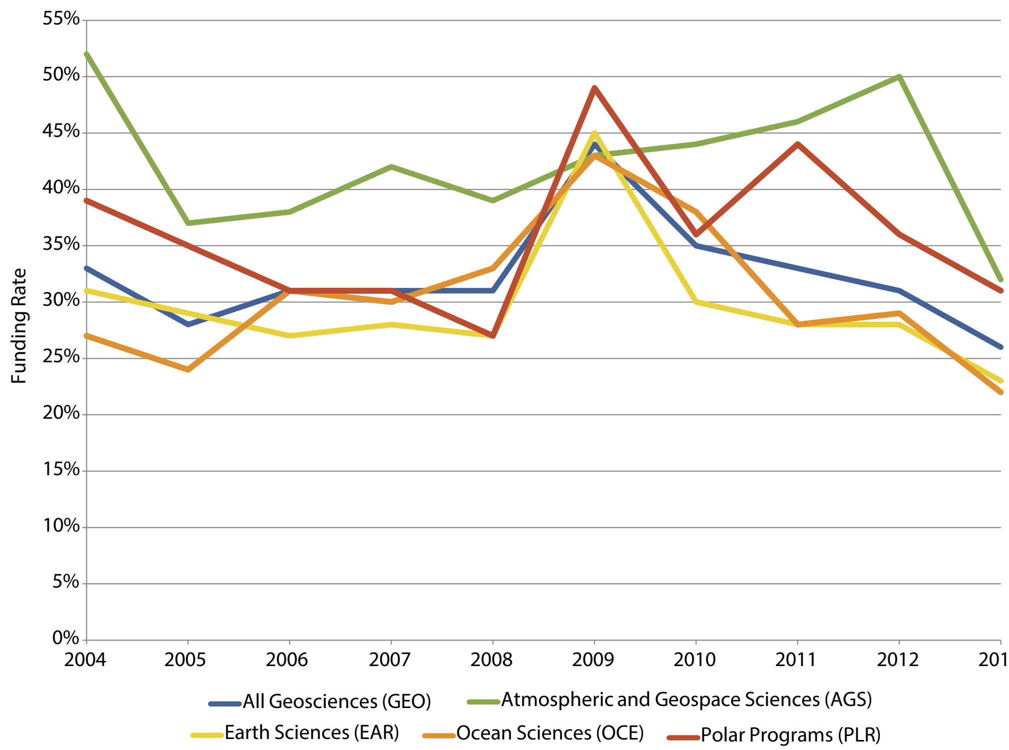


AGI Geoscience Workforce Program; Data derived from NSF/SRS Survey of Federal Funds for Research & Development

Figure 3.44: Funding of Geoscience Proposals at NSF

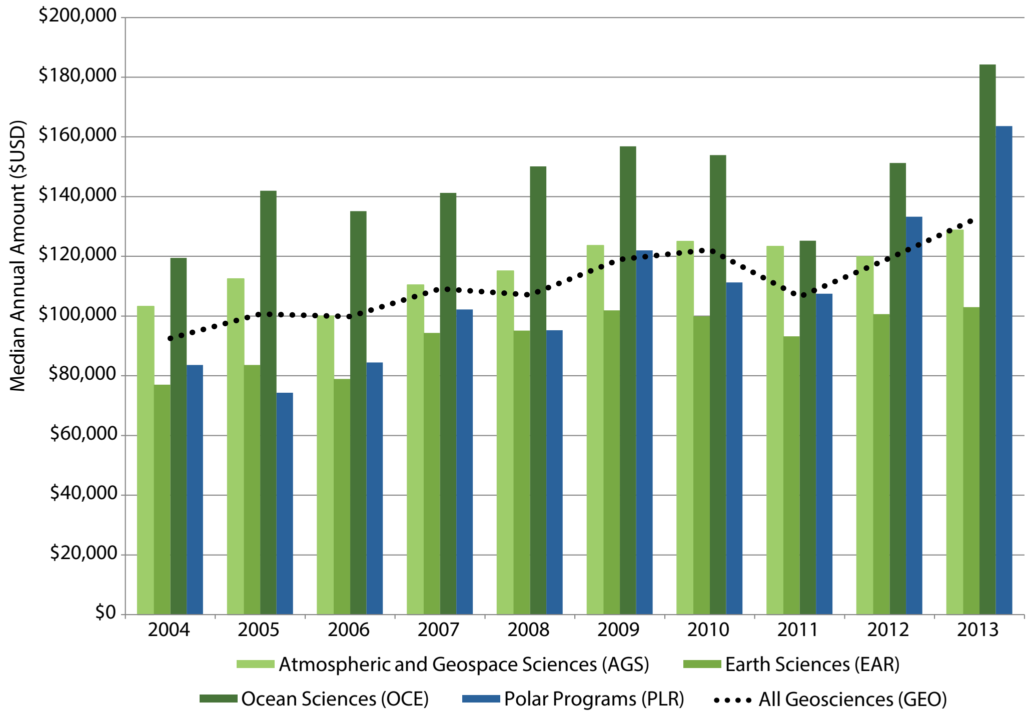
AGI Geoscience Workforce Program; Data derived from NSF's BIIS Funding Trends database

Figure 3.45: Funding Rate of Geoscience Proposals at NSF by GEO Division



AGI Geoscience Workforce Program; Data derived from NSF's BIIS Funding Trends database

Figure 3.46: Median Annual Size of Geoscience Awards at NSF by GEO Division



AGI Geoscience Workforce Program; Data derived from NSF's BIIS Funding Trends database

Table 3.10: Top 10 Universities Receiving NSF Atmospheric and Geospace Science (AGS) Awards Annually, 2004–2013 (Millions $USD)

Institution	State	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Columbia University	NY		$3.2	$3.4				$3.7		$2.7	$8.3
Colorado State University	CO	$4.6	$6.6	$6.2	$8.3	$8.7	$8.8	$9.4	$9.0	$8.8	$7.6
University of Colorado–Boulder	CO	$5.3	$3.9	$3.2	$5.1	$4.6	$8.3	$4.4	$8.4	$6.8	$5.2
University of Wyoming	WY	$2.8				$2.5			$3.3	$3.6	$5.2
University of Washington	WA	$4.5	$4.4	$3.3	$4.4	$3.7	$4.8		$5.5	$5.2	$4.2
Harvard University	MA										$3.2
Massachusetts Institute of Technology	MA	$3.9	$5.1	$3.9		$2.6	$5.5	$4.5	$3.2	$4.2	$3.2
University of Massachusetts–Amherst	MA										$3.0
University of Arizona	AZ				$2.9		$8.2				$2.8
University of Illinois–Urbana-Champaign	IL			$5.1	$2.8		$5.5				$2.7
University of New Hampshire	NH								$3.3	$4.5	
UCLA	CA	$4.7	$2.6	$3.4		$2.7			$4.2	$3.5	
University of Oklahoma	OK			$3.3	$3.5	$3.4				$2.9	
Pennsylvania State University	PA	$3.8					$4.4			$2.8	
Boston College	MA	$5.4	$5.7	$5.7	$5.6	$5.7	$6.1	$6.2	$4.8		
Cornell University	NY	$4.2	$2.8		$5.4	$6.5		$6.0	$4.0		
North Carolina State University	NC								$3.3		
New Jersey Institute of Technology	NJ							$6.0			
University of Hawaii	HI	$3.2						$4.0			
University of Michigan	MI		$2.7					$3.4			
Johns Hopkins University	MD					$2.9	$5.3	$3.0			
Virginia Polytechnic Institute and State University	VA						$7.8				
Scripps Institute of Oceanography	CA				$5.4						
University of California–Berkeley	CA			$3.2							
University of Minnesota–Twin Cities	MN		$2.7								

AGI Geoscience Workforce Program; Data derived from NSF's BIIS Funding Trends database

Table 3.11: Top 10 Universities Receiving NSF Earth Science (EAR) Awards Annually, 2004–2013 (Millions $USD)

Institution	State	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
University of Arizona	AZ	$5.4	$6.2	$6.6	$6.3	$5.4	$11.6				$7.3
Arizona State University	AZ								$3.6	$4.1	$5.5
University of Southern California	CA	$5.9	$5.1	$4.7	#4.8		$7.2	$5.8	$5.4	$7.1	$5.2
University of Minnesota–Twin Cities	MN	$5.2	$6.3	$5.5	$8.0	$5.9	$7.5	$5.7	$5.4	$4.1	$5.0
University of Colorado–Boulder	CO		$2.7		$3.9	$3.2	$4.9	$4.0	$6.2	$6.8	$4.6
Columbia University	NY			$2.9		$3.8	$4.4	$3.6			$3.9
University of Washington	WA										$3.6
Pennsylvania State University	PA		$3.1	$2.7		$3.0	$3.9	$4.2		$3.8	$3.6
University of Texas–Austin	TX					$2.7		$3.8			$3.5
Duke University	NC										$3.1
University of Chicago	IL	$3.1			$2.7	$2.7		$3.6	$3.2	$5.8	
Vanderbilt University	TN									$4.5	
University of Illinois–Urbana–Champaign	IL							$3.8	$3.3	$4.1	
University of California–Berkeley	CA			$2.8					$5.4	$3.9	
University of California–Davis	CA									$3.7	
University of California–Riverside	CA								$3.8		
John Hopkins University	MD								$3.3		
Stanford University	CA	$11.2	$3.1	$6.8	$6.3				$3.0		
University of Wisconsin–Madison	WI	$2.8	$3.4					$4.0			
Scripps Institute of Oceanography	CA							$3.1			
California Institute of Technology	CA	$3.3	$4.8	$4.6	$4.0	$4.0	$5.1				
Massachusetts Institute of Technology	MA	$3.7	$6.2	$3.1	$3.3	$3.1	$4.9				
University of Pennsylvania	PA						$4.8				
SUNY–Stony Brook	NY	$3.5	$3.9	$3.7	$3.3	$3.5	$4.5				
Oregon State University	OR				$4.4						
UCLA	CA	$2.9									

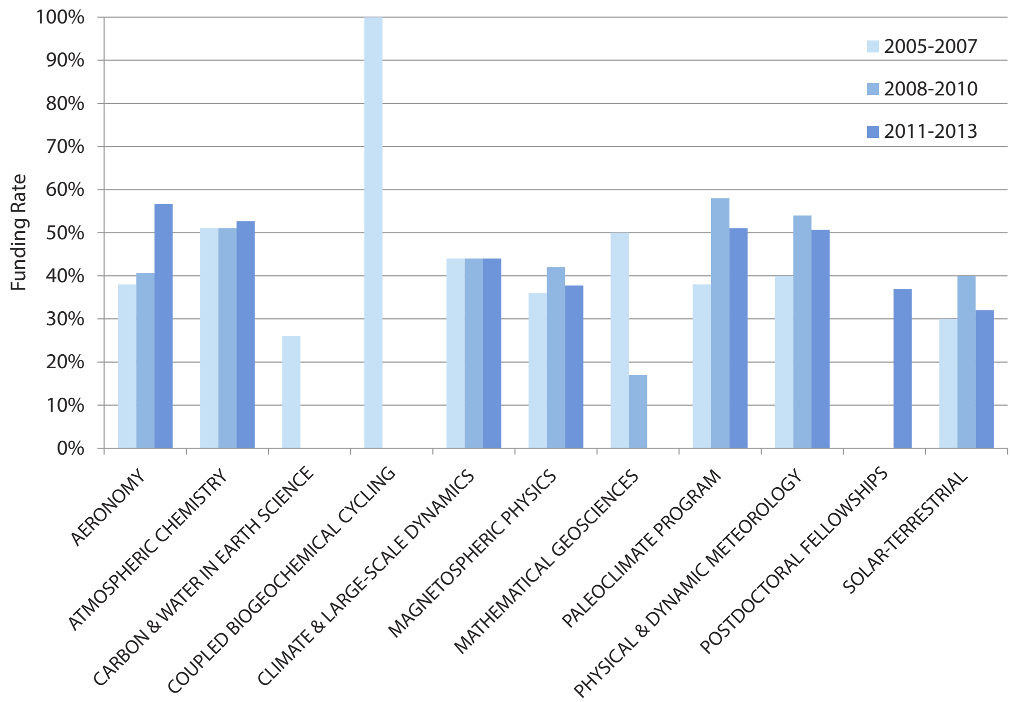
AGI Geoscience Workforce Program; Data derived from NSF's BIIS Funding Trends database

Table 3.12: Top 10 Universities Receiving NSF Ocean Sciences (OCE) Awards Annually, 2004-2013 (Millions $USD)

Institution	State	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Woods Hole Oceanographic Institution	MA	$57.9	$53.5	$58.7	$64.1	$56.6	$82.0	$67.6	$66.5	$54.0	$59.5
Scripps Institute of Oceanography	CA	$31.7	$27.9	$28.2	$29.0	$24.6	$40.0	$24.0	$25.8	$32.3	$21.0
Columbia University	NY	$19.8	$18.5	$17.9	$13.4	$22.8	$27.6	$18.6	$23.5	$28.1	$18.5
University of Hawaii	HI	$14.7	$10.0	$17.0	$15.5	$14.0	$19.9	$18.0	$7.5	$12.1	$13.7
Oregon State University	OR	$9.8	$12.8	$14.7	$11.4	$11.4	$12.7	$7.9	$13.0	$9.2	$12.3
University of Washington	WA	$15.7	$16.9	$17.1	$18.4	$14.8	$23.8	$15.9	$15.4	$21.5	$9.5
University of Southern California	CA		$4.0						$9.5	$5.9	$9.0
University of Miami	FL	$7.5	$6.8	$10.5	$7.3	$7.0	$10.0	$7.0	$6.7	$5.2	$6.5
University of California–Santa Barbara	CA	$5.2	$3.3		$3.7	$4.3		$7.2		$4.7	$6.0
Oregon Health and Science University	OR			$3.0	$4.2						$4.7
University of Rhode Island	RI	$5.5	$5.9	$4.8	$5.2	$5.2	$9.9	$6.3	$6.9	$4.7	
Rutgers University	NJ								$5.8		
University of Alaska–Fairbanks	AK						$162.4	$34.0			
Georgia institute of Technology	GA						$4.8				
Massachusetts Institute of Technology	MA					$4.6					
University of Delaware	NY	$4.1		$2.5							

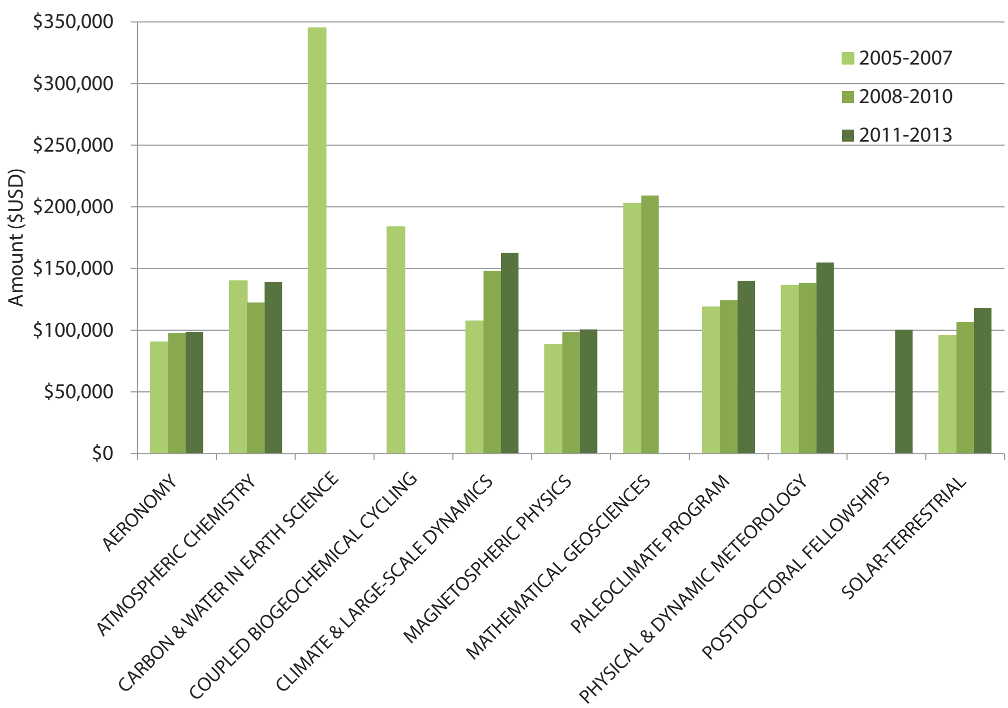
AGI Geoscience Workforce Program; Data derived from NSF's BIIS Funding Trends database

Figure 3.47: Trends in NSF Atmospheric and Geospace Science Funding Rates by Subject



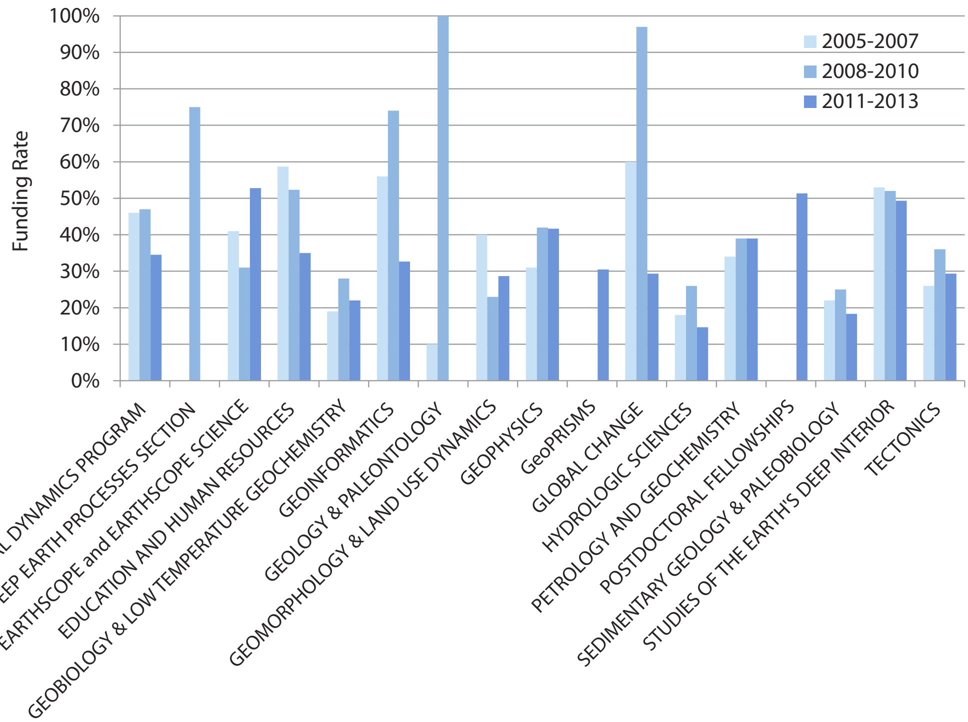
AGI Geoscience Workforce Program; Data derived from NSF's BIIS Funding Trends database

Figure 3.48: Trends in NSF Atmospheric and Geospace Sciences Award Size by Subject



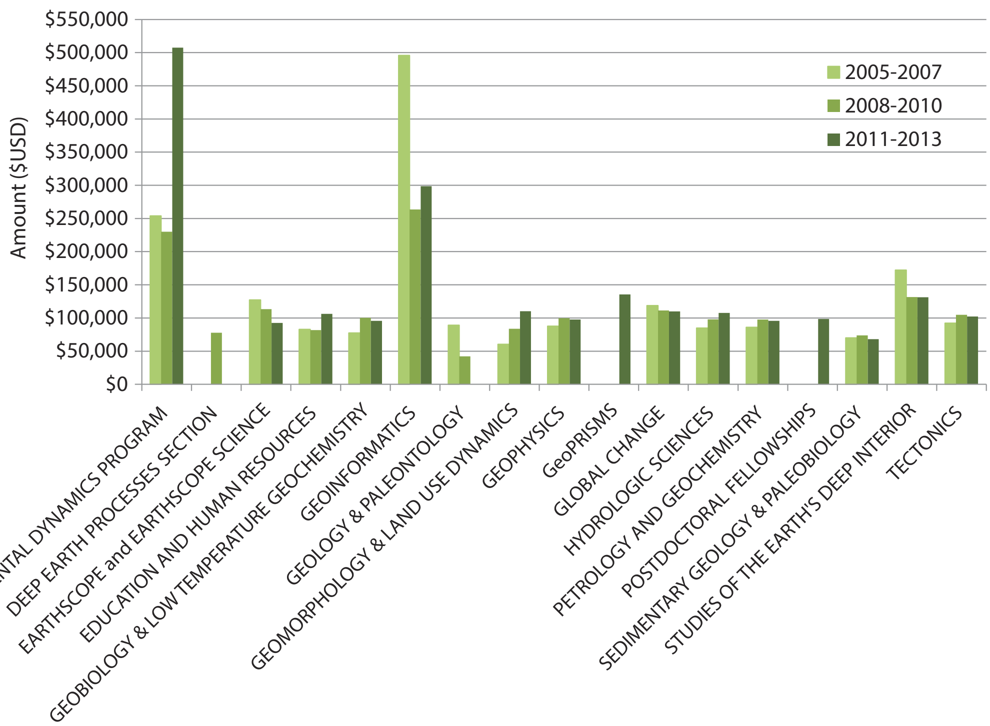
AGI Geoscience Workforce Program; Data derived from NSF's BIIS Funding Trends database

Figure 3.49: Trends in NSF Earth Sciences Funding Rates by Subject



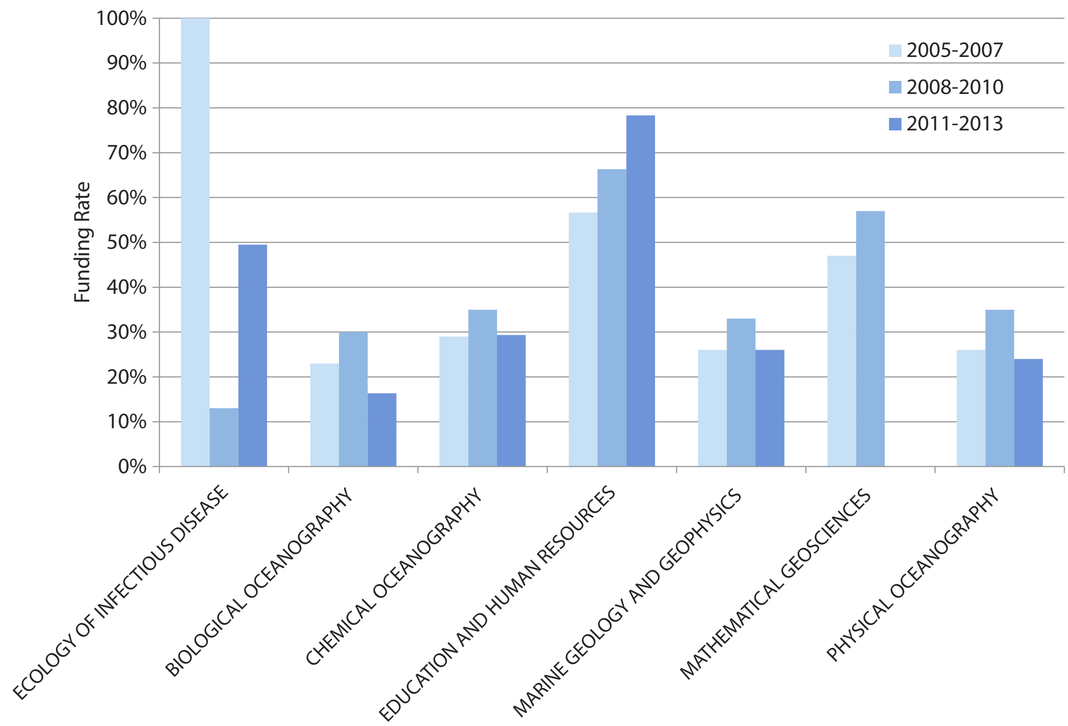
AGI Geoscience Workforce Program; Data derived from NSF's BIIS Funding Trends database

Figure 3.50: Trends in NSF Earth Sciences Award Size by Subject



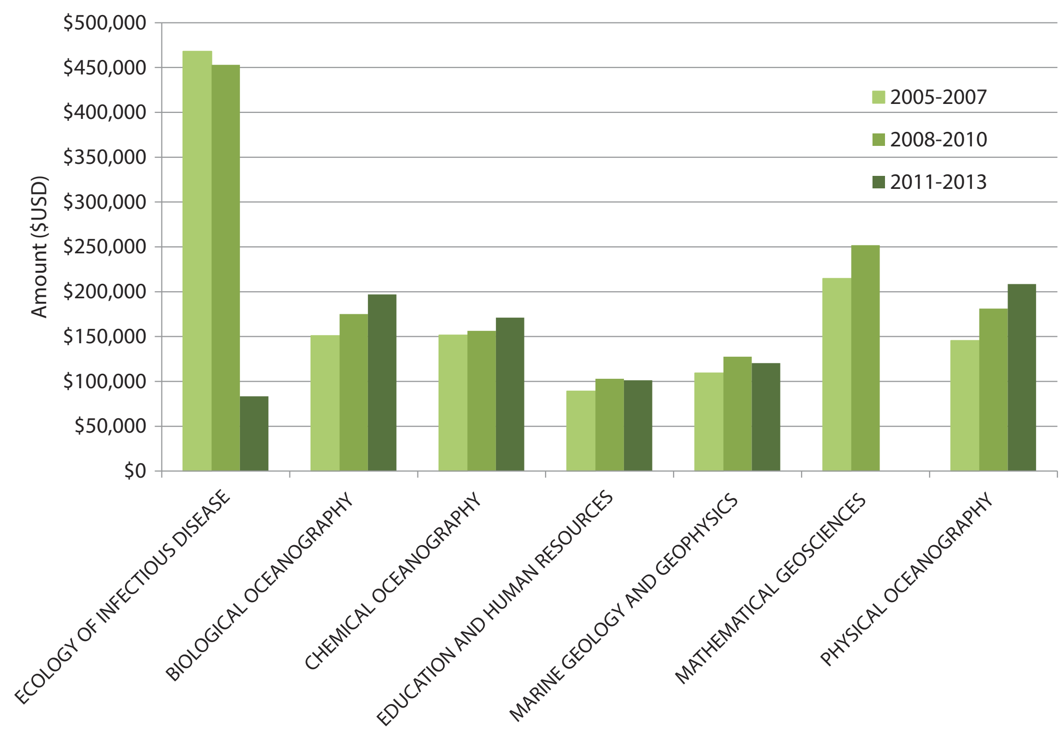
AGI Geoscience Workforce Program; Data derived from NSF's BIIS Funding Trends database

Figure 3.51: Trends in NSF Ocean Sciences Funding Rates by Subject



AGI Geoscience Workforce Program; Data derived from NSF's BIIS Funding Trends database

Figure 3.52: Trends in NSF Ocean Sciences Award Size by Subject



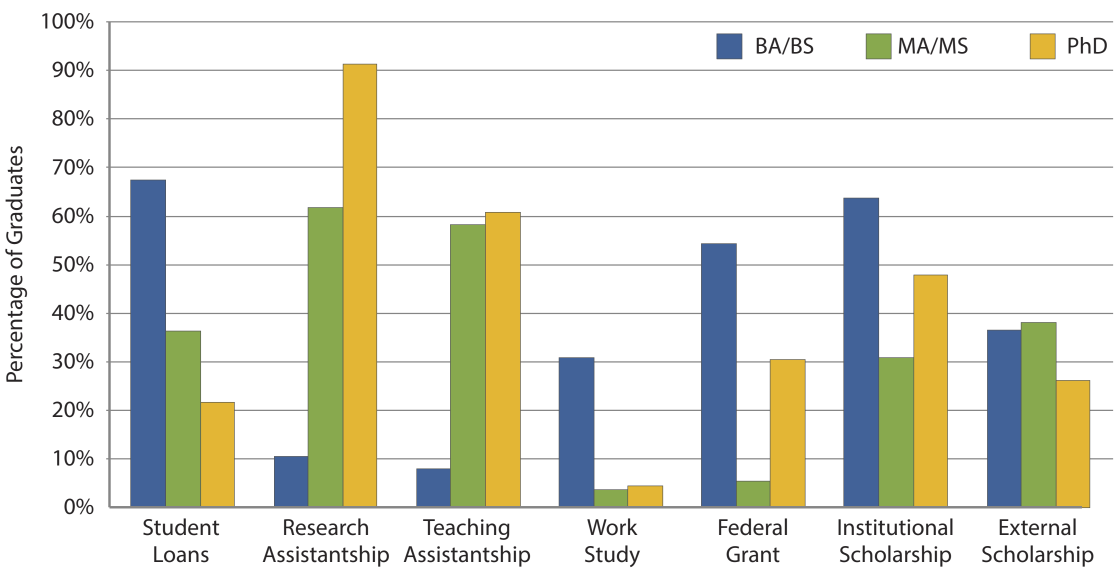
AGI Geoscience Workforce Program; Data derived from NSF's BIIS Funding Trends database

Funding of Geoscience Students

Geoscience students use a variety of funding sources to pay for their degree programs, including student loans, teaching assistantships, research assistantships, federal grants, and institutional scholarships. It is somewhat surprising that 37% of master's graduates and 20% of doctoral graduates used student loans to help pay for their degree program (Figure 3.53).

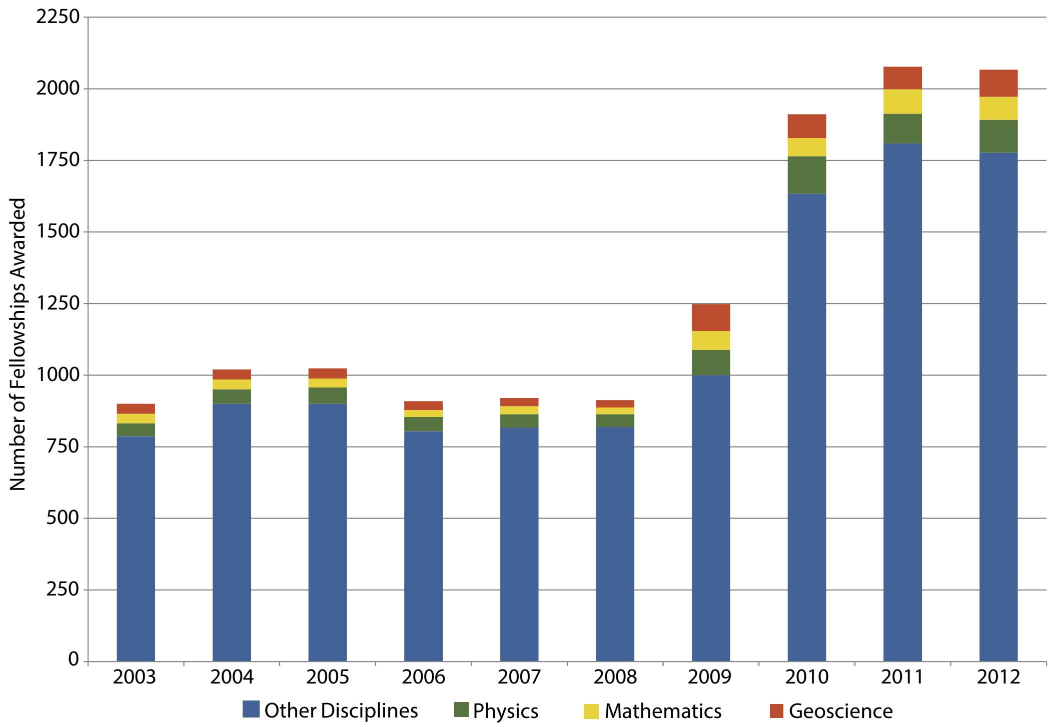
NSF's Graduate Research Fellowships are a prestigious and well funded award for graduate students, and the number of awards given to geoscience graduates has been increasing since 2008 to a high of 95 awards in 2012 totaling $4 million in award money (Figure 3.54 and 3.55). The rapid increase in the total number of graduate fellowships was due to the ARRA stimulus funding in 2009. But the continuing high number of awards since then is due to a focus by NSF to do more to increase the quality of the future academic workforce.

Figure 3.53: Types of Financial Aid Used by Geoscience Graduates While Working Towards Their Degree



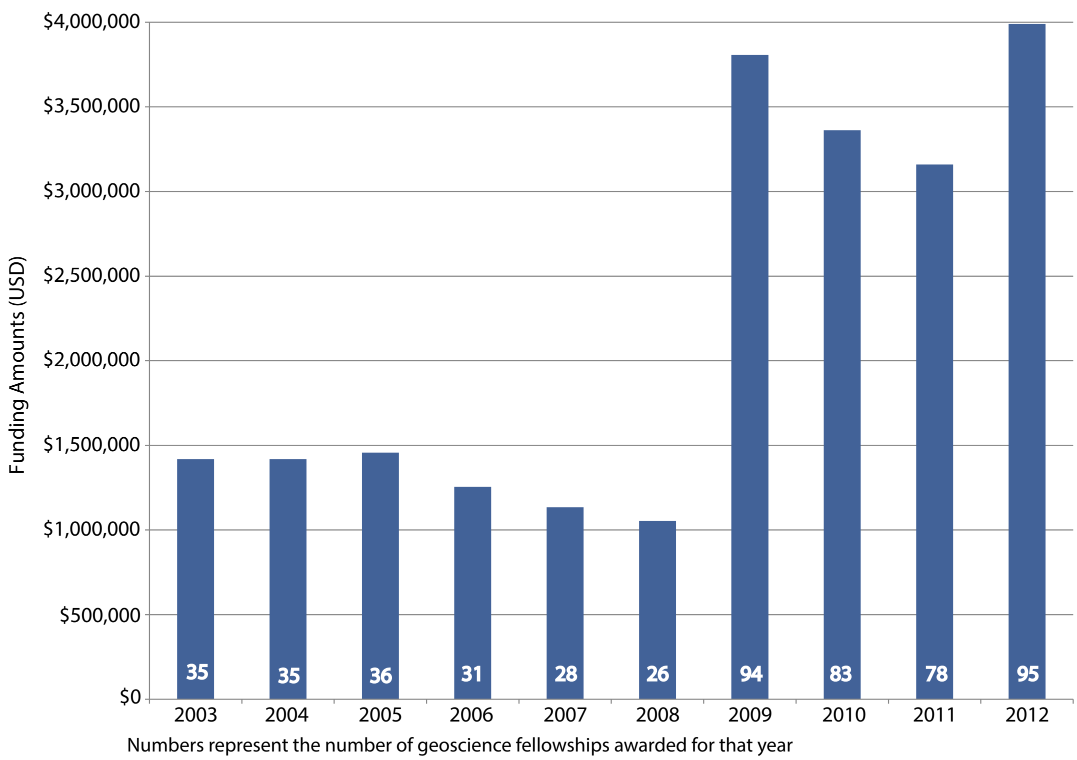
AGI Geoscience Workforce Program; Data derived from AGI's Geoscience Student Exit Survey; Figure created by Kathleen Cantner

Figure 3.54: Number of NSF Graduate Fellowships Awarded, 2003-2012



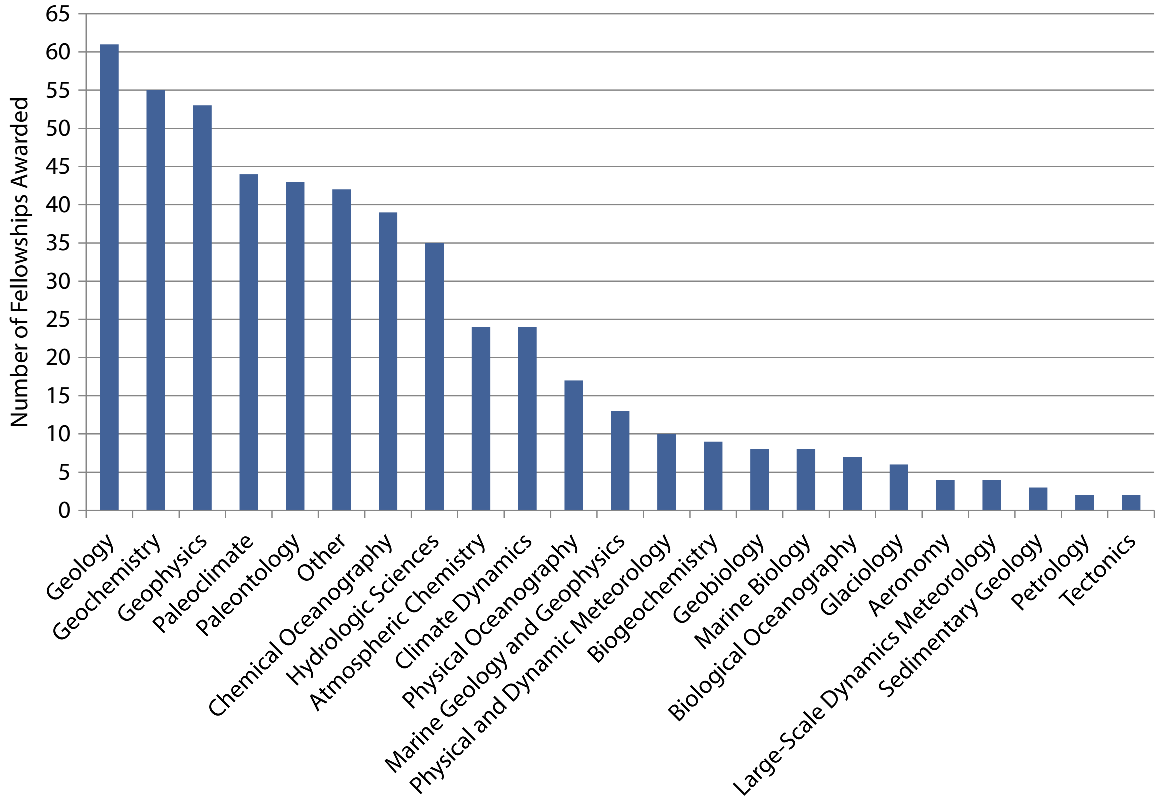
AGI Geoscience Workforce Program; Data derived from NSF Graduate Fellowship Program reports posted on data.gov

Figure 3.55: Total Funding of Geoscience NSF Graduate Fellowships



AGI Geoscience Workforce Program; Data derived from NSF Graduate Fellowship Program reports posted on data.gov

Figure 3.56: NSF Geoscience Graduate Fellowships by Field of Study, 2003-2012



AGI Geoscience Workforce Program; Data derived from NSF Graduate Fellowship Program reports posted on data.gov

Table 3.13: Top 10 Baccalaureate Institutions Attended by NSF Geoscience Graduate Fellows (2003–2012)

Baccalaureate Institutions of Geoscience NSF Graduate Fellows	State	Number of Fellows (2003–2012)
Harvard University	MA	25
California Institute of Technology	CA	17
Brown University	RI	14
Carleton College	MN	14
Stanford University	CA	12
University of Washington	WA	12
Massachusetts Institute of Technology	MA	11
University of California-Berkeley	CA	11
Cornell University	NY	10
University of Chicago	IL	10

AGI Geoscience Workforce Program; Data derived from NSF Graduate Fellowship Program reports posted on www.data.gov

Table 3.14: Top 10 Graduate Institutions Attended by NSF Geoscience Graduate Fellows (2003–2012)

Graduate Institutions of Geoscience NSF Graduate Fellows	State	Number of Fellows (2003-2012)
Massachusetts Institute of Technology	MA	41
University of Washington	WA	38
Harvard University	MA	27
University of California–San Diego	CA	26
Columbia University	NY	23
Stanford University	CA	22
University of California–Berkeley	CA	22
University of Colorado at Boulder	CO	21
California Institute of Technology	CA	20
University of Arizona	AZ	16

AGI Geoscience Workforce Program; Data derived from NSF Graduate Fellowship Program reports posted on www.data.gov

Chapter 4: Trends in Geoscience Employment — Examining Student Transitions and Workforce Dynamics

The 2011 edition of this report noted issues related to the increasing shortage of geoscience talent needed in the U.S. economy. The two major critical issues that face the geoscience workforce is the rate at which new talent transitions into geoscience professions and the rapid loss of experienced talent as they approach retirement. Over the last several years, the improved employment prospects for geoscientists has helped increase enrollments and awarded degrees within geoscience departments.

According to the Bureau of Labor Statistics (BLS), there were a total of 296,963 geoscience jobs in 2012, and this number is expected to increase by 14% by 2022 to a total of 339,737 jobs. Approximately 143,000 geoscientists are expected to retire by 2022, but over the next decade, approximately 51,000 students will be graduating with their bachelor's, master's, or doctoral degrees in the geosciences. Therefore, assuming minimal non-retirement attrition from the geoscience workforce, there is expected to be a deficit of approximately 135,000 geoscientists by 2022 — a decrease from the previously predicted 150,000 geoscientists deficit, mostly being adjusted by recent increases in enrollments and slight downward employment projections for mining and federal employment.

Some of the decrease in the predicted deficit in geoscientists can be attributed to the increased recruitment by certain industries, such as the petroleum industry, environmental consulting, and research institutes to hire new bachelor recipients, which is a profound change from trends of the last 25 years. Students have also become savvier about looking for jobs by networking through personal and professional contacts, as well as utilizing faculty referrals. Professional societies have also made an effort to increase their student memberships and retain students as they transition into the workforce, which can connect more students to future jobs and allow the societies to provide more support to the early career geoscientist community. The petroleum industry, in particular, has made strides at attempting to meet the future workforce demands that will become more apparent in the next five to ten years.

These initiatives have led to increases in the number of new entrants into the traditional geoscience workforce. The starting salaries for new employees can vary widely based on job type and degree, but master's degree recipients tend to make more money initially than other graduates. However, the median salaries for all geoscience industries continue to increase each year.

While some industries and companies are working to bridge the expected gap in the geoscience workforce, the federal workforce continues to age without any major change in the number of new entries into government positions. In fact, the BLS predicts a 10% decrease in the federal geoscience workforce by 2022.

BLS is also predicting a 5% decrease in the number of geoscientists in the mining industry, however this might change as the mining industry changes. The National Mining Association reported an increase in young geoscientists entering the mining industry and in support activities for mining and oil and gas. Also, with the increased pressure for the United States to be less dependent on such imports as rare earth minerals, there might be new jobs developing in the mining industry.

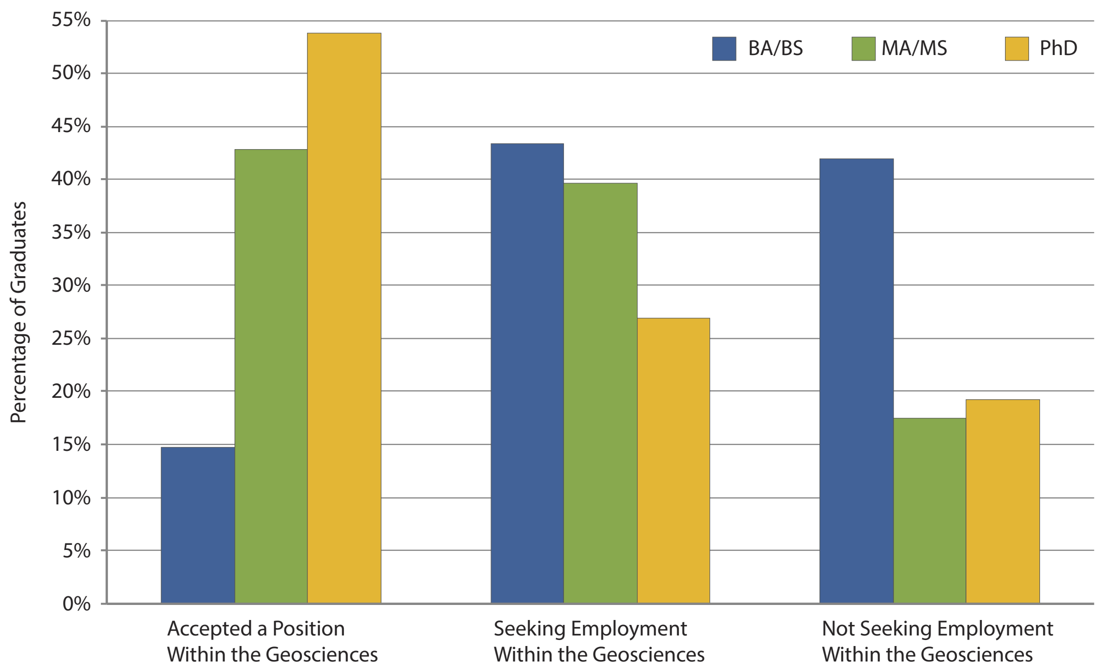
The academic workforce in the geosciences has seen a small increase in the number of faculty and research staff since 2011. However, there is little change in the faculty distributions by rank, and there was a decrease in the number of assistant professors since 2010, which reinforces the concern of decreased hiring of new doctorate recipients within academia for the geosciences.

Future research at AGI will be focused on tracking the early-career geoscientists as they work to establish a permanent career. Careers are typically established five to seven years after completing a terminal degree. During this five-year period, one can typically experience changes in personal, professional, and economic issues that will impact one's workforce trajectory and lead to changes in jobs and/or industries. AGI plans to measure these changes in order to look at workforce skills development, compare entry-level positions with permanent positions, identify the various industries and organizations that hire geoscience graduates, and measure the attrition rate of early-career geoscientists from the geoscience workforce.

Early Career Workforce

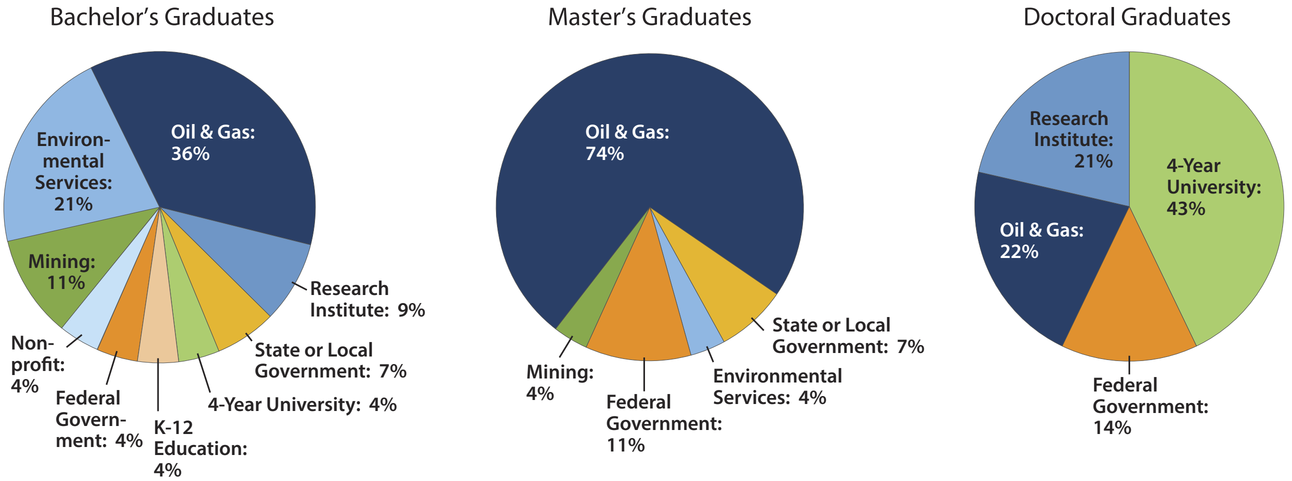
Among geoscience graduates, 15% of bachelor's graduates, 43% of master's graduates, and 54% of doctoral graduates have obtained a job within the geosciences at graduation, and 44% of bachelor's graduates, 40% of master's graduates, and 26% of doctoral graduates are still looking for a job in the geosciences (Figure 4.1). Of all the industries hiring new graduates, the petroleum industry appears to be the most successful in their recruitment efforts at postsecondary institutions (Figure 4.2). Interestingly, the number of industries hiring recent graduates decreases with each higher degree, and the number of industries that interest graduating students decreases with each higher degree (Figure 4.2 and 4.3). The starting salaries for graduates with geoscience degrees vary widely from less than $30,000 to more than $120,000; however, bachelor's graduates tend to earn between $30,000 and $60,000, and master's graduates tend to earn a higher starting salary than doctoral graduates (Figure 4.4). Geosciences graduates largely used their personal contacts and faculty referrals to find these jobs, and 48% of master's graduates that found a job utilized campus recruiting events and job fairs very successfully (Figure 4.7).

Figure 4.1: Geoscience Graduates Seeking, or who have Accepted a Position Within the Geosciences



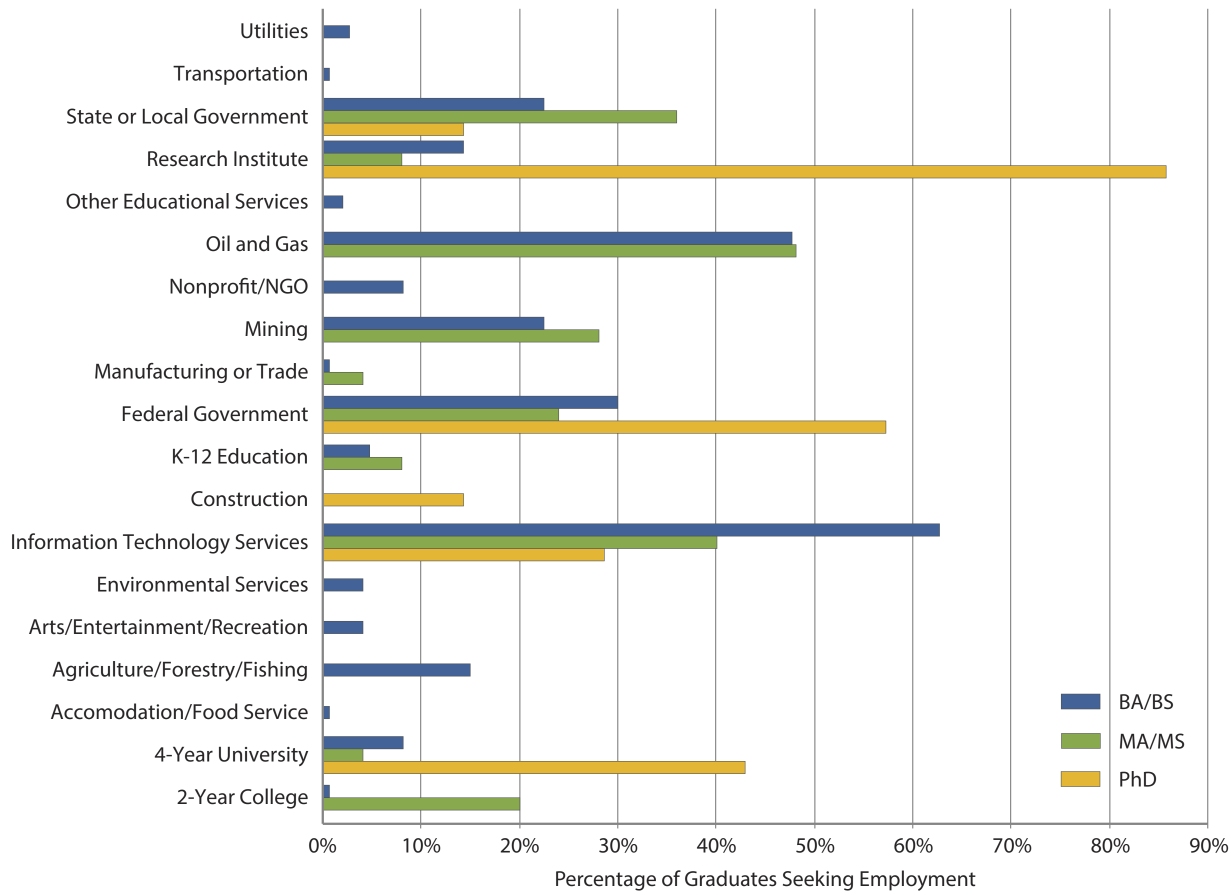
AGI Geoscience Workforce Program; Data derived from AGI's Geoscience Student Exit Survey; Figure created by Kathleen Cantner

Figure 4.2: Industries Hiring Geoscience Graduates



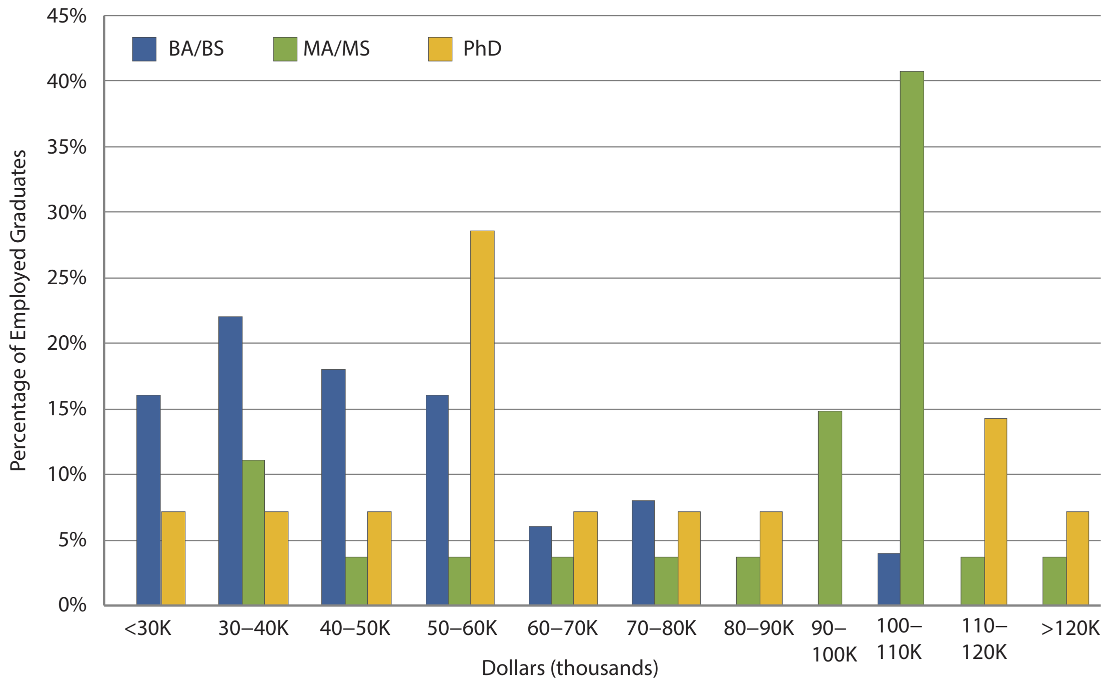
AGI Geoscience Workforce Program; Data derived from AGI's Geoscience Student Exit Survey; Figure created by Kathleen Cantner

Figure 4.3: Industries of Interest for Graduating Students Seeking a Job Within the Geosciences



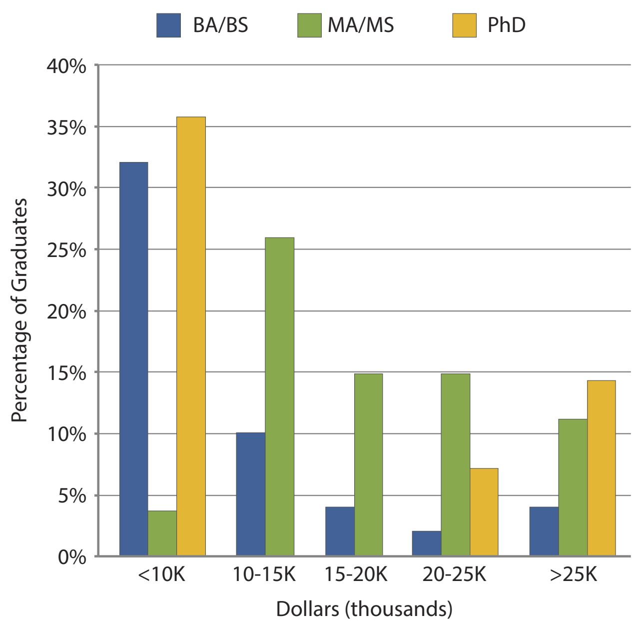
AGI Geoscience Workforce Program; Data derived from AGI's Geoscience Student Exit Survey; Figure created by Kathleen Cantner

Figure 4.4: Starting Salaries for Employed Geoscience Graduates



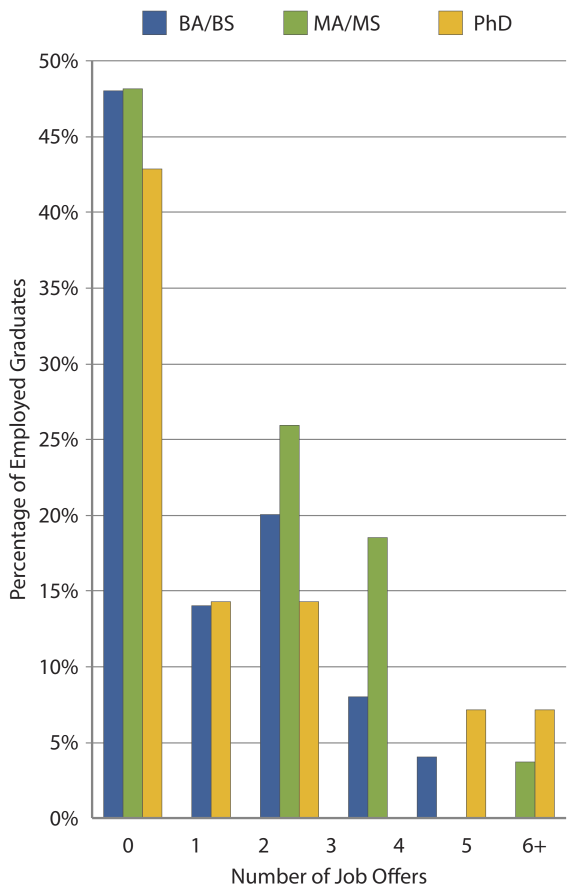
AGI Geoscience Workforce Program; Data derived from AGI's Geoscience Student Exit Survey; Figure created by Kathleen Cantner

Figure 4.5: Additional Compensation Granted to Geoscience Graduates with a Geoscience Job



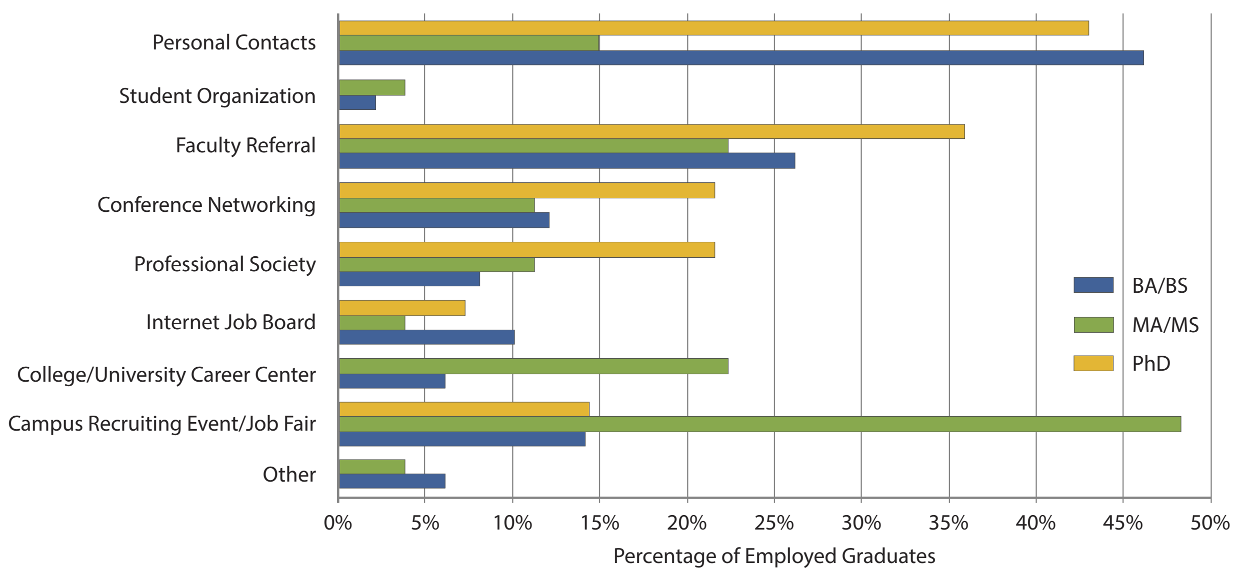
AGI Geoscience Workforce Program; Data derived from AGI's Geoscience Student Exit Survey; Figure created by Kathleen Cantner

Figure 4.6: Other Job Opportunities Granted to Employed Geoscience Graduates



AGI Geoscience Workforce Program; Data derived from AGI's Geoscience Student Exit Survey; Figure created by Kathleen Cantner

Figure 4.7: Useful Resources Used by Geoscience Students to Find a Job

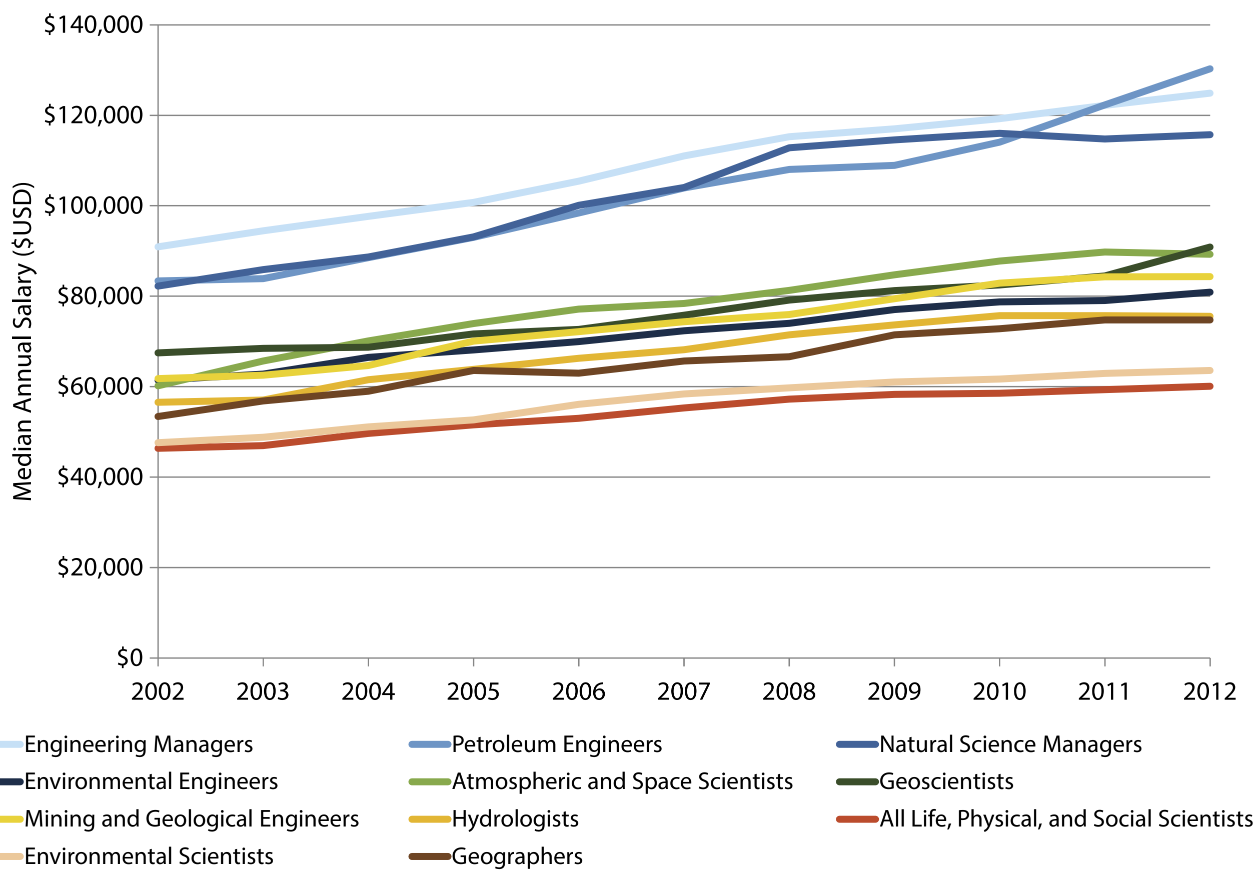


AGI Geoscience Workforce Program; Data derived from AGI's Geoscience Student Exit Survey; Figure created by Kathleen Cantner

Salary Trends for Geoscience Occupations

Median occupation salaries present more realistic typical salaries for particular occupations compared to mean salaries. Geoscience salaries have increased by 7% since 2009, which is higher than the growth seen in other science occupations (3%) and for all U.S. occupations (4%) (Figure 4.8). In 2012, the geoscience occupations with the highest median salaries were for petroleum engineers ($130,280), engineering managers ($124,870), natural science managers ($115,730), and geoscientists (excluding hydrologists and geographers) ($90,890).

Figure 4.8: Median Annual Salaries of Geoscience Occupations (2002-2012)



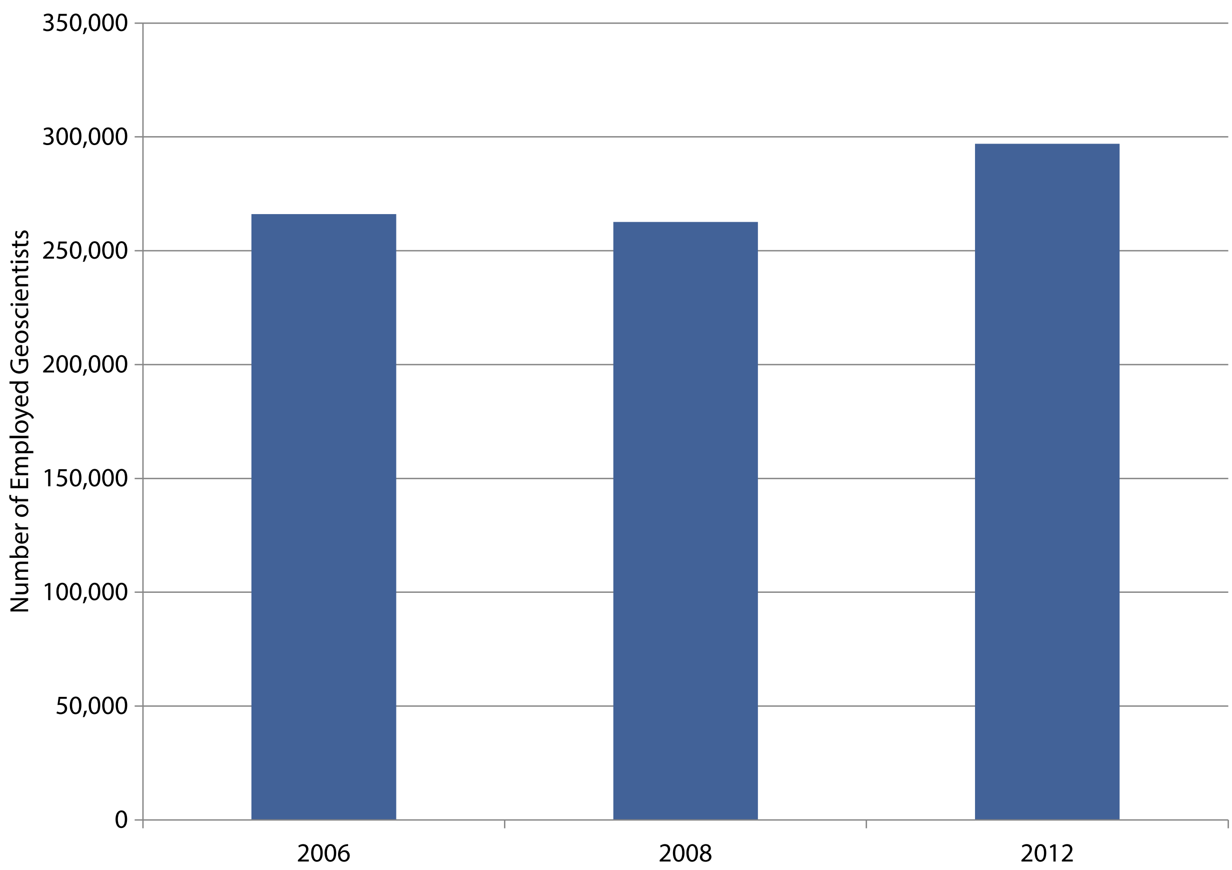
AGI Geoscience Workforce Program; Data derived from the U.S. Bureau of Labor Statistics, National Occupational Employment and Wage Estimates

Demographics of the Geoscience Profession

The total number of employed geoscientists has increased 13% since 2008 to 296,963 in 2012 according to the U.S. Bureau of Labor Statistics (Figure 4.9). While the total number of geoscientists is increasing, the percentage of women in the geoscience workforce has been decreasing since 2007 from 30% to 26% in 2012 (Figure 4.10). Also, the percentage of female geoscientists is 10% lower than the overall percentage of female physical scientists, according to the National Science Foundation (Figure 4.11).

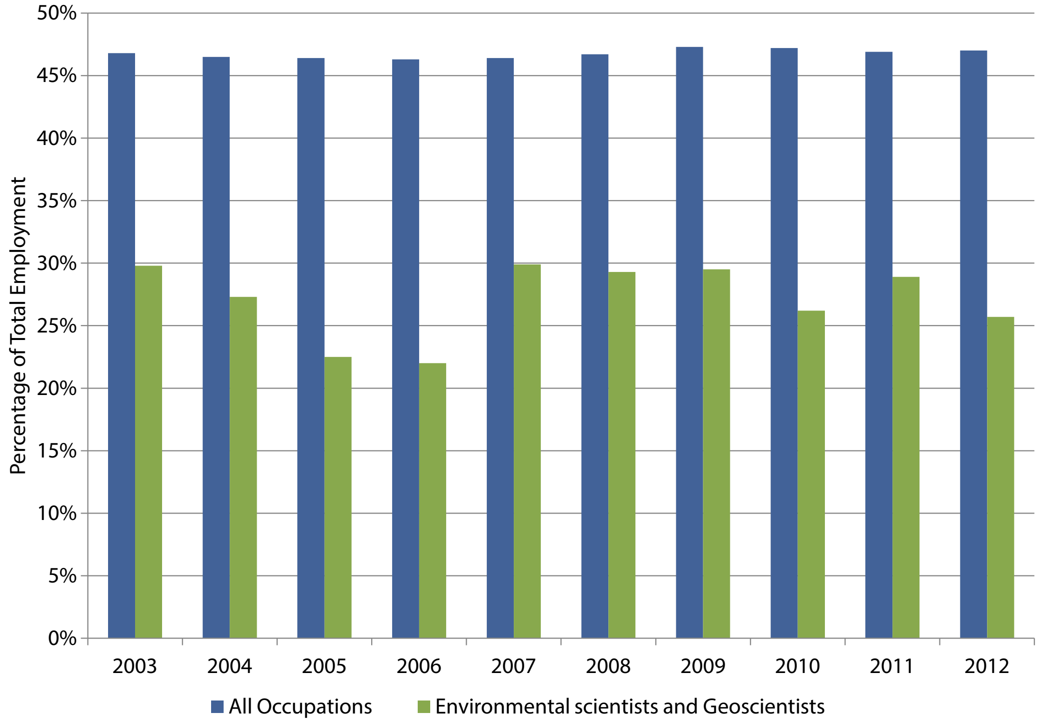
The percentage of underrepresented minorities in the geoscience workforce has hovered around 6–8% from 2010–2012 (Figure 4.13). The percentage of underrepresented minorities is almost 2% lower than the percentage of underrepresented minorities in the physical scientist workforce.

Figure 4.9: Total Number of Employed Geoscientists in the United States



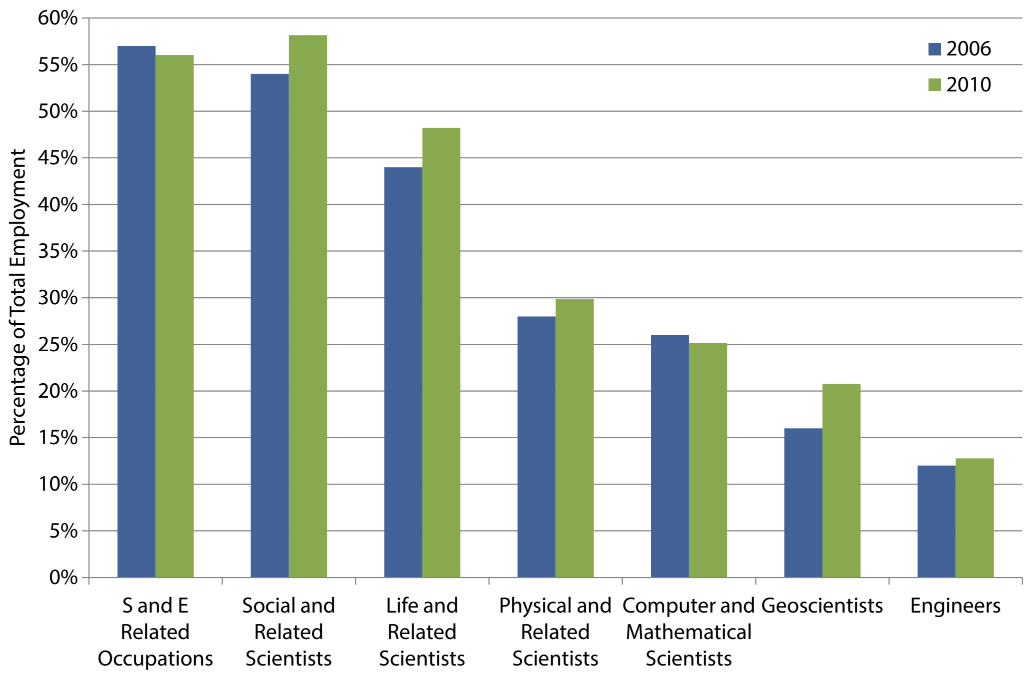
AGI Geoscience Workforce Program; Data derived from the U.S. Bureau of Labor Statistics Employment Projections

Figure 4.10: Percentage of Women in Environmental Science and Geoscience Occupations



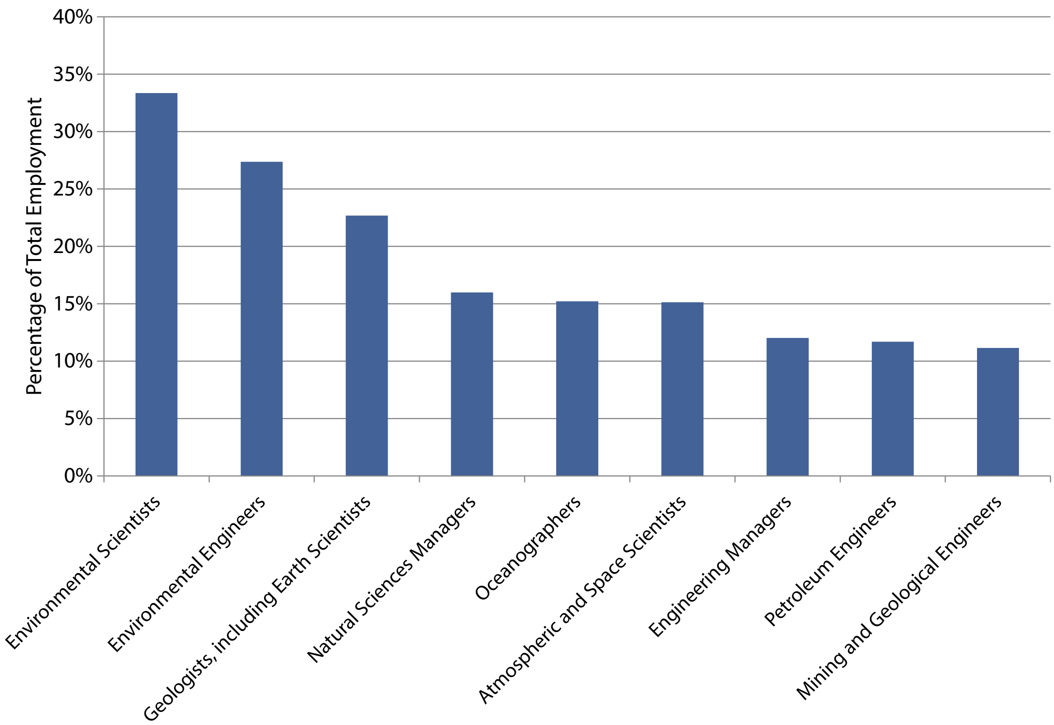
AGI Geoscience Workforce Program; Data derived from the U.S. Bureau of Labor Statistics, Current Population Survey

Figure 4.11: Percentage of Women in Geoscience and Other Science and Engineering Occupations



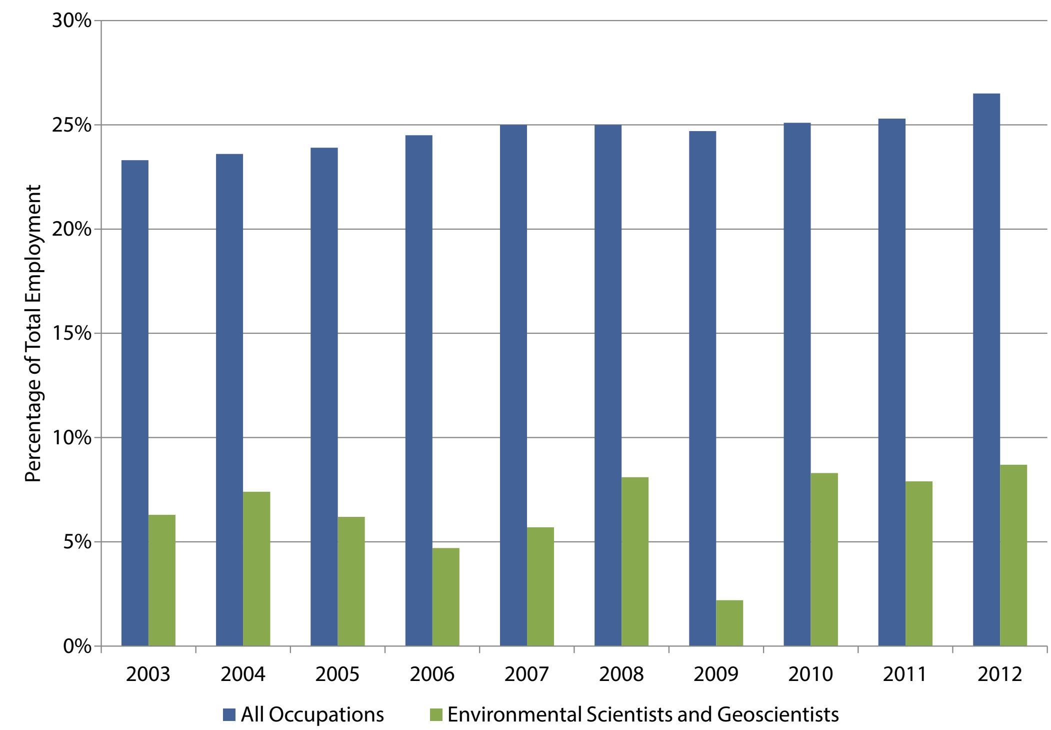
AGI Geoscience Workforce Program; Data derived from NSF SESTAT Public Data Files

Figure 4.12: Percentage of Women in Detailed Geoscience Occupations



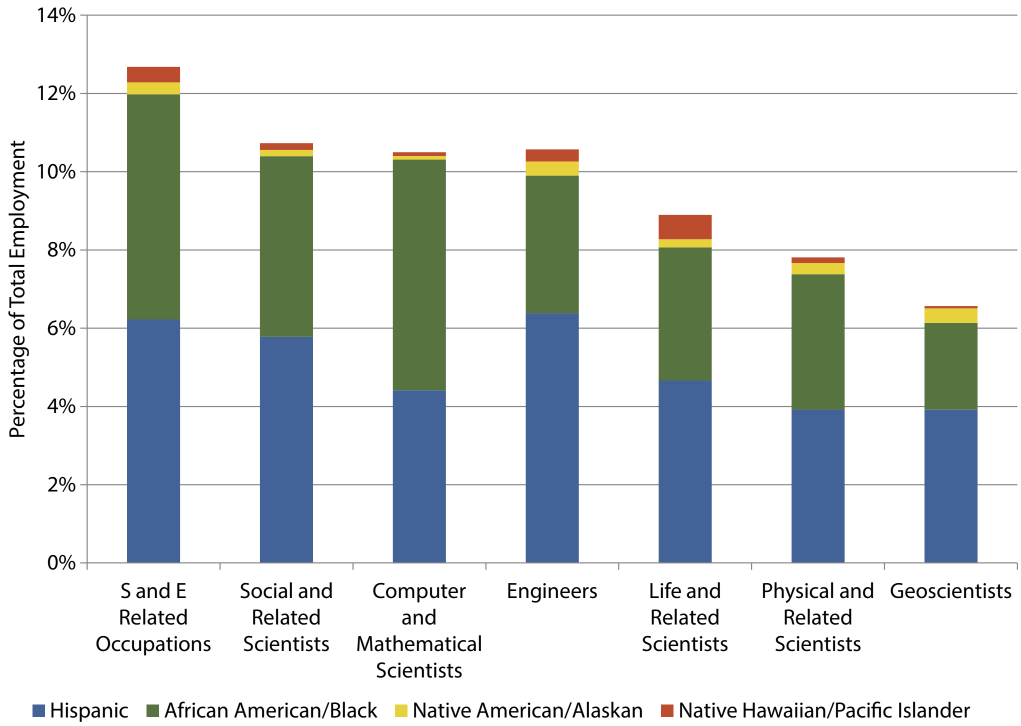
AGI Geoscience Workforce Program; Data derived from NSF SESTAT Public Data Files

Figure 4.13: Percentage of Underrepresented Minorities in Environmental Science and Geoscience Occupations



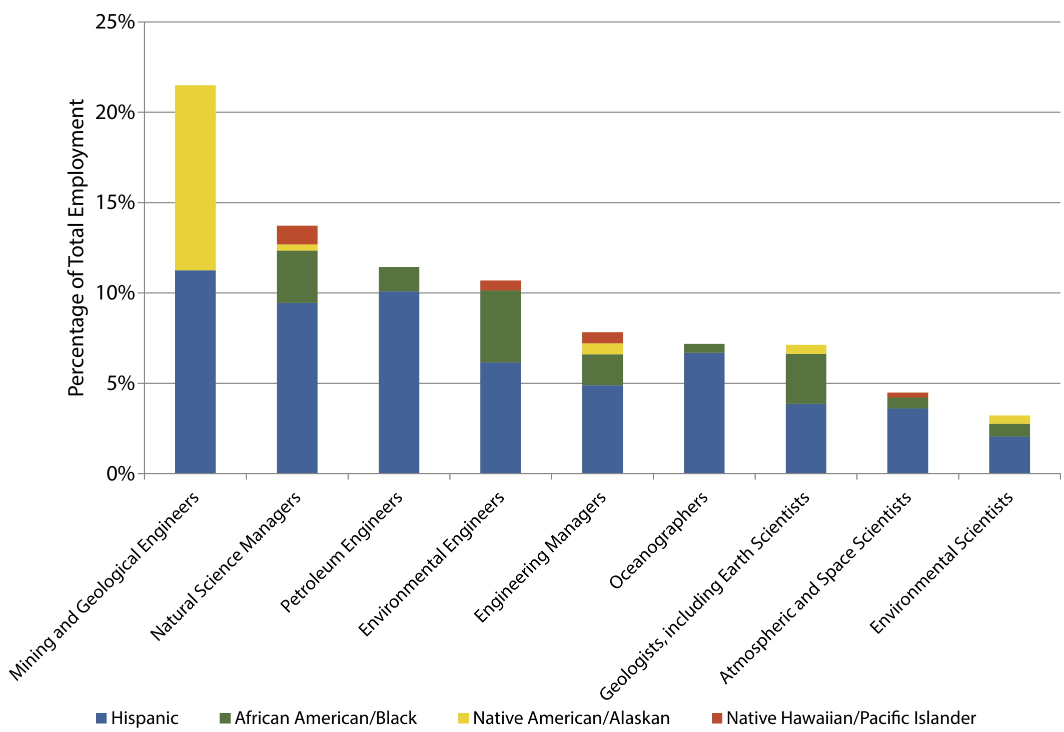
AGI Geoscience Workforce Program; Data derived from the U.S. Bureau of Labor Statistics, Current Population Survey

Figure 4.14: Percentage of Underrepresented Minorities in Geoscience and Other Science and Engineering Occupations



AGI Geoscience Workforce Program; Data derived from NSF SESTAT Public Data Files

Figure 4.15: Percentage of Underrepresented Minorities in Detailed Geoscience Occupations



AGI Geoscience Workforce Program; Data derived from NSF SESTAT Public Data Files

Workforce Age Demographics

The age distribution of the members of professional societies, such as the American Association of Petroleum Geologists, the Society of Economic Geologists, the Society of Exploration Geophysicists, and the National Groundwater Association, provides a good representation of the general age distribution of the traditional geoscience workforce. Figures 4.16 and 4.17 present the same data, but Figure 4.16 displays the society membership percentage for their members that are 30 and younger. All of these societies have become more engaged with students and have tried to increase their student membership, which appears to be successful. When the student membership data is removed, the majority of the traditional geoscience workforce is in their late 50s, except the majority of the hydrologists tend to be in their late 40s (Figure 4.17).

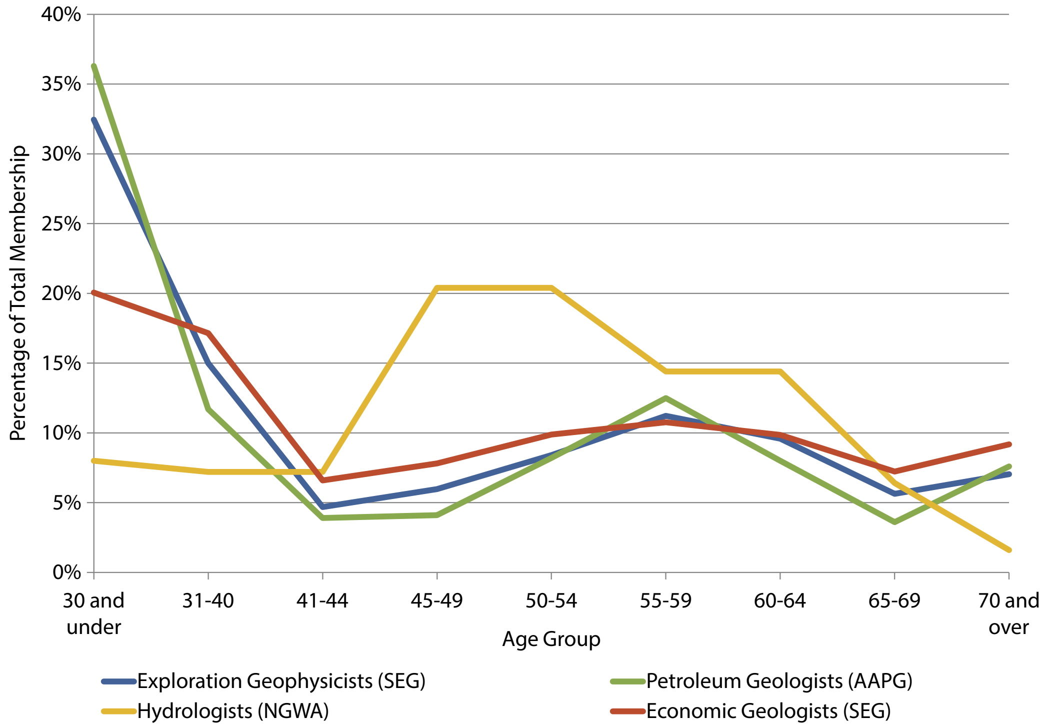
The age distributions of geoscientists in the federal government are trending towards retirement age without clear signs of future replacements for the aging workforce (Figures 4.18–4.26). In fact, the overall employment of geoscientists in the federal government has decreased by 10% since 2003.

The 2011 edition of this report introduced the prediction of the supply and demand of employees for the future in the petroleum industry. This model was updated, taking into account recent data AGI has collected showing the influx of new graduates into the petroleum industry. Because AGI believes that most departments are at capacity for student enrollments, a realistic 1% growth in geoscience graduate students entering the petroleum industry was used to represent the current and future workforce, compared to the demand that will develop as the current workforce reaches retirement. With these changes to the model, it appears the petroleum industry has been working to bridge the future gap in the workforce that may appear as the majority of the current workforce reaches retirement age (Figure 4.27). It is important to note that this model assumes that the majority of new graduates that enter the petroleum industry will remain within the industry as a full career, which may not be the case.

According to the National Mining Association, the mining industry, however, appears to have had an influx of young geoscientists for all mining (except oil and gas extraction) and for support activities for mining and oil and gas (Figure 4.28 and 4.29).

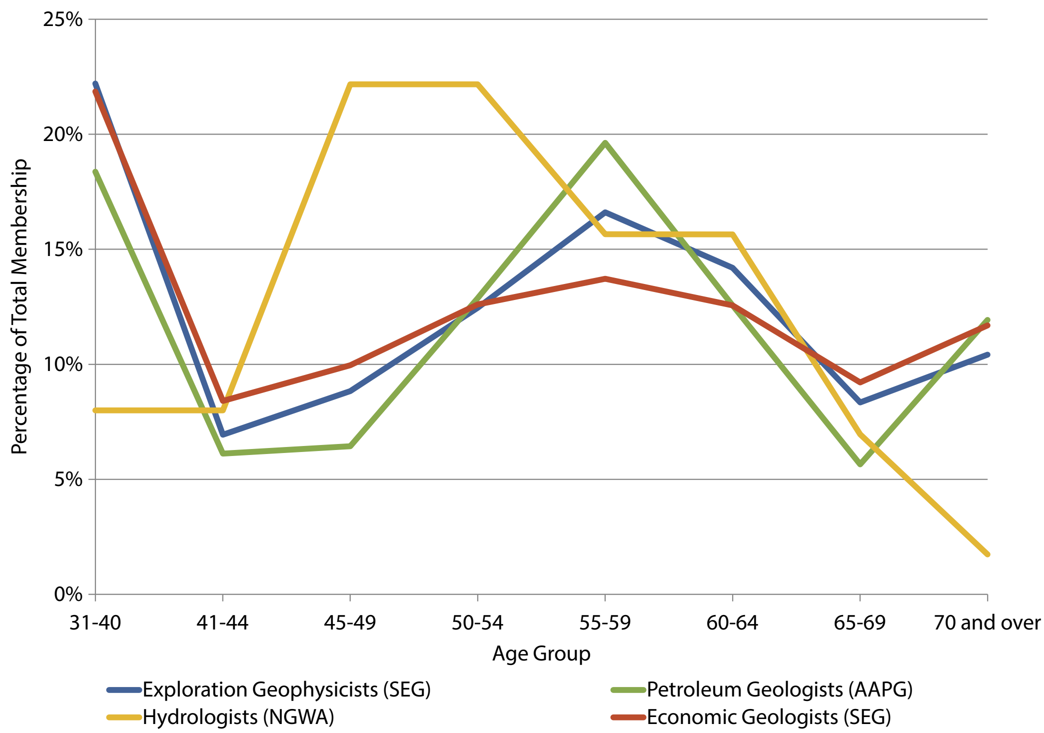
Between 2009 and 2013, there have been slight decreases in the percentages of faculty in the different ranks, but the overall number of current faculty in geoscience departments at four-year universities has increased by approximately 10% (Figure 4.30). There have also been shifts in the age distribution of the tenure and tenure-track faculty within all ranks, except Associate Professor, from 2010 to 2013 (Figure 4.31). Interestingly, there are nearly 150 fewer assistant professors in 2013 than in 2010. Progress of tenure-track faculty moves steadily through the ranks to reach full professor between the ages of 46–50 on average. However, full professors tend to work later in their career creating a crossover in the population of full professors and emeritus in their early to mid 70s.

Figure 4.16: Geoscience Age Distribution by Member Society



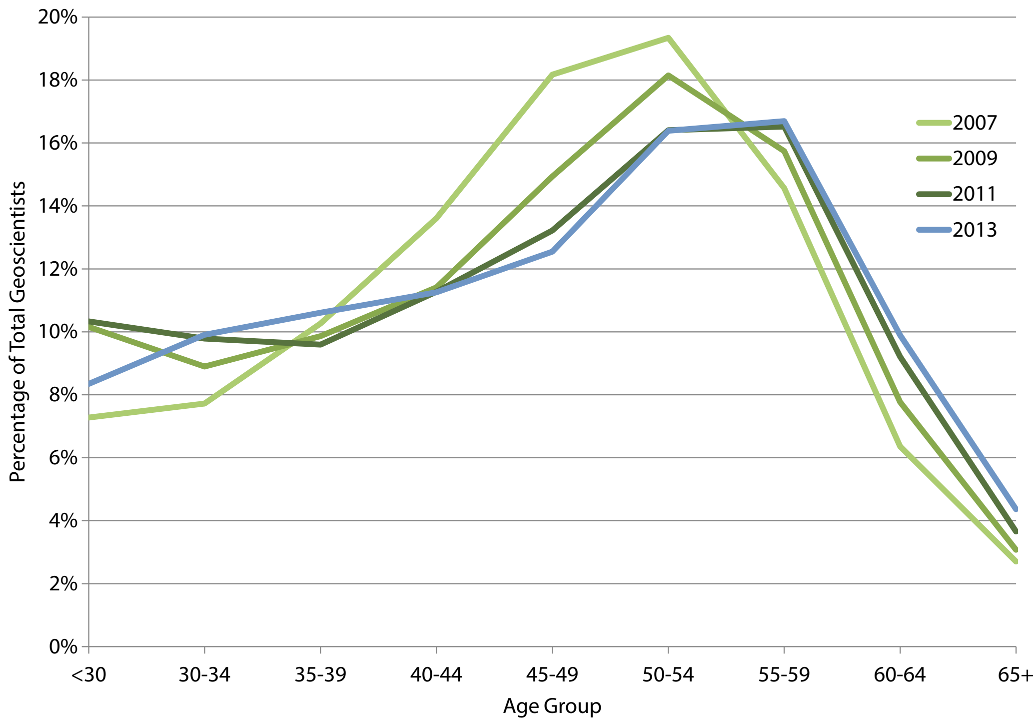
AGI Geoscience Workforce Program; Data provided by the Society of Exploration Geophysicists, American Association of Petroleum Geologists, Society of Economic Geologists, and the National Groundwater Association

Figure 4.17: Geoscience Age Distribution by Membership Society without Student Memberships



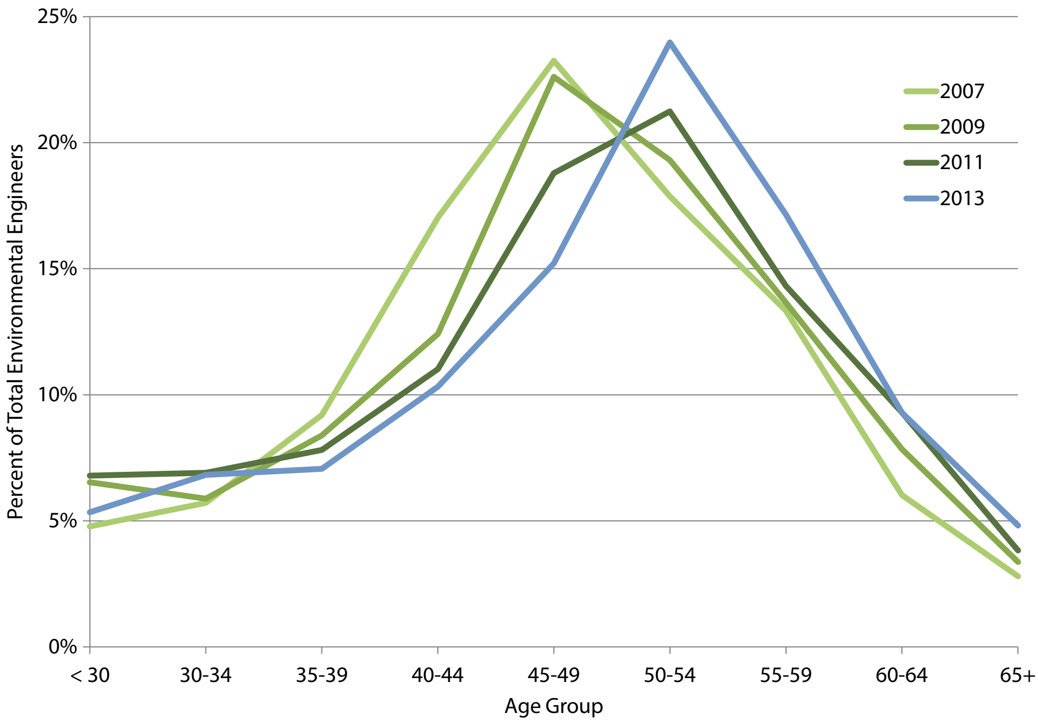
AGI Geoscience Workforce Program; Data provided by the Society of Exploration Geophysicists, American Association of Petroleum Geologists, Society of Economic Geologists, and the National Groundwater Association

Figure 4.18: Age Distribution of Geoscientists in the U.S. Government



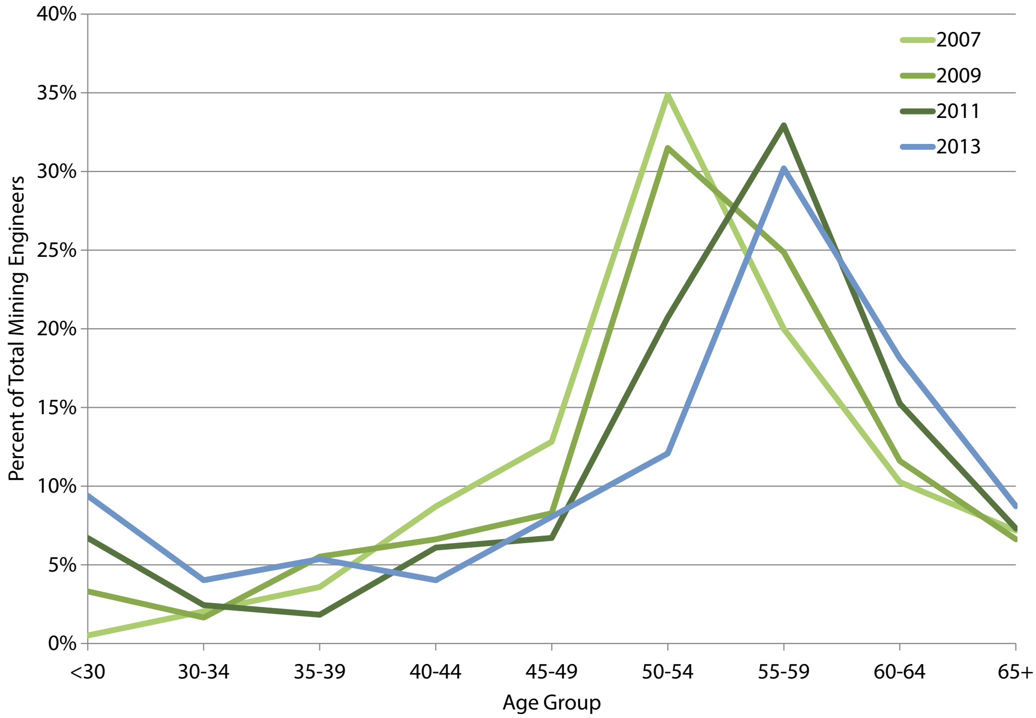
AGI Geoscience Workforce Program; Data derived from the Office of Personnel Management fedscope database

Figure 4.19: Age Distribution of Environmental Engineers in the U.S. Government



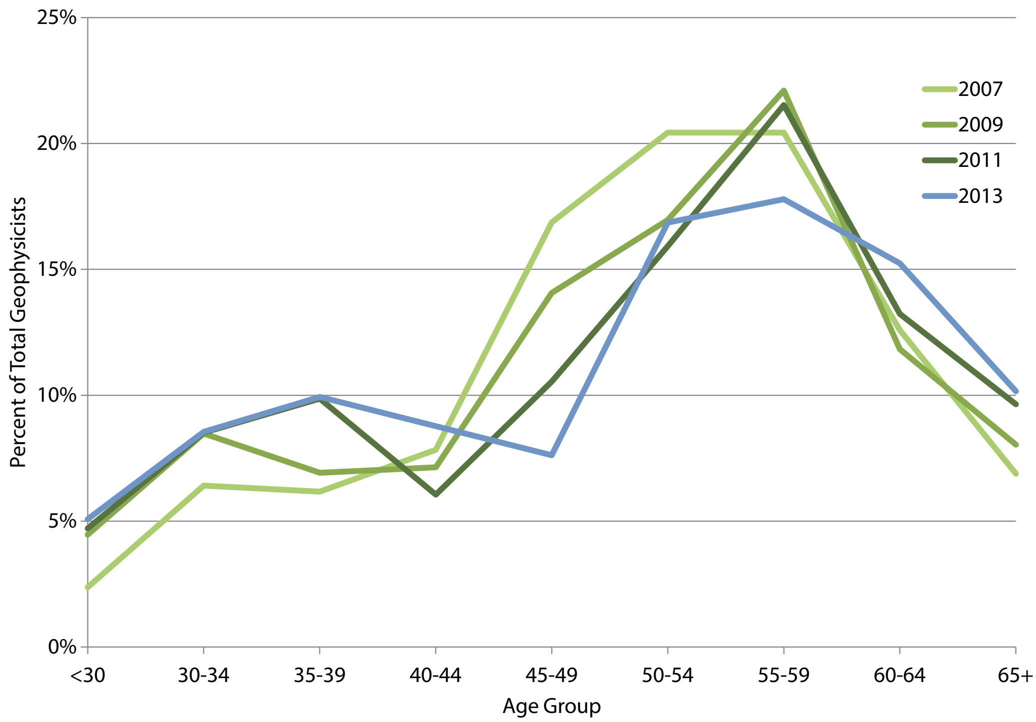
AGI Geoscience Workforce Program, Data derived from the Office of Personnel Management fedscope database

Figure 4.20: Age Distribution of Mining Engineers in the U.S. Government



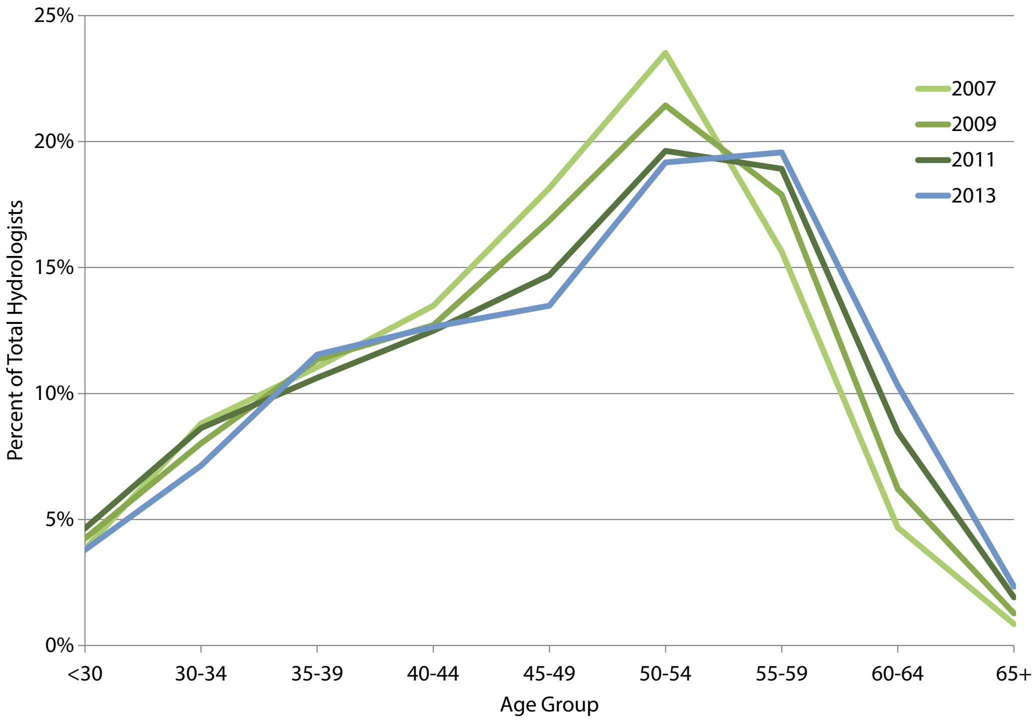
AGI Geoscience Workforce Program; Data derived from the Office of Personnel Management fedscope database

Figure 4.21: Age Distribution of Geophysicists in the U.S. Government



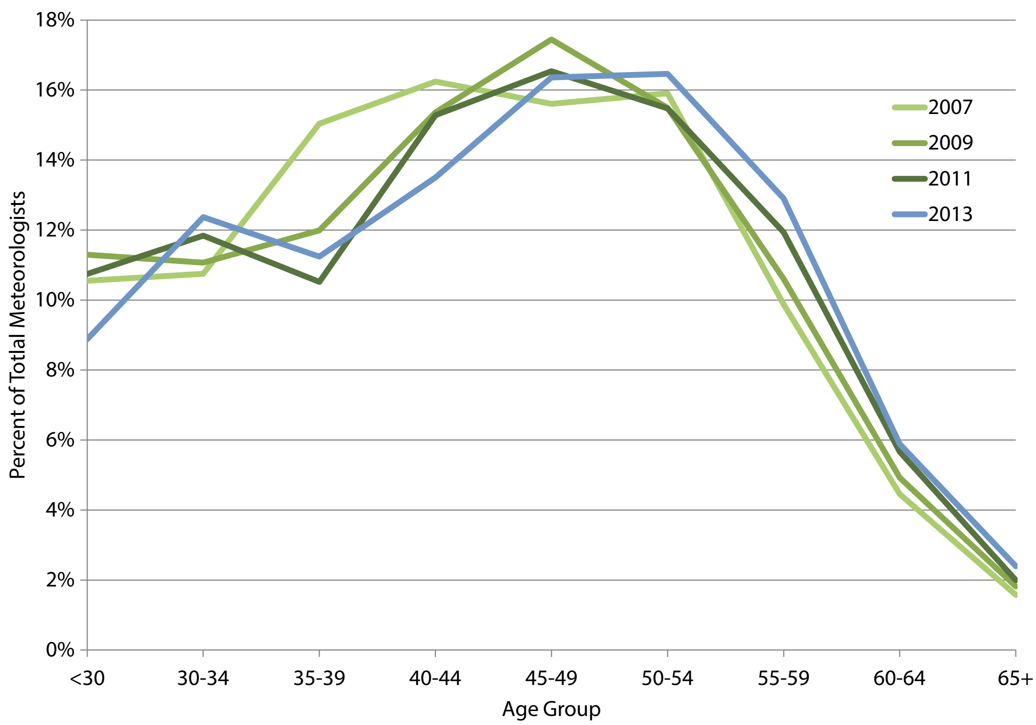
AGI Geoscience Workforce Program; Data derived from the Office of Personnel Management fedscope database

Figure 4.22: Age Distribution of Hydrologists in the U.S. Government



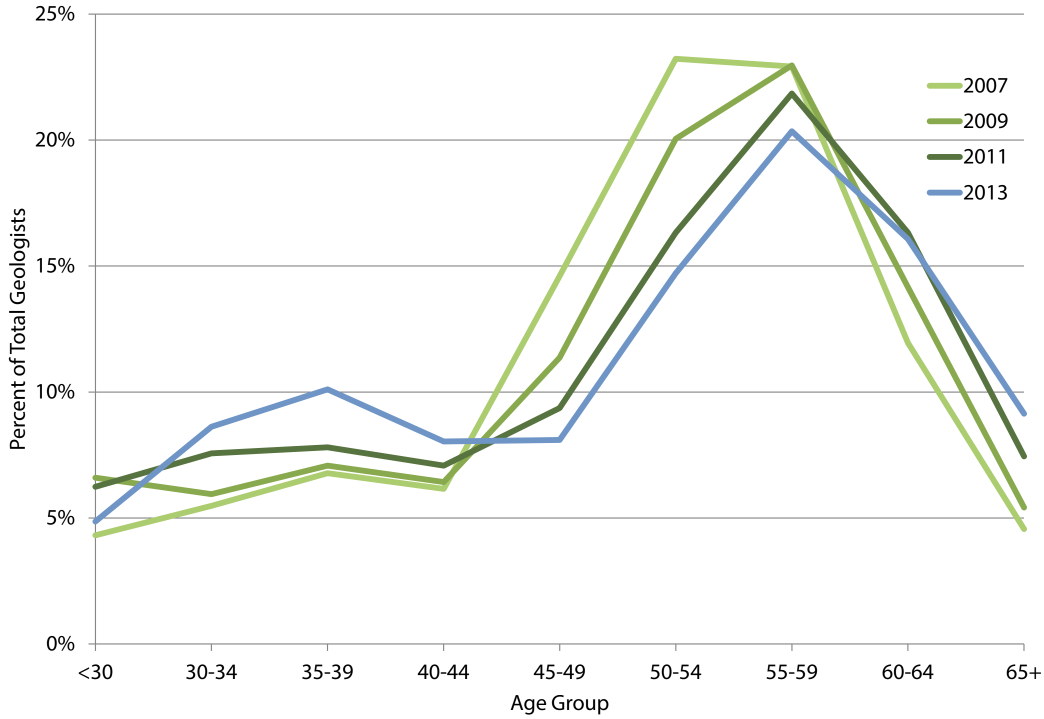
AGI Geoscience Workforce Program; Data derived from the Office of Personnel Management fedscope database

Figure 4.23: Age Distribution of Meteorologists in the U.S. Government



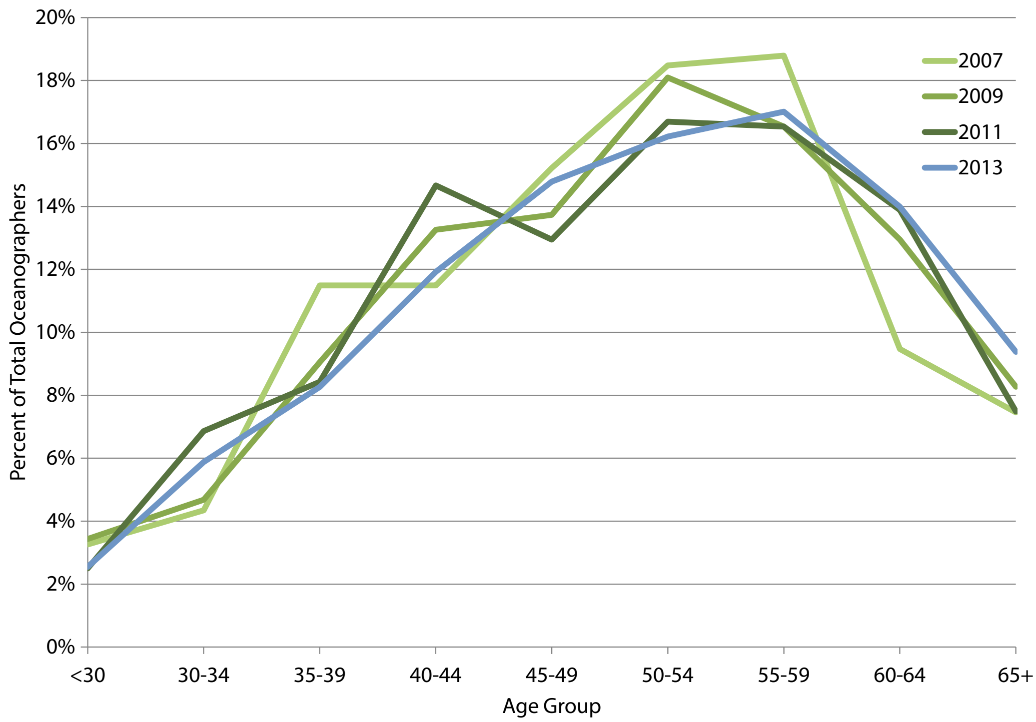
AGI Geoscience Workforce Program; Data derived from the Office of Personnel Management fedscope database

Figure 4.24: Age Distribution of Geologists in the U.S. Government



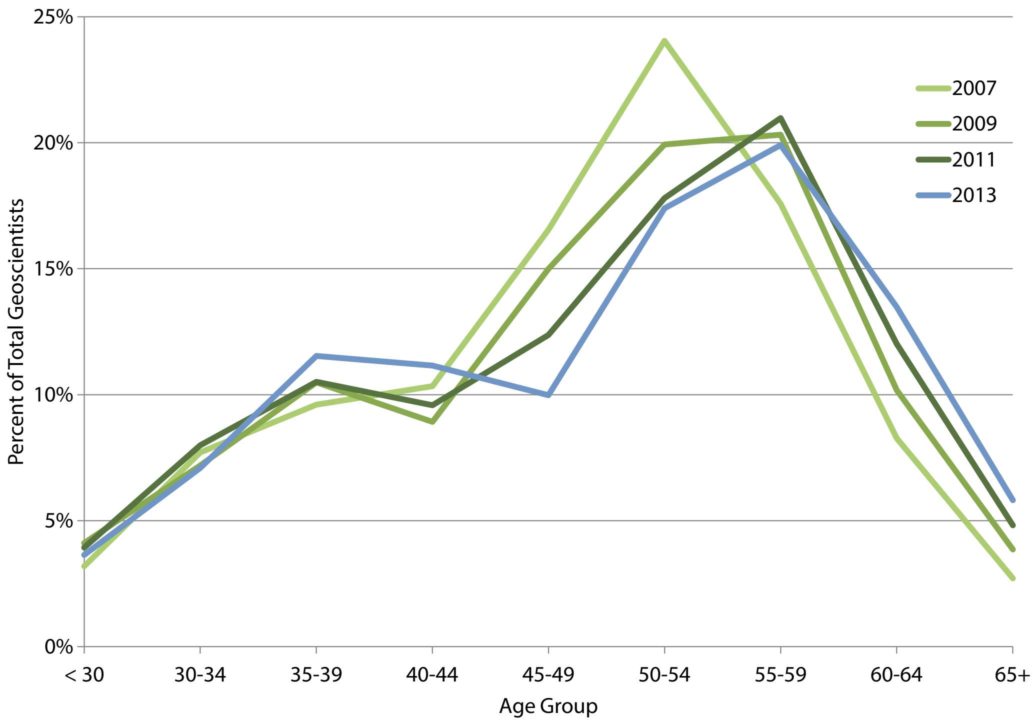
AGI Geoscience Workforce Program; Data derived from the Office of Personnel Management fedscope database

Figure 4.25: Age Distribution of Oceanographers in the U.S. Government



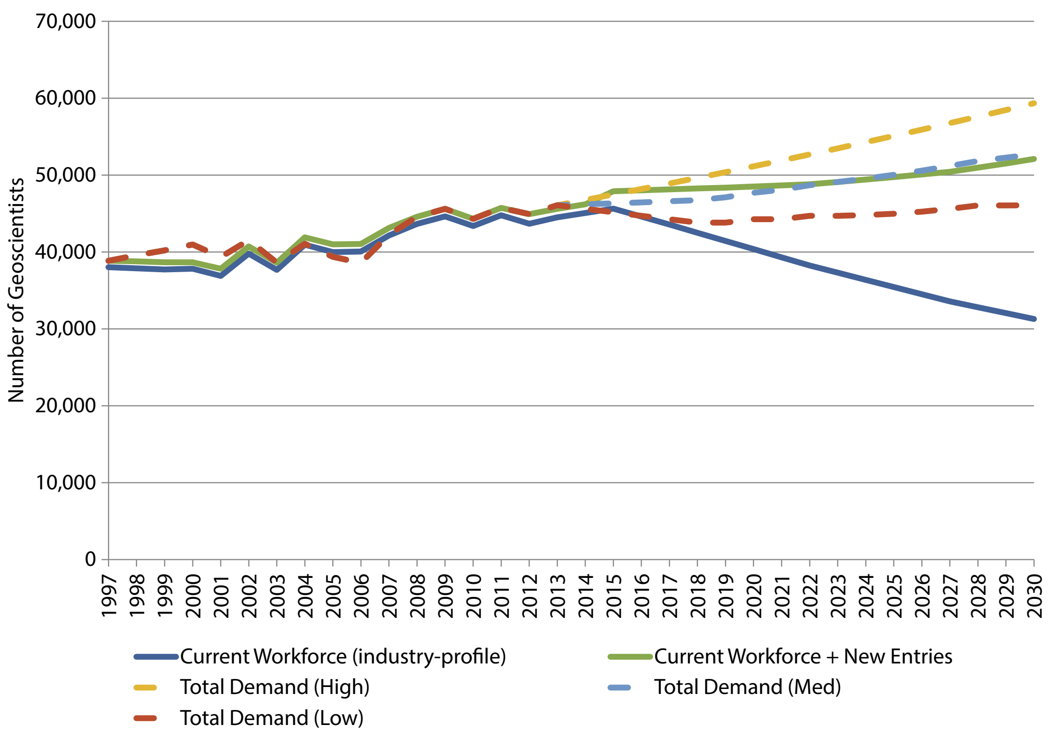
AGI Geoscience Workforce Program; Data derived from the Office of Personnel Management fedscope database

Figure 4.26: Age Distribution of Geoscientists in the U.S. Geological Survey



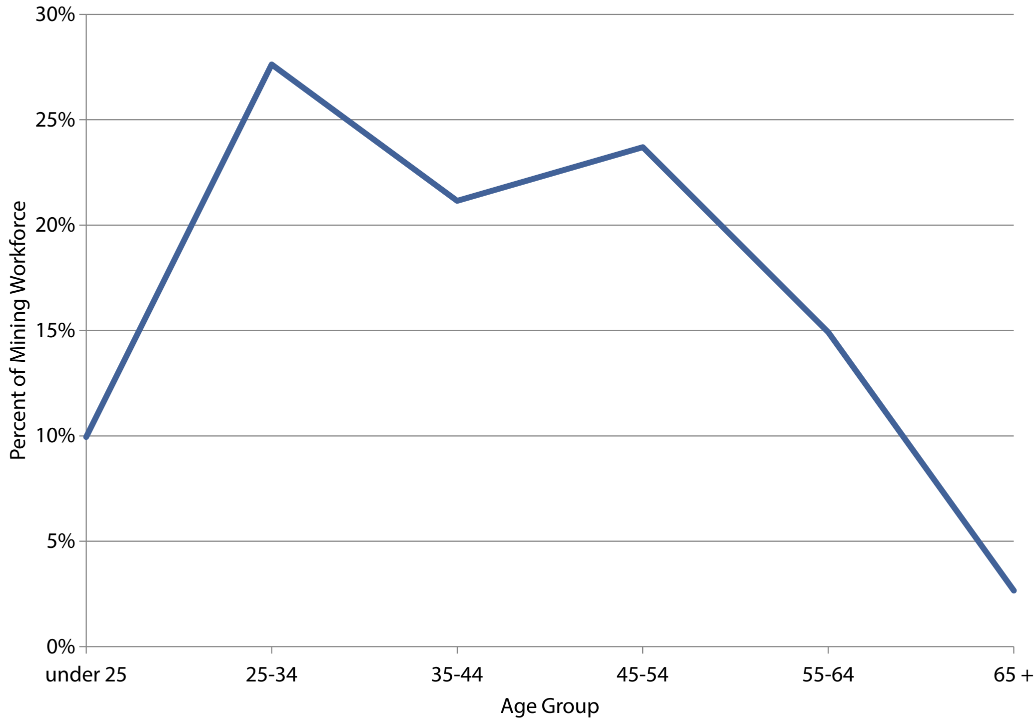
AGI Geoscience Workforce Program; Data derived from the Office of Personnel Management fedscope database

Figure 4.27: Oil and Gas Industry Supply and Demand for Geoscientists



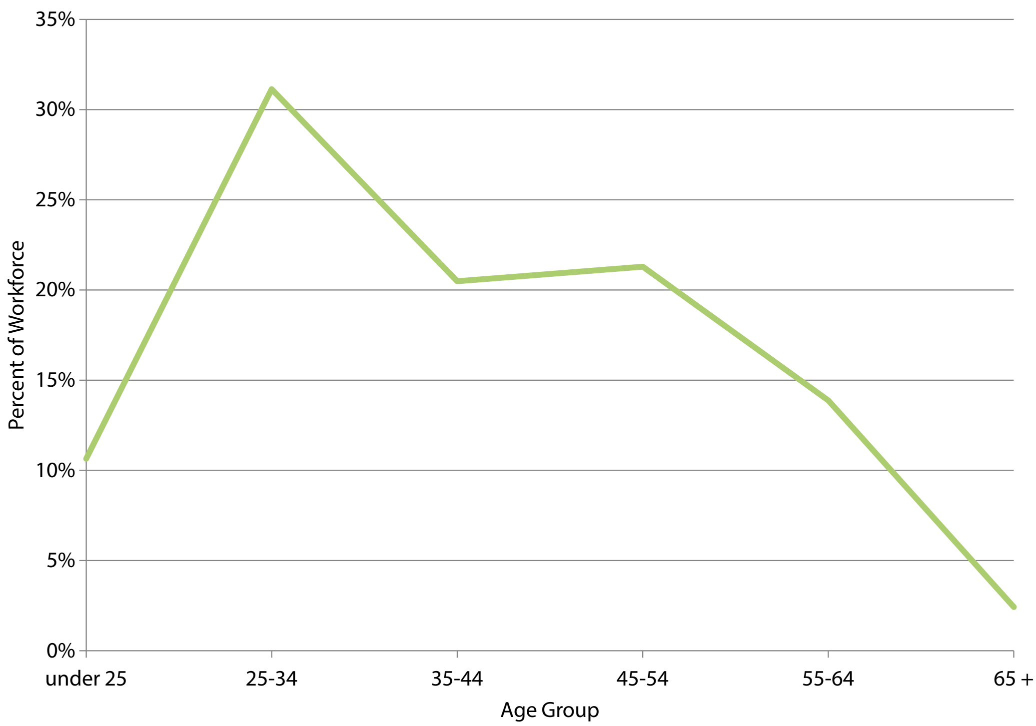
AGI Geoscience Workforce Program

Figure 4.28: Age Distribution of Geoscientists in Mining



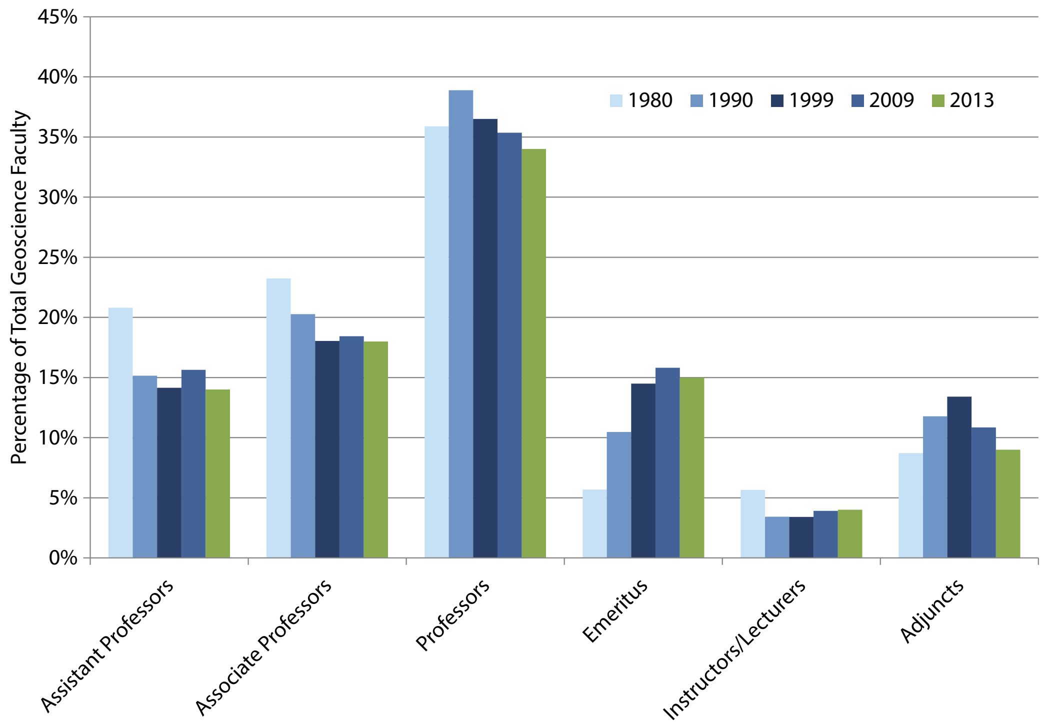
AGI Geoscience Workforce Program; Data provided by the National Mining Association

Figure 4.29: Age Distribution of Geoscientists in Support Activities for Mining and Oil & Gas



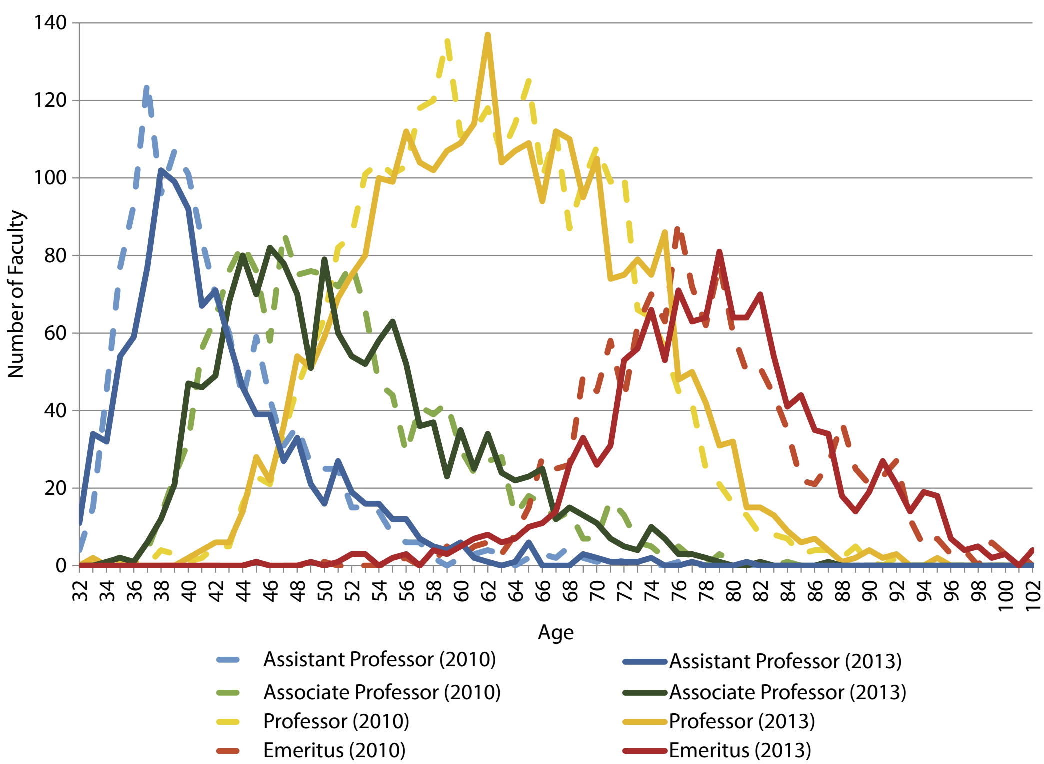
AGI Geoscience Workforce Program; Data provided by the National Mining Association

Figure 4.30: Trends in Faculty Rank Distribution at Four-Year Institutions (1980-2013)



AGI Geoscience Workforce Program; Data derived from AGI's Directory of Geoscience Departments database

Figure 4.31: Age Distribution of Geoscience Faculty Members



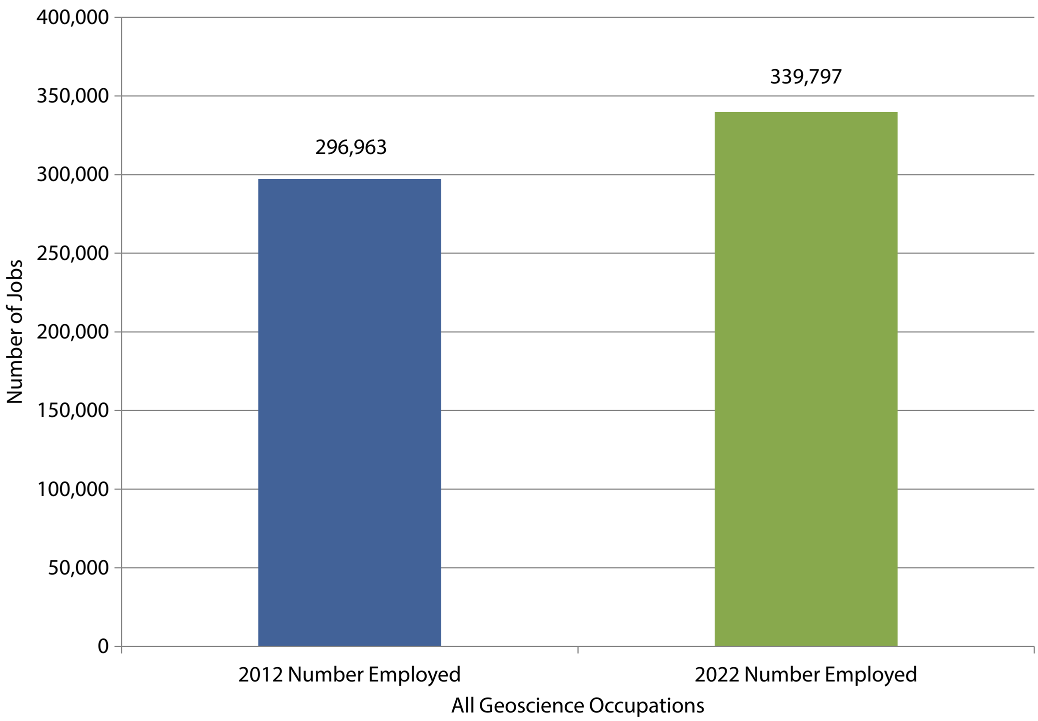
AGI Geoscience Workforce Program; Data derived from AGI's Directory of Geoscience Departments database

Geoscience Employment Projections 2012–2022

According to the U.S. Bureau of Labor Statistics, there were a total of 296,963 geoscience jobs in 2012, and they are projecting job growth to 339,797 geoscience jobs in 2022 — a 14% increase from 2012 to 2022 (Figure 4.32). This growth translates in all major industries hiring geoscientists except for the mining (except oil and gas) industry and the federal government (Figure 4.33). The U.S. Bureau of Labor Statistics is projecting a 6% loss in jobs in the mining industry and a 10% loss of jobs in the federal government for geoscientists. Petroleum engineers and geographers are projected to have the highest percent change in number of available jobs by 2022 (Figure 4.34).

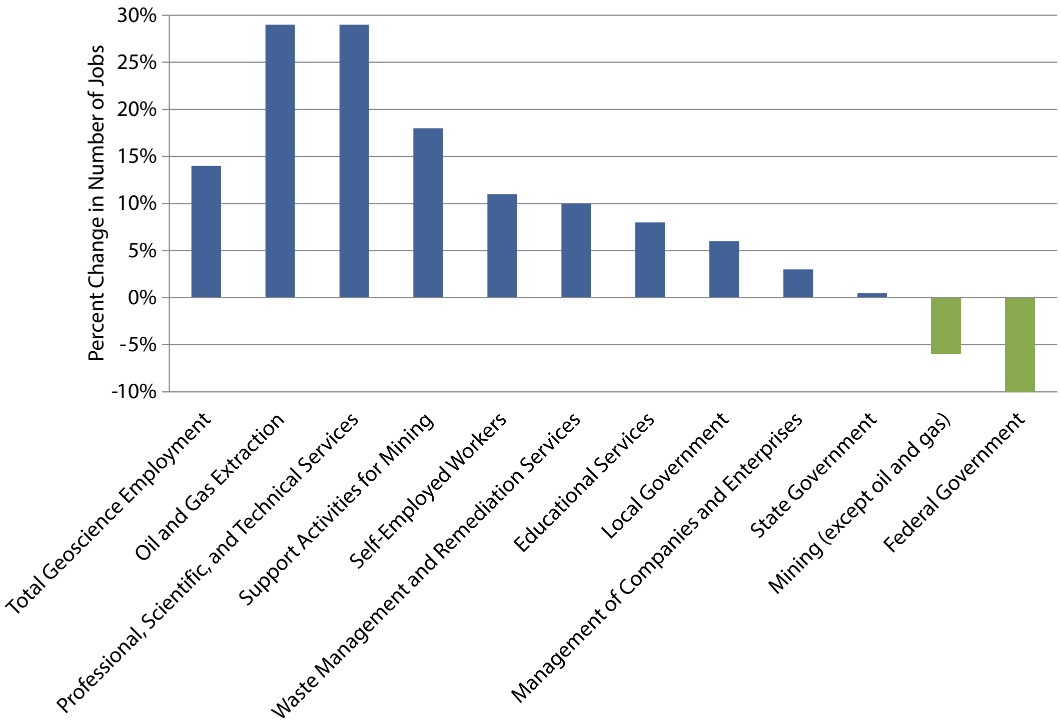
Table 4.1 documents the number of jobs in 2012 and projected for 2022 for different occupations within various industries known for hiring geoscientists, as well as the 2012 median annual salary for these occupations.

Figure 4.32: Employment Projection for Geoscience Occupations (2012-2022)



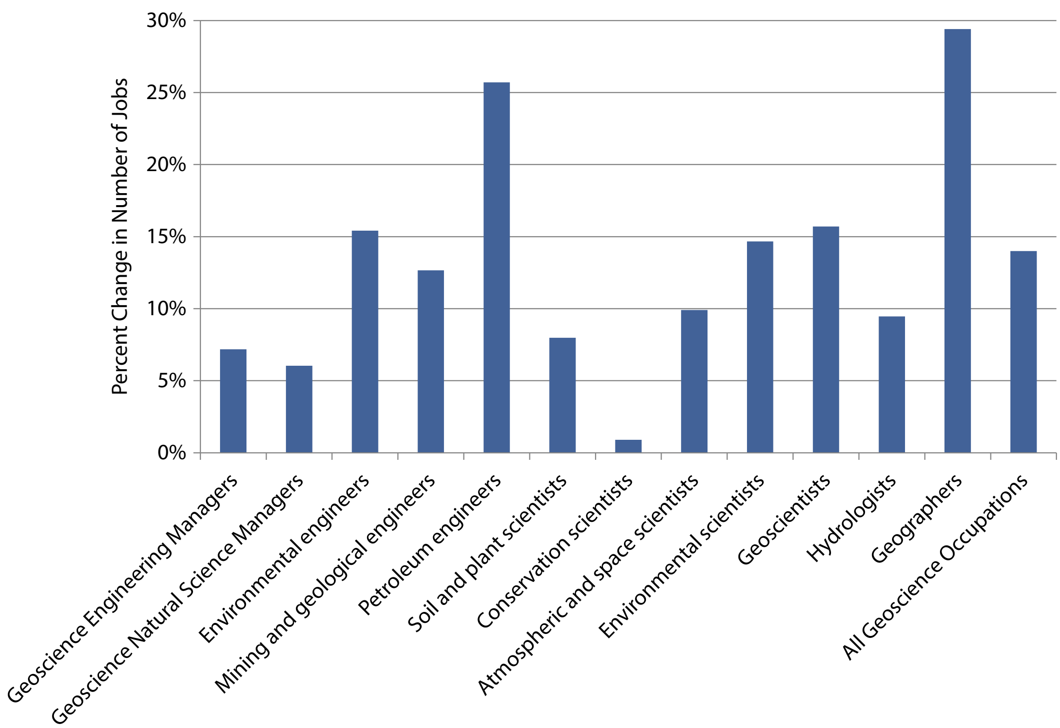
AGI Geoscience Workforce Program; Data derived from the U.S. Bureau of Labor Statistics Employment Projections

Figure 4.33: Employment Projections for All Geoscience Occupations by Industry Sector (2012-2022)



AGI Geoscience Workforce Program; Data derived from the U.S. Bureau of Labor Statistics Employment Projections

Figure 4.34: Employment Projections for Detailed Geoscience Occupations (2012-2022)



AGI Geoscience Workforce Program; Data derived from the U.S. Bureau of Labor Statistics Employment Projections

Table 4.1: U.S. Bureau of Labor Statistics Current and Projected Geoscience Employment

Occupation	2012 Number Employed	2022 Number Employed	2012–2022 Percent Change	2012 Median Annual Salary (OES)
Total Employment, All Workers				
Engineering managers (*)	8,342	8,941	7%	-
Natural science managers (*)	2,221	2,355	6%	$156,720
Environmental engineers	53,200	61,400	15%	$80,890
Mining and geological engineers, including mining safety engineers	7,900	8,900	13%	$84,320
Petroleum engineers	38,500	48,400	26%	$130,280
Soil and plant scientists	16,300	17,600	8%	$58,740
Conservation scientists	22,100	22,300	1%	$61,100
Atmospheric and space scientists	11,100	12,200	10%	$89,260
Environmental scientists	90,000	103,200	15%	$69,750
Geoscientists, except hydrologists and geographers	38,200	44,200	16%	$90,890
Hydrologists	7,400	8,100	9%	$75,530
Geographers	1,700	2,200	29%	$74,760
All Geoscience Occupations	296,963	339,797	14%	
Self-Employed Workers, All Jobs				
Engineering managers (*)	129	137	6%	-
Natural science managers (*)	23	20	-16%	-
Environmental engineers	1,000	1,000	0%	-
Mining and geological engineers, including mining safety engineers	100	0	-100%	-
Petroleum engineers	1,200	1,200	0%	-
Soil and plant scientists	1,900	2,100	11%	-
Conservation scientists	300	400	33%	-
Atmospheric and space scientists	200	200	0%	-
Environmental scientists	2,000	2,400	20%	-
Geoscientists, except hydrologists and geographers	1,300	1,500	15%	-
Hydrologists	100	200	100%	-
Geographers	100	100	0%	-
All Geoscience Occupations	8,353	9,257	11%	
Oil and Gas Extraction				
Engineering managers (*)	4,698	5,609	19%	-
Natural science managers (*)	196	203	4%	$180,400
Environmental engineers	600	700	17%	$114,470
Mining and geological engineers, including mining safety engineers	400	400	0%	$104,630
Petroleum engineers	20,500	28,500	39%	$144,810
Environmental scientists	700	900	29%	$132,790
Geoscientists, except hydrologists and geographers	9,900	11,400	15%	$137,750
All Geoscience Occupations	36,993	47,712	29%	
Mining (Except Oil and Gas)				
Engineering managers (*)	152	148	-3%	-
Environmental engineers	300	300	0%	$80,350

Occupation	2012 Number Employed	2022 Number Employed	2012–2022 Percent Change	2012 Median Annual Salary (OES)
Mining and geological engineers, including mining safety engineers	2,500	2,400	-4%	$81,460
Environmental scientists	100	100	0%	$83,290
Geoscientists, except hydrologists and geographers	500	400	-20%	$82,210
All Geoscience Occupations	3,552	3,348	-6%	
Support Activities for Mining				
Engineering managers (*)	581	654	13%	-
Environmental engineers	100	100	0%	$80,140
Mining and geological engineers, including mining safety engineers	500	600	20%	$84,030
Petroleum engineers	5,300	6,300	19%	$101,800
Environmental scientists	100	100	0%	$124,010
Geoscientists, except hydrologists and geographers	1,800	2,100	17%	$127,030
All Geoscience Occupations	8,381	9,854	18%	
Utilities				
Engineering managers (*)	234	195	-17%	-
Natural science managers (*)	5	5	0%	$131,490
Environmental engineers	800	700	-13%	$84,200
Mining and geological engineers, including mining safety engineers	0	0	0%	$82,570
Petroleum engineers	700	600	-14%	$101,380
Atmospheric and space scientists	0	0	0%	$93,240
Environmental scientists	1,300	1,400	8%	$88,520
Geoscientists, except hydrologists and geographers	200	100	-50%	$72,590
Hydrologists	0	0	0%	$81,780
All Geoscience Occupations	3,239	3,000	-7%	
Construction				
Engineering managers (*)	25	25	0%	-
Environmental engineers	200	200	0%	$72,810
Petroleum engineers	0	0	0%	$101,710
Environmental scientists	100	100	0%	$68,950
All Geoscience Occupations	325	325	0%	
Manufacturing				
Engineering managers (*)	546	504	-8%	-
Natural science managers (*)	50	46	-8%	-
Environmental engineers	3,100	2,900	-6%	-
Mining and geological engineers, including mining safety engineers	200	200	0%	
Petroleum engineers	2,700	2,500	-7%	-
Environmental scientists	700	600	-14%	-
Geoscientists, except hydrologists and geographers	700	600	-14%	-
All Geoscience Occupations	7,996	7,350	-8%	
Wholesale Trade				
Engineering managers (*)	42	40	-3%	-

Occupation	2012 Number Employed	2022 Number Employed	2012–2022 Percent Change	2012 Median Annual Salary (OES)
Natural science managers (*)	10	9	-8%	$161,420
Environmental engineers	400	500	25%	$92,540
Petroleum engineers	400	400	0%	$129,370
Soil and plant scientists	1,600	1,500	-6%	$62,900
Environmental scientists	100	100	0%	$84,980
Geoscientists, except hydrologists and geographers	100	100	0%	$84,280
Geographers	0	0	0%	$72,750
All Geoscience Occupations	2,652	2,650	0%	
Transportation and Warehousing				
Engineering managers (*)	34	28	-18%	-
Environmental engineers	200	200	0%	-
Petroleum engineers	400	400	0%	-
Atmospheric and space scientists	100	100	0%	-
Environmental scientists	300	200	-33%	-
All Geoscience Occupations	1,034	928	-10%	
Information				
Engineering managers (*)	9	8	-10%	-
Natural science managers (*)	0	0	-8%	-
Atmospheric and space scientists	900	900	0%	$83,090
Geoscientists, except hydrologists and geographers	100	100	0%	$105,780
All Geoscience Occupations	1,009	1,008	0%	
Finance and Insurance				
Engineering managers (*)	0	0	-14%	-
Natural science managers (*)	0	0	-14%	$176,040
Petroleum engineers	100	100	0%	-
All Geoscience Occupations	100	100	0%	
Professional, Scientific, and Technical Services				
Engineering managers (*)	2,961	3,573	21%	-
Natural science managers (*)	836	966	16%	$143,690
Environmental engineers	27,900	35,800	28%	$80,720
Mining and geological engineers, including mining safety engineers	2,800	3,700	32%	$81,030
Petroleum engineers	4,400	5,600	27%	$119,550
Soil and plant scientists	4,600	5,600	22%	$58,740
Conservation scientists	1,200	1,600	33%	$70,760
Atmospheric and space scientists	4,000	5,000	25%	$82,310
Environmental scientists	36,300	47,500	31%	$68,980
Geoscientists, except hydrologists and geographers	14,000	17,900	28%	$75,850
Hydrologists	3,000	3,900	30%	$78,380
Geographers	500	800	60%	$65,150
All Geoscience Occupations	102,497	131,939	29%	
Architectural, Engineering, and Related Services				
Engineering managers (*)	3,997	4,797	20%	-
Natural science managers (*)	217	265	22%	$110,500

Occupation	2012 Number Employed	2022 Number Employed	2012–2022 Percent Change	2012 Median Annual Salary (OES)
Environmental engineers	15,100	18,200	21%	$81,900
Mining and geological engineers, including mining safety engineers	2,400	3,200	33%	$79,580
Petroleum engineers	2,600	3,200	23%	$121,790
Soil and plant scientists	300	400	33%	$57,510
Conservation scientists	400	400	0%	$79,380
Atmospheric and space scientists	200	200	0%	$91,170
Environmental scientists	12,900	15,700	22%	$68,760
Geoscientists, except hydrologists and geographers	7,600	9,300	22%	$75,880
Hydrologists	1,300	1,600	23%	$79,470
Geographers	300	400	33%	$56,400
All Geoscience Occupations	47,314	57,662	22%	
Testing Laboratories				
Engineering managers (*)	134	165	23%	-
Natural science managers (*)	117	140	20%	$103,730
Environmental engineers	1,000	1,200	20%	$73,490
Mining and geological engineers, including mining safety engineers	100	200	100%	$69,240
Petroleum engineers	100	100	0%	$114,210
Soil and plant scientists	200	300	50%	$58,070
Environmental scientists	3,800	4,600	21%	$55,170
Geoscientists, except hydrologists and geographers	300	400	33%	$70,600
All Geoscience Occupations	5,751	7,105	24%	
Computer Systems Design and Related Services				
Engineering managers (*)	1	2	29%	-
Natural science managers (*)	0	0	91%	$152,490
Environmental engineers	0	0	0%	$103,500
Atmospheric and space scientists	100	100	0%	$96,710
Environmental scientists	0	0	0%	$82,160
Geoscientists, except hydrologists and geographers	200	300	50%	$104,430
All Geoscience Occupations	301	402	33%	
Management, Scientific, and Technical Consulting Services				
Engineering managers (*)	775	1,085	40%	-
Natural science managers (*)	450	623	38%	$119,500
Environmental engineers	11,100	15,600	41%	$77,000
Mining and geological engineers, including mining safety engineers	300	500	67%	$88,820
Petroleum engineers	1,100	1,600	45%	$116,850
Soil and plant scientists	1,500	2,100	40%	$56,550
Conservation scientists	600	900	50%	$64,660
Atmospheric and space scientists	100	100	0%	$83,530
Environmental scientists	19,200	27,000	41%	$67,270
Geoscientists, except hydrologists and geographers	4,800	6,700	40%	$74,020
Hydrologists	1,500	2,100	40%	$78,580
Geographers	100	200	100%	$66,850

Occupation	2012 Number Employed	2022 Number Employed	2012–2022 Percent Change	2012 Median Annual Salary (OES)
All Geoscience Occupations	41,525	58,508	41%	
Scientific Research and Development Services				
Engineering managers (*)	339	381	12%	-
Natural science managers (*)	443	498	13%	$155,550
Environmental engineers	1,500	1,700	13%	$92,930
Petroleum engineers	500	600	20%	$128,630
Soil and plant scientists	2,800	3,200	14%	$59,970
Conservation scientists	300	300	0%	$74,300
Atmospheric and space scientists	2,000	2,300	15%	$94,130
Environmental scientists	3,600	4,100	14%	$79,170
Geoscientists, except hydrologists and geographers	900	1,100	22%	$81,130
Hydrologists	100	100	0%	$67,890
Geographers	0	0	0%	$89,900
All Geoscience Occupations	12,482	14,279	14%	
Other Professional, Scientific, and Technical Services				
Engineering managers (*)	7	7	0%	-
Natural science managers (*)	7	14	101%	$133,440
Environmental engineers	0	0	0%	$92,040
Atmospheric and space scientists	1,700	2,300	35%	$63,740
Environmental scientists	100	100	0%	$68,550
Geoscientists, except hydrologists and geographers	400	600	50%	$70,380
All Geoscience Occupations	2,214	3,021	36%	
Management of Companies and Enterprises				
Engineering managers (*)	184	187	2%	-
Natural science managers (*)	60	62	3%	$140,090
Environmental engineers	1,200	1,200	0%	$93,730
Mining and geological engineers, including mining safety engineers	700	700	0%	$92,030
Petroleum engineers	2,100	2,200	5%	$143,240
Soil and plant scientists	300	300	0%	$77,940
Atmospheric and space scientists	100	100	0%	$75,290
Environmental scientists	800	800	0%	$87,900
Geoscientists, except hydrologists and geographers	800	900	13%	$99,140
Hydrologists	0	0	0%	$86,330
All Geoscience Occupations	6,244	6,449	3%	
Administrative and Support and Waste Management and Remediation Services				
Engineering managers (*)	56	61	10%	-
Natural science managers (*)	5	7	39%	$101,710
Environmental engineers	2,700	3,100	15%	$83,970
Mining and geological engineers, including mining safety engineers	0	0	0%	$79,680
Soil and plant scientists	400	400	0%	$49,870
Conservation scientists	0	0	0%	$63,350
Environmental scientists	2,100	2,400	14%	$68,840
Geoscientists, except hydrologists and geographers	400	500	25%	$74,610

Occupation	2012 Number Employed	2022 Number Employed	2012–2022 Percent Change	2012 Median Annual Salary (OES)
All Geoscience Occupations	5,661	6,469	14%	
Waste Management and Remediation Services				
Engineering managers (*)	245	276	13%	-
Natural science managers (*)	31	31	0%	$96,870
Environmental engineers	2,400	2,600	8%	$83,890
Environmental scientists	1,600	1,800	13%	$67,900
Geoscientists, except hydrologists and geographers	200	200	0%	$67,400
All Geoscience Occupations	4,476	4,907	10%	
Educational Services, Public and Private				
Engineering managers (*)	34	38	12%	-
Natural science managers (*)	102	118	16%	$82,200
Environmental engineers	200	200	0%	$64,150
Soil and plant scientists	2,300	2,500	9%	$46,620
Conservation scientists	700	700	0%	$51,470
Atmospheric and space scientists	2,200	2,400	9%	$85,400
Environmental scientists	3,500	3,800	9%	$58,570
Geoscientists, except hydrologists and geographers	2,400	2,600	8%	$80,090
Geographers	100	100	0%	$53,150
All Geoscience Occupations	11,536	12,456	8%	
Federal Government, Excluding Postal Service				
Engineering managers (*)	707	616	-13%	-
Natural science managers (*)	865	758	-12%	$107,210
Environmental engineer	3,900	3,40,0	-13%	$98,890
Mining and geological engineers, including mining safety engineers	100	100	0%	$89,440
Petroleum engineers	300	300	0%	$98,560
Soil and plant scientists	1,700	1,500	-12%	$72,540
Conservation scientists	7,500	6,600	-12%	$71,110
Atmospheric and space scientists	3,300	3,100	-6%	$97,710
Environmental scientists	6,200	5,500	-11%	$92,340
Geoscientists, except hydrologists and geographers	2,600	2,300	-12%	$94,830
Hydrologists	2,100	1,900	-10%	$84,540
Geographers	800	900	13%	$78,720
All Geoscience Occupations	30,072	26,974	-10%	
State Government, Excluding Education and Hospitals				
Engineering managers (*)	448	442	-1%	-
Natural science managers (*)	586	577	-1%	$73,080
Environmental engineers	7,000	7,000	0%	$69,570
Mining and geological engineers, including mining safety engineers	500	500	0%	$82,720
Petroleum engineers	100	100	0%	$98,470
Soil and plant scientists	500	500	0%	$50,500
Conservation scientists	4,600	4,600	0%	$53,310
Atmospheric and space scientists	300	300	0%	$82,180
Environmental scientists	20,100	20,200	0%	$57,420

Occupation	2012 Number Employed	2022 Number Employed	2012–2022 Percent Change	2012 Median Annual Salary (OES)
Geoscientists, except hydrologists and geographers	2,800	2,900	4%	$62,030
Hydrologists	1,300	1,300	0%	$63,450
Geographers	100	100	0%	$55,510
All Geoscience Occupations	38,334	38,519	0%	
Local Government, Excluding Education and Hospitals				
Engineering managers (*)	655	696	6%	-
Natural science managers (*)	164	174	6%	$93,730
Environmental engineers	3,400	3,600	6%	$75,350
Soil and plant scientists	800	900	13%	$55,800
Conservation scientists	3,200	3,400	6%	$51,230
Environmental scientists	12,200	13,000	7%	$60,910
Geoscientists, except hydrologists and geographers	200	200	0%	$87,960
Hydrologists	600	600	0%	$69,000
Geographers	0	0	0%	$61,380
All Geoscience Occupations	21,218	22,570	6%	

(*): Engineering managers and Natural science manager employment numbers were estimated from the federal data by dividing the total non-manager geoscientists by the total number of non-manager S&E employees per industry and then multiplying this result by the total number of engineering (or natural science) managers per industry.

AGI Geoscience Workforce Program; Data derived from the U.S. Bureau of Labor Statistics Employment Projections

Chapter 5: Trends in Economic Metrics and Drivers of the Geoscience Workforce

Tracking the economic metrics related to the geoscience workforce can help indicate potential changes in the supply and demand for the future workforce, which in turn impacts students finishing geoscience degrees at four-year universities. Therefore, this chapter looks at the changes in federal funding for geoscience research, economic metrics in the petroleum and mining industries, and the contribution of geoscience to the overall U.S. gross domestic product.

The percentage of federal research funding awarded to geoscience research declined over the years from 13% in 1970 to 6% in 2012, but the total dollar amount of federal geoscience research funding has increased steadily to $3.3 billion in 2010. Over this time period, the percentage of funding for environmental sciences has continued to increase and ultimately was integrated by definition into the geosciences by federal data agencies in 2009, which mirrors when environmental science became the geoscience field receiving the highest amount of federal funding due to the rapid increase in applied research.

Many of the economic metrics for the geoscience workforce clearly reflect the recent recessions in 2008/09 and ensuing recovery, particularly in the oil and gas industry. The price of oil, the commodity outputs, gross operating surplus, profit margins, and number of working oil rigs all decreased rapidly in 2009 and quickly recovered in 2010 and 2011. The United States still has control of the most oil and gas rigs, but the number of foreign (excluding Canada) rigs continues to increase closer to the number owned by the U.S. After the recession there was a flip in type of the of yearly average number of rigs in the U.S. with the number of crude oil rigs rapidly increasing and the number of natural gas rigs decreasing.

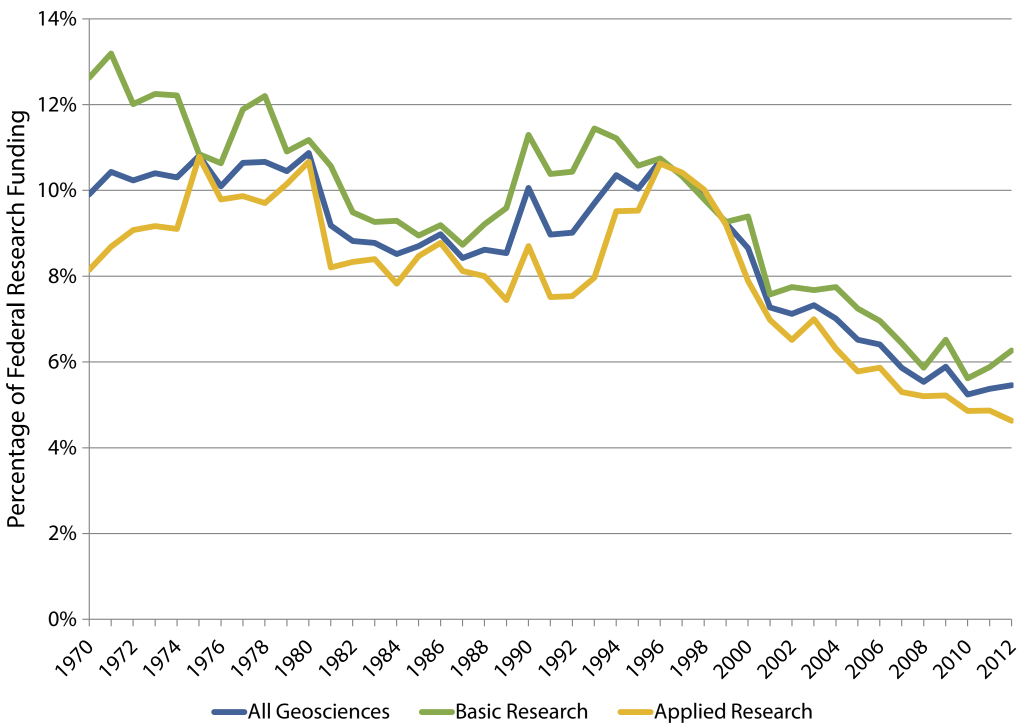
Economic changes in the mining industry during the recession occurred but not as drastically as for the oil and gas industry. However, the value of industrial materials, as well as sand, gravel and stone, has not fully recovered to the value before the recession. The total value of metal ore, on the other hand, has rapidly increased since 2009.

All major employment sectors that directly hire geoscientists currently make up approximately 0.62% of the total U.S. economy equaling $100 billion of the U.S. gross domestic product. This is expected to increase in 2022, particularly through the oil and gas industry, which is projected to alone be worth over $70 billion.

Federal Research Funding for the Geosciences

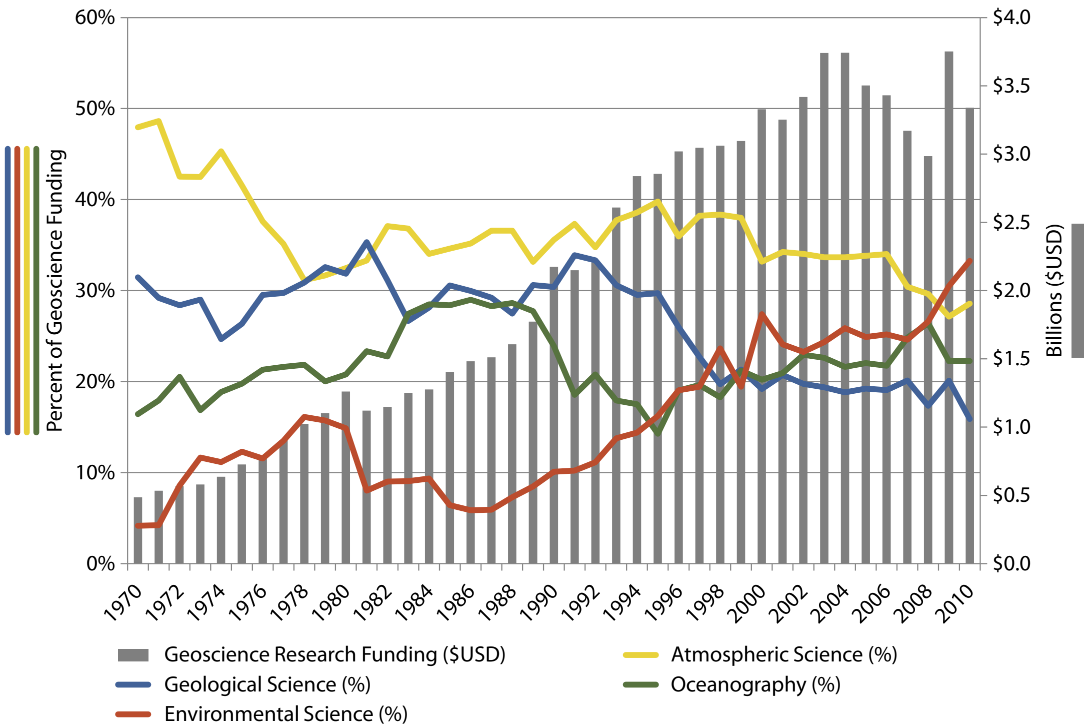
Federal funding for applied and basic research in the geosciences has decreased since 1996, reaching a low of 6% of the total federal research and development funding for basic geoscience research and 5% for applied geoscience research in 2012 (Figure 5.1). However, in absolute dollar terms, the overall investment on geoscience research by the federal government has been steadily increasing (Figure 5.2). Environmental science funding has steadily increased since 1986, and has been receiving the highest percentage of geoscience federal funding since 2009. This increase can be attributed to the dramatic increase in applied research federal funding for the environmental science field (Figure 5.4).

Figure 5.1: Percentage of Federal Research Funding Applied to the Geosciences



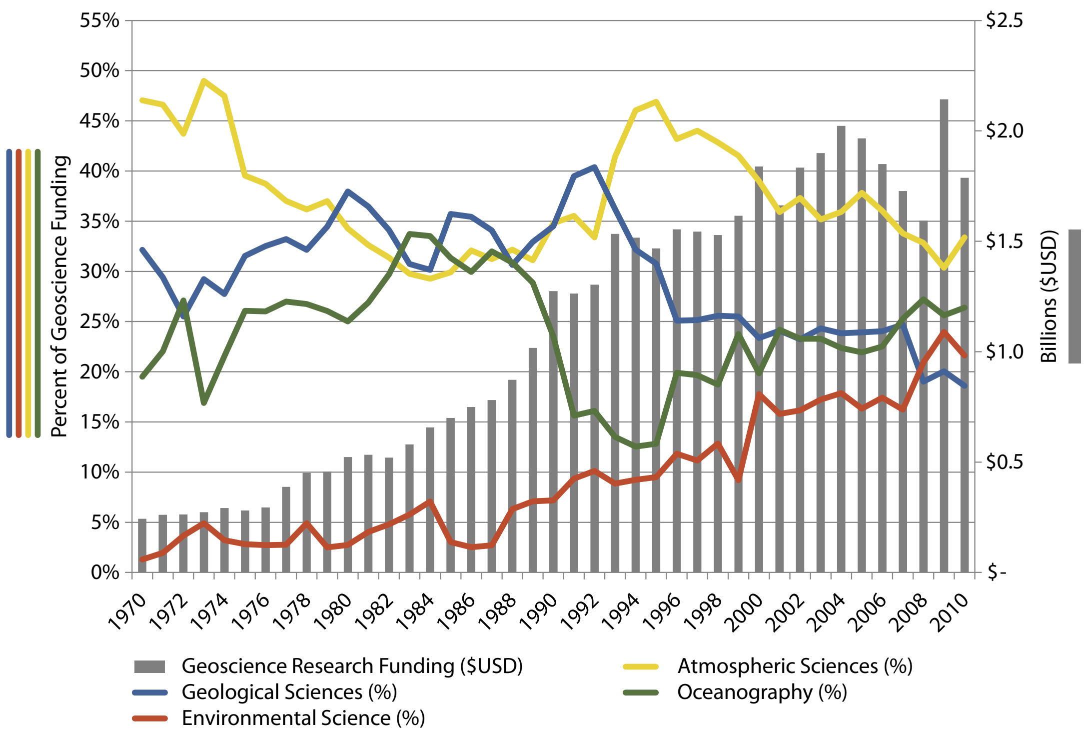
AGI Geoscience Workforce Program; Data derived from NSF/SRS Survey of Federal Funds for Research & Development

Figure 5.2: Total Federal Research Funding of the Geosciences



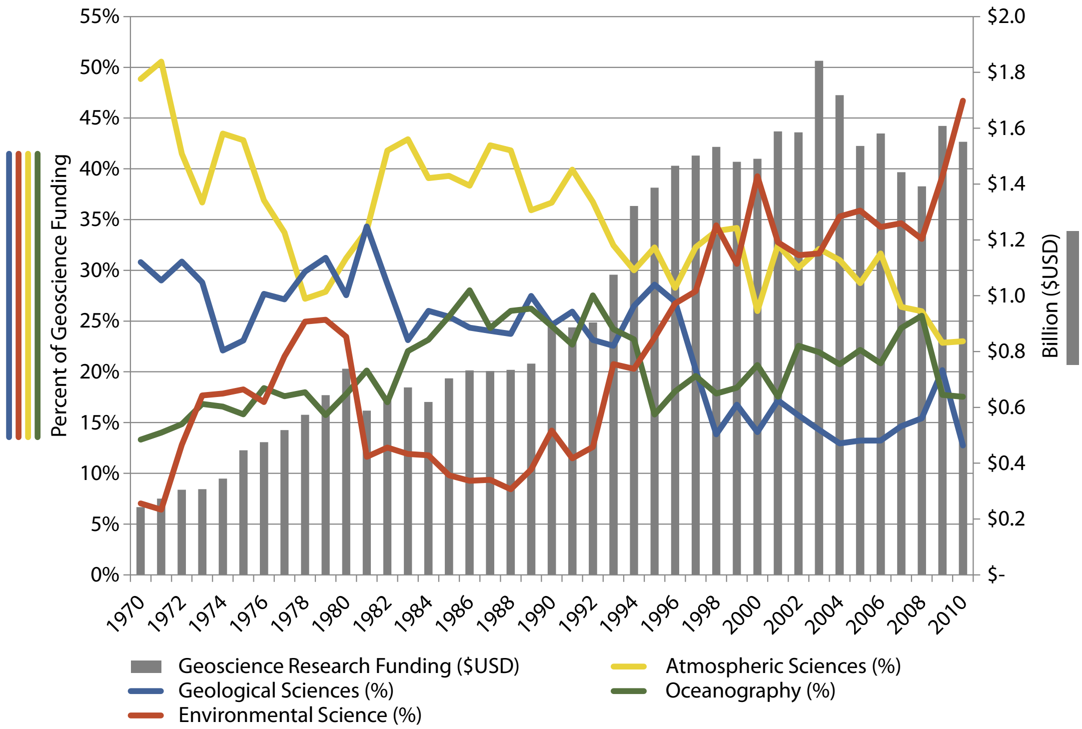
AGI Geoscience Workforce Program; Data derived from NSF/SRS Survey of Federal Funds for Research & Development

Figure 5.3: Federal Funding of Basic Research in the Geosciences



AGI Geoscience Workforce Program; Data derived from NSF/SRS Survey of Federal Funds for Research & Development

Figure 5.4: Federal Funding of Applied Research in the Geosciences



AGI Geoscience Workforce Program; Data derived from NSF/SRS Survey of Federal Funds for Research & Development

Commodity Prices and Output

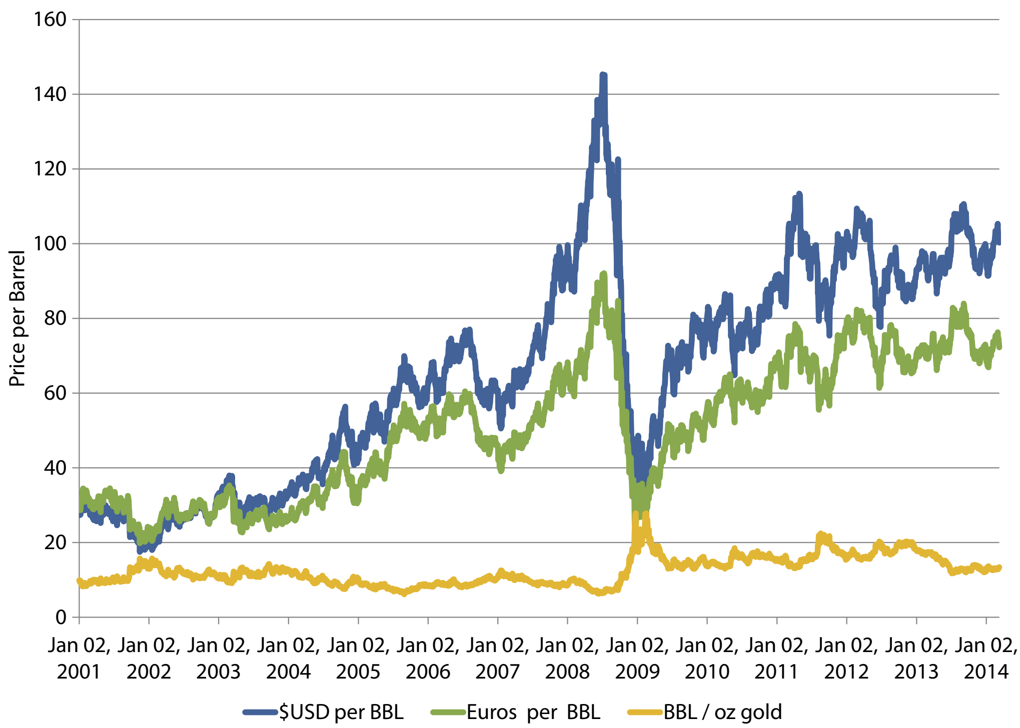
Figure 5.5 shows the changes in spot prices of crude oil per barrel (BBL) in US dollars and in euros from 2001 through 2013, which covers the recent economic recession and subsequent recovery period. The graph also shows the number of barrels per troy ounce of gold. The price of oil grew faster relative to the dollar than the euro through the recession and this trend has continued through the economic recovery to the present representing the ongoing strength of the Euro. Some portion of the rise in oil prices can be attributed to the fall of the value of the dollar.

The total domestic commodity output data for the petroleum and mining industries shows a steady increase from 2002 to 2008, followed by a sharp decline in 2009 due to the economic recession (Figure 5.6). However, the industries were able to bounce back quickly during the economic recovery.

The gross operating surplus for the petroleum and mining industries grew steadily until 2008, after which only mining continued to increase (Figure 5.7). After the economic shock of the recession the oil and gas extraction industry rebounded and continued to increase into 2012. The gross operating surplus for the mining industry doubled from 2009 to 2010 and continued to increase into 2012.

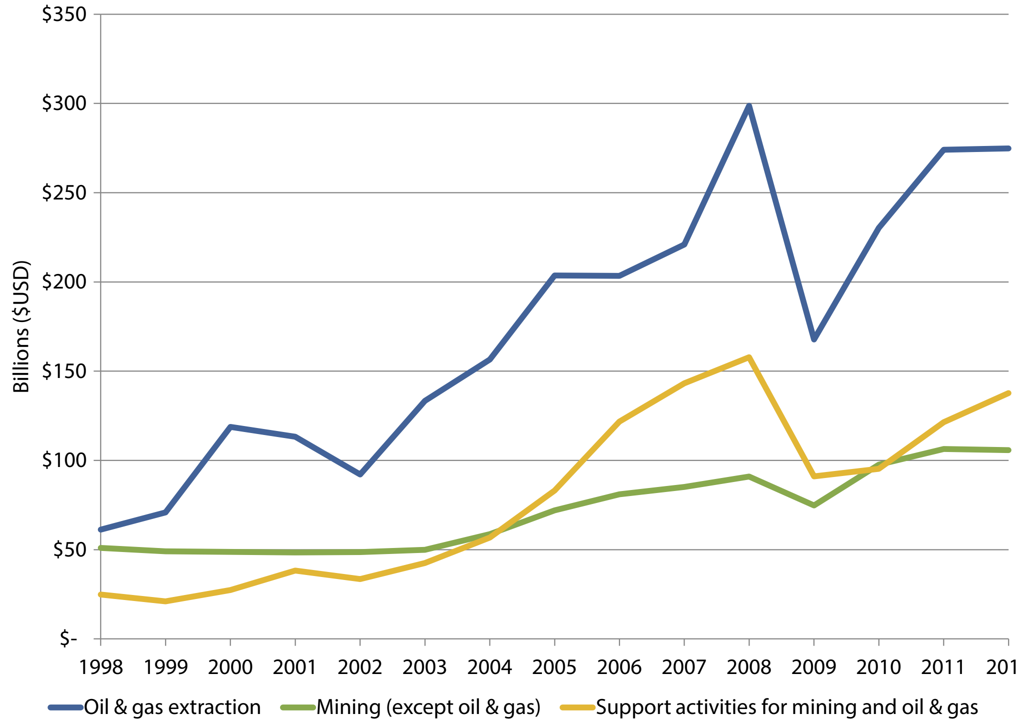
Figure 5.8 was reproduced from the 2011 edition of this report because the data source has not released new data on the profit margins of independent and major energy companies. The profit margins were calculated by dividing the net income by total revenue. The recession in 2009 was also apparent in the profit margins for independent and major energy companies. Both independent and major companies recovered quickly during the recovery, but the major companies have not reached the same profit margins experienced prior to the recession.

Figure 5.5: Price of Oil by Currency and by Gold



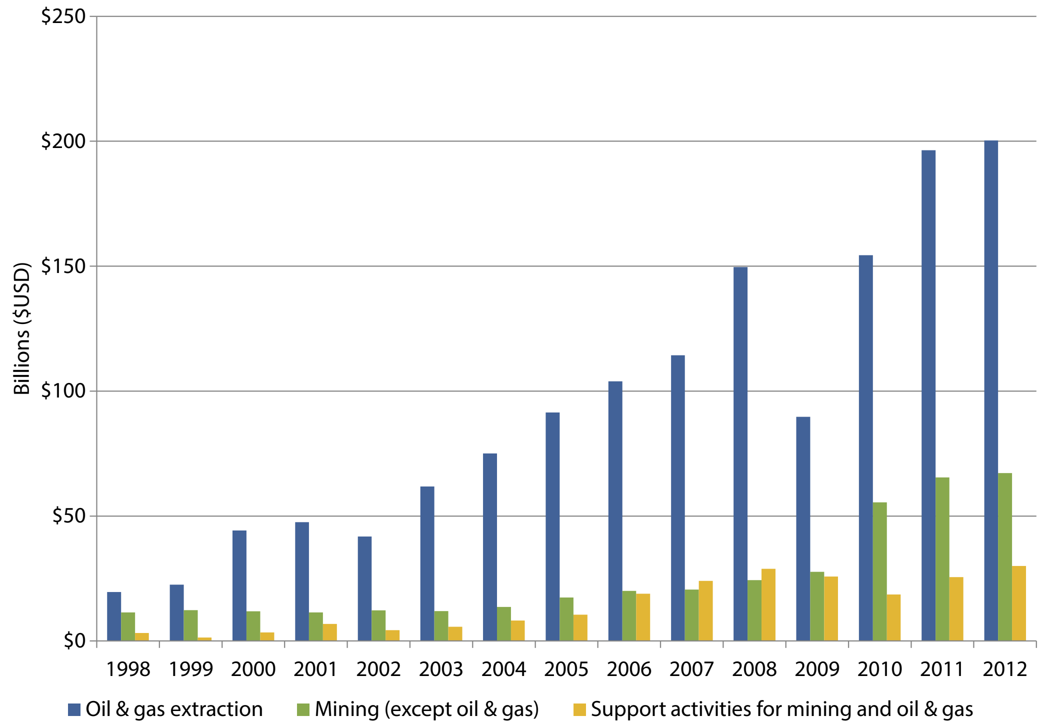
AGI Geoscience Workforce Program; Data derived from EIA, OANDA, and World Gold Council

Figure 5.6: Commodity Output for the U.S. Mining, Oil and Gas Extraction, and Support Industries



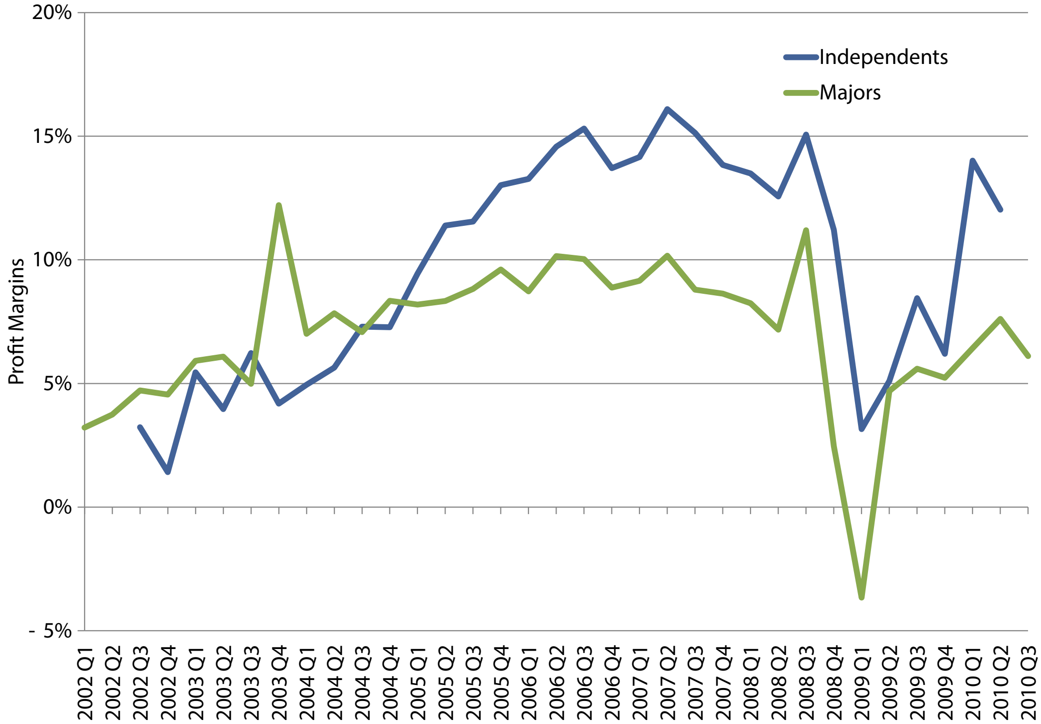
AGI Geoscience Workforce Program; Data derived from the U.S. Bureau of Economic Analysis

Figure 5.7: Gross Operating Surplus for the U.S. Mining, Oil and Gas Extraction, and Support Industries



AGI Geoscience Workforce Program; Data derived from the U.S. Bureau of Economic Analysis

Figure 5.8: Margins for Independent and Major Energy Companies

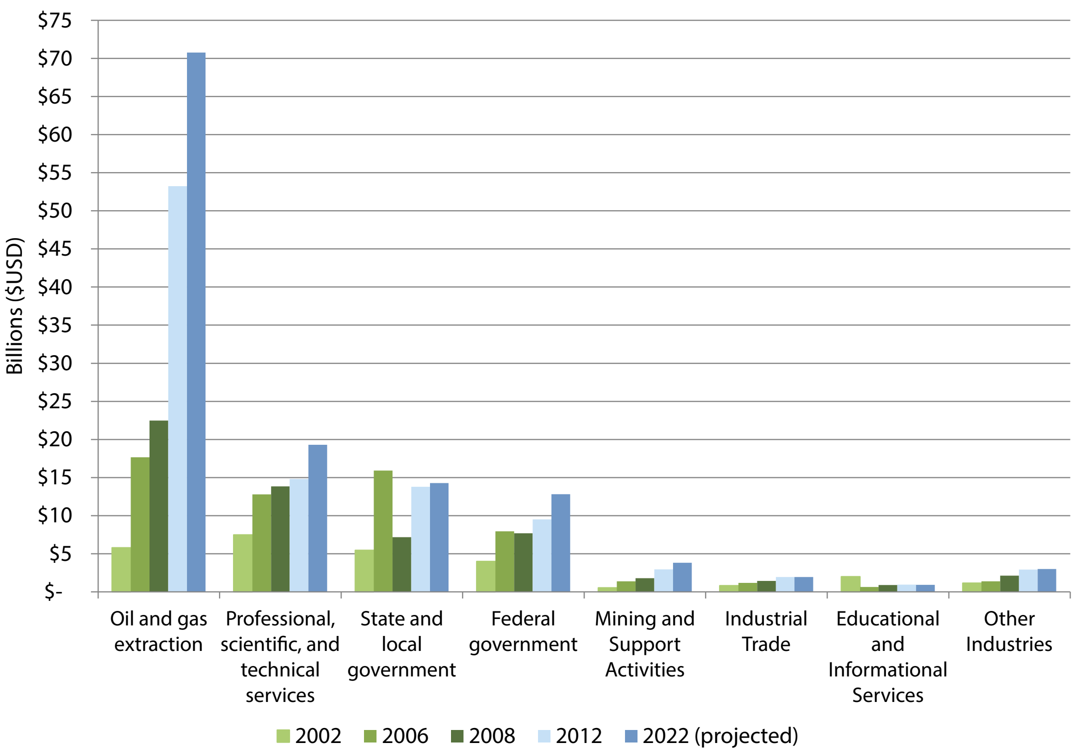


AGI Geoscience Workforce Program; Data derived from the Energy Information Administration

Gross Domestic Product Contribution of Geosciences

The geoscience component of industry gross domestic product (GDP) represents the first order economic contribution of geoscientists to the U.S. economy. The geoscience component of industry GDP is calculated by multiplying the value added amount for a specific industry by the percentage of the industry's total employment that are geoscientists. Thus, the total geoscience component of industry GDP is usually less than an industry's domestic production. For example, for the oil and gas industry, the value added amount was $269 billion in 2012. Geoscientists comprise 19.8% of the industry's employment. Therefore, the geoscience component of the oil and gas industry's GDP in 2012 was $53.24 billion (Figure 5.9).

Figure 5.9: Amount of Geoscience Industry GDP Contributed by Specific Industries



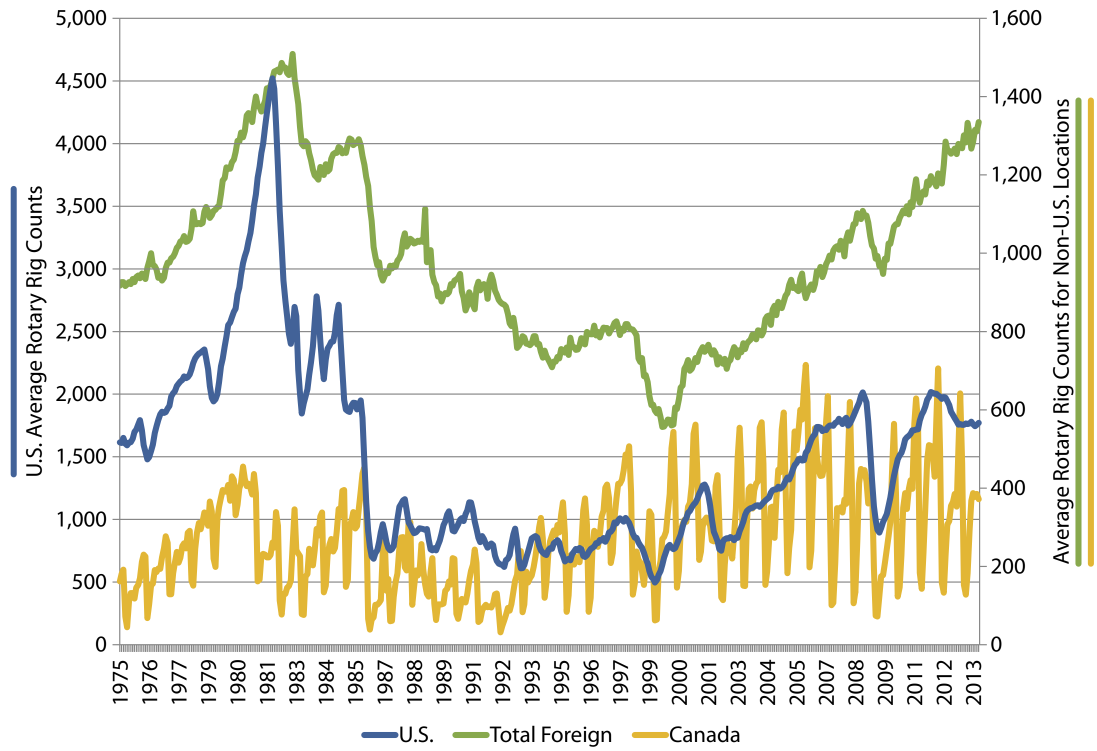
AGI Geoscience Workforce Program; Data derived from U.S. Bureau of Economic Analysis, U.S. Bureau of Labor Statistics, and AGI's Directory of Geoscience Departments database

Productive Activity of Geoscience Industries

At the close of 2013, the U.S. was operating 51% of the drilling rigs in the world (Figure 5.10). The majority of the U.S. wells continue to be onshore (land) wells (Figure 5.12). Since the recession in 2009, there has been a rapid increase in crude oil wells and a rapid decrease in natural gas wells (Figure 5.13).

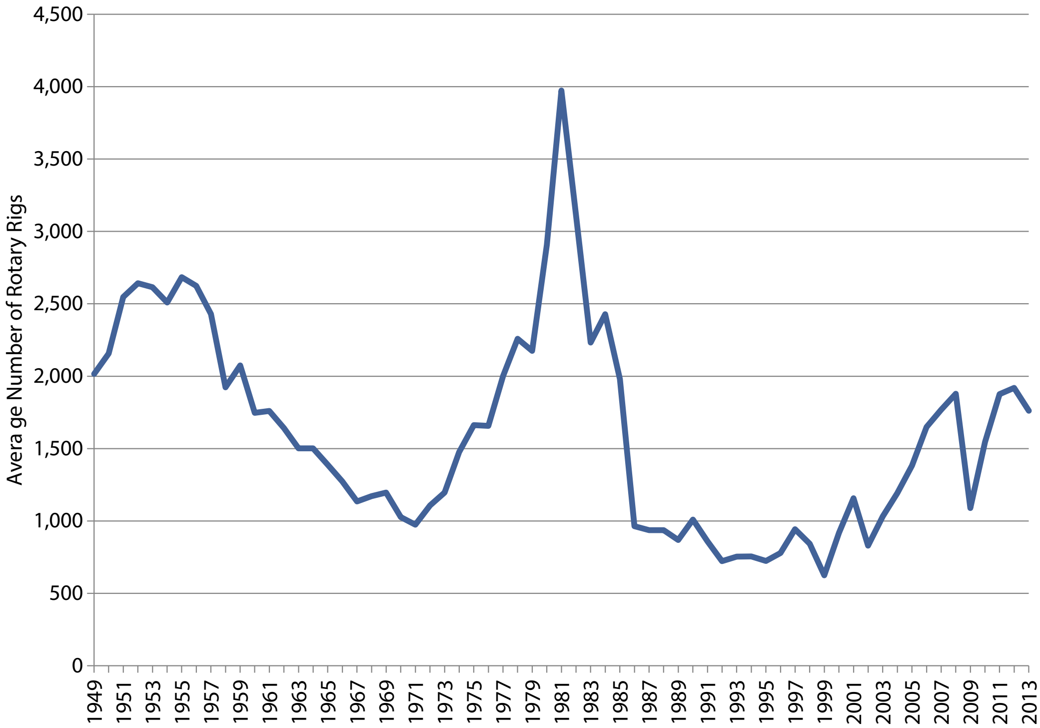
U.S. mines for industrial minerals and sand, gravel and stone appear to have been harder hit during the recession, but both types of mines have begun to rebound since 2009 (Figure 5.15). The decreases in the number of mines are also reflected in the amount of material handled each year (Figure 5.16). In 2008 with the decrease in sand, gravel, and stone mines, metal ore became the material with the highest yield in metric tons since 1998. Along with higher yields of metal ore and buoyed by elevated commodity prices, the value of the metal ore mined has risen sharply since 2009 reaching $35 billion in 2011 (Figure 5.17).

Figure 5.10: Average Rotary Rig Count by World Region



AGI Geoscience Workforce Program; Data derived from Baker Hughes

Figure 5.11: U.S. Rotary Rig Counts

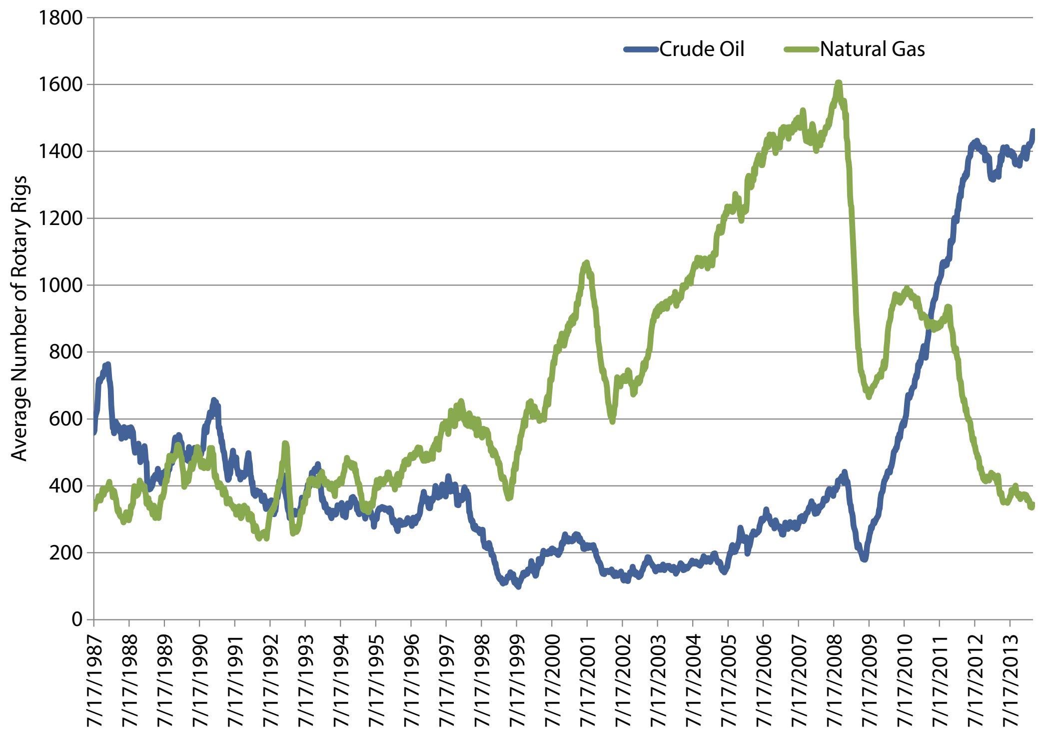


AGI Geoscience Workforce Program; Data derived from Baker Hughes

Figure 5.12: U.S. Rotary Rigs by Location

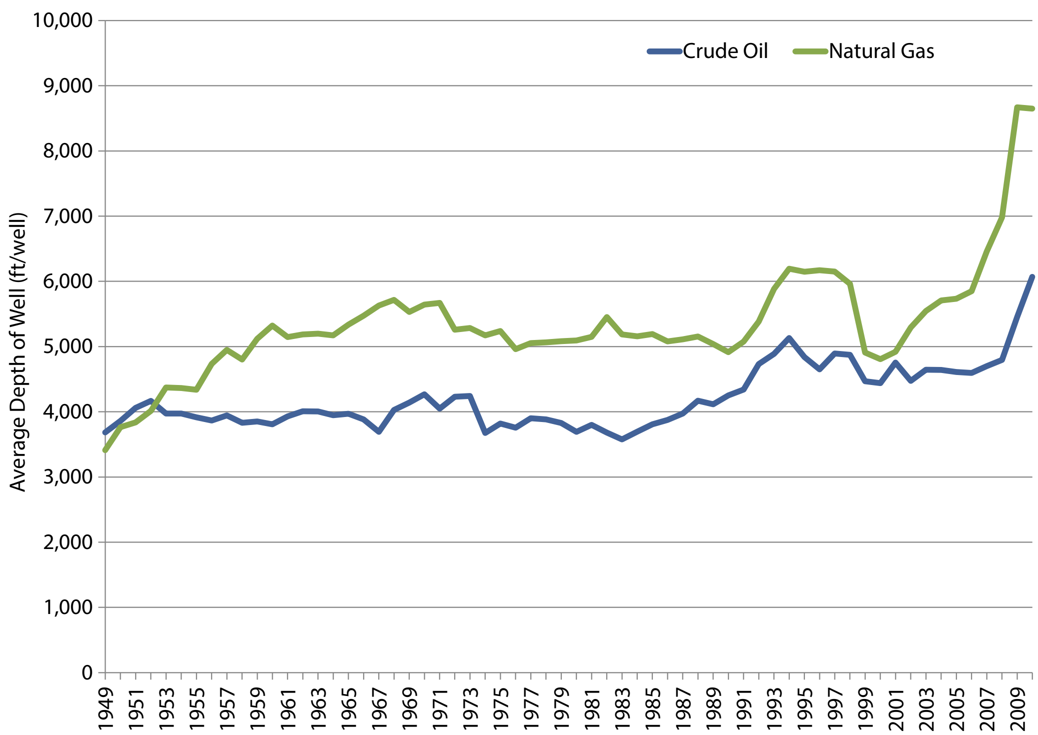
AGI Geoscience Workforce Program; Data derived from Baker Hughes

Figure 5.13: U.S. Rigs by Type



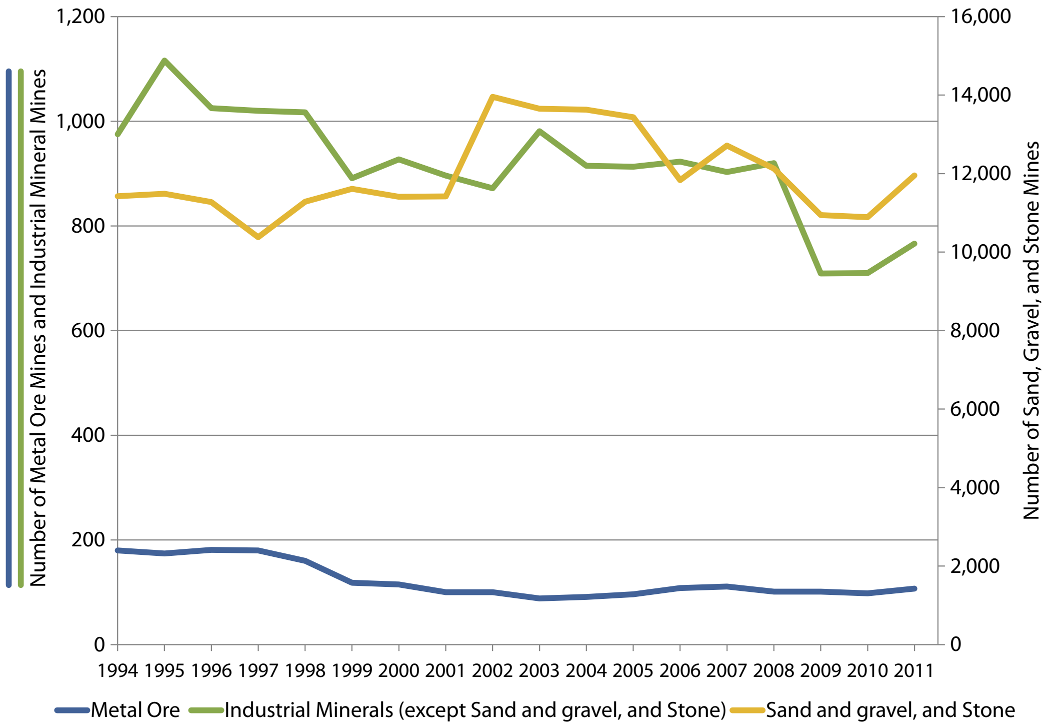
AGI Geoscience Workforce Program; Data derived from Baker Hughes

Figure 5.14: Average Depth of Wells Drilled by Type



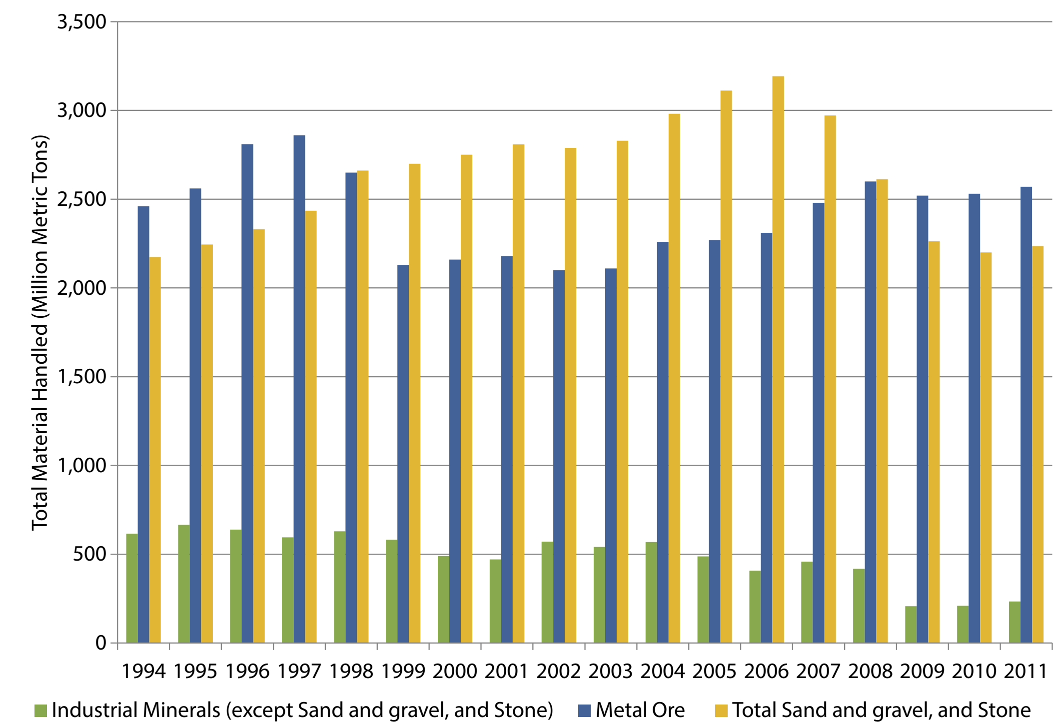
AGI Geoscience Workforce Program; Data derived from U.S. Energy Information Administration

Figure 5.15: Number of U.S. Mines



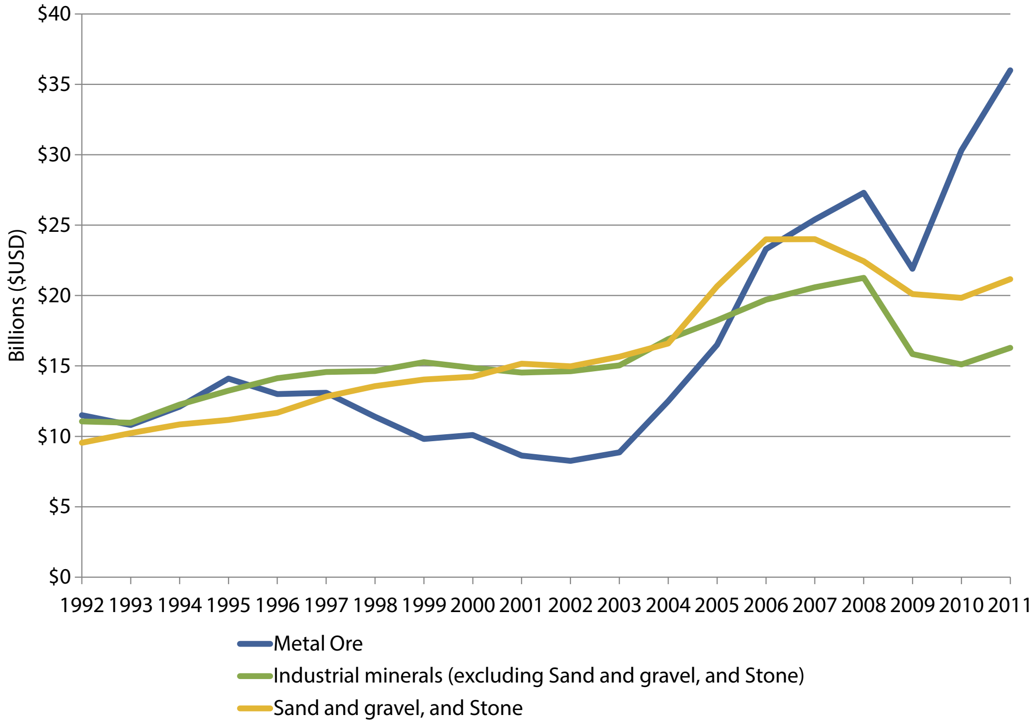
AGI Geoscience Workforce Program; Data Derived from the USGS Mining and Quarrying Trends

Figure 5.16: Material Handled at U.S. Mines



AGI Geoscience Workforce Program; Data Derived from the USGS Mining and Quarrying Trends

Figure 5.17: Value of Non-Fuel Mineral Production from U.S. Mines



AGI Geoscience Workforce Program; Data derived from USGS Minerals Yearbook

Appendix A: Defining the Geosciences

Given its complexity, the geoscience occupation is difficult to define under existing nomenclature. This is the result of varied educational pathways geoscientists pursue and because of the different industries in which geoscientists work. Additionally, each federal data source (U.S. Bureau of Labor Statistics, U.S. Census Bureau, National Center for Education Statistics, National Science Foundation, U.S. Bureau of Economic Analysis, Office of Personnel Management), professional society, and industry classifies geoscientists differently depending on the intent of data collection (national occupational trends, science and engineering trends, education vs. occupation, internal classification codes, etc.), the characteristics of the population surveyed, and the focus of the organization.

U.S. federal policy and funding is partially determined by the economic activity and employment trends of a given profession. Accurate measurement and analysis of the geoscience profession are central to successful decisions that support a robust geoscience profession in the U.S.

Unfortunately, the geosciences are not consistently defined across the myriad of data sources collected and used by federal government and professional societies. In many cases the issues of definition are related to splitting of disciplines, in some cases they are archaic artifacts of early labor policy, and in other, represent a lack of domain knowledge in the agencies setting the definitions. Though many federal agencies are attempting to improve their classification approach, the current diversity of definitions will continue for the foreseeable future. Unfortunately, the public statistics from this data are used by counselors and individuals seeking career options, and the current state of geoscience workforce data usually severely under-represents the size of the profession and the breadth of opportunities.

To address this issue, AGI has established a working definition for the geoscience profession in order to improve comparability of data across sources and time periods, which is laid out in this section.

Many federal data sources use the Classification Instructional Programs (CIP) codes to classify educational programs, the Standard Occupational Classification (SOC) codes to classify occupations, and the North American Industry Classification System (NAICS) to classify industries. In this appendix we report how each data source defines a geoscientist. The CIP codes are managed by the U.S. Department of Education's National Center for Education Statistics. The SOC codes were developed by the U.S. Office of Management and Budget and are managed by the Standard Occupational Classification Revision Policy Committee. This committee consists of representatives from the U.S. Bureau of Labor Statistics, the U.S. Bureau of Census, the U.S. Department of Labor (Employment and Training Administration), the Office of Personnel Management, the Defense Manpower Data Center, the National Science Foundation, the National Occupational Information Coordinating Committee, and the Office of Management and Budget. The NAICS was developed under the guidance of the Office of Management and Budget by the U.S. Economic Classification Policy Committee, Statistics Canada, and Mexico's Instituto Nacional de Estadistica, Geografia e Informatica in order to allow for economic comparisons between North American countries.

Educational Classifications

Classification of Instructional Programs (CIP)

The National Science Foundation and the National Center for Education Statistics use the Classification of Instructional Programs (CIP) to classify educational programs including fields of study and program completions.

The CIP website (https://nces.ed.gov/pubs2002/cip2000/) also has an online application that allows for the cross-referencing of instructional programs to the Standard Occupational Classification codes.

Appendix Table 1: CIP Codes that Refer to Geoscience Programs

CIP Code	Title	Description
3.0104	Environmental Science	A program that focuses on the application of biological, chemical, and physical principles to the study of the physical environment and the solution of environmental problems, including subjects such as abating or controlling environmental pollution and degradation; the interaction between human society and the natural environment; and natural resources management. Including instruction in biology, chemistry, physics, geosciences, climatology, statistics, and mathematical modeling.
14.0802	Geotechnical Engineering	A program that prepares individuals to apply mathematical and scientific principles to the design, development, and operational evaluation of systems for manipulating and controlling surface and subsurface features at or incorporated into structural sites, including earth and rock moving and stabilization, land fills, structural use and environmental stabilization of wastes and by-products, underground construction, and groundwater and hazardous material containment.
14.1401	Environmental/ Environmental Health Engineering	A program that prepares individuals to apply mathematical and scientific principles to the design, development and operational evaluation of systems for controlling contained living environments and for monitoring and controlling factors in the external natural environment, including pollution control, waste and hazardous material disposal, heath and safety protection, conservation, life support, and requirements for protection of special materials and related work environments.
14.2101	Mining and Mineral Engineering	A program that prepares individuals to apply mathematical and scientific principles to the design, development and operational evaluation of mineral extraction, processing and refining systems, including open pit and shaft mines, prospecting and site analysis equipment and instruments, environmental and safety systems, mine equipment and facilities, mineral processing and refining methods and systems, and logistics and communication systems.
14.2401	Ocean Engineering	A Program that prepares individuals to apply mathematical and scientific principles to the design, development, and operational evaluation of systems to monitor, control, manipulate, and operate within coastal or ocean environments, such as underwater platforms, flood control systems, dikes, hydroelectric power systems, tide and current control and warning systems, and communications equipment; the planning and design of total systems for working and functioning in water or underwater environments; and the analysis of related engineering problems such as the action of water properties and behavior on physical systems and people, tidal forces, current movements, and wave motion.
14.2501	Petroleum Engineering	A program that prepares individuals to apply mathematical and scientific principles to the design, development, and operational evaluation of systems for locating, extracting, processing and refining crude petroleum and natural gas, including prospecting instruments and equipment, mining and drilling systems, processing and refining systems and facilities, storage facilities, transportation systems, and related environmental and safety systems.
14.3901	Geological/ Geophysical Engineering	A program that prepares individuals to apply mathematical and geological principles to the analysis and evaluation of engineering problems, including the geological evaluation of construction sites, the analysis of geological forces acting on structures and systems, the analysis of potential natural resource recovery sites, and applied research on geological phenomena.
26.1302	Marine Biology and Biological Oceanography	A program that focuses on the scientific study of the ecology and behavior of microbes, plants, and animals inhabiting oceans, coastal waters, and saltwater wetlands and their interactions with the physical environment. Includes instruction in chemical, physical, and geological oceanography; molecular, cellular, and biochemical studies; marine microbiology; marine botany; ichthyology; mammalogy; marine population dynamics and biodiversity; reproductive biology; studies of specific species, phyla, habitats, and ecosystems; marine paleoecology and paleontology; and applications to fields such as fisheries science and biotechnology.

CIP Code	Title	Description
40.0401	Atmospheric Sciences and Meteorology, General	A general program that focuses on the scientific study of the composition and behavior of the atmospheric envelopes surrounding the earth, the effect of earth's atmosphere on terrestrial weather, and related problems of environment and climate. Includes instruction in atmospheric chemistry and physics, atmospheric dynamics, climatology and climate change, weather simulation, weather forecasting, climate modeling and mathematical theory; and studies of specific phenomena such as clouds, weather systems, storms, and precipitation patterns.
40.0402	Atmospheric Chemistry and Climatology	A program that focuses on the scientific study of atmospheric constituents, reactions, measurement techniques, and processes in predictive, current, and historical contexts. Includes instruction in climate modeling, gases and aerosols, trace gases, aqueous phase chemistry, sinks, transport mechanisms, computer measurement, climate variability, paleoclimatology, climate diagnosis, numerical modeling and data analysis, ionization, recombination, photoemission, and plasma chemistry
40.0403	Atmospheric Physics and Dynamics	A program that focuses on the scientific study of the processes governing the interactions, movement, and behavior of atmospheric phenomena and related terrestrial and solar phenomena. Includes instruction in cloud and precipitation physics, solar radiation transfer, active and passive remote sensing, atmospheric electricity and acoustics, atmospheric wave phenomena, turbulence and boundary layers, solar wind, geomagnetic storms, coupling, natural plasma, and energization.
40.0404	Meteorology	A program that focuses on the scientific study of the prediction of atmospheric motion and climate change. Includes instruction in general circulation patterns, weather phenomena, atmospheric predictability, parameterization, numerical and statistical analysis, large-and mesoscale phenomena, kinematic structures, precipitation processes, and forecasting techniques.
40.0499	Atmospheric Sciences and Meteorology, Other	Any instructional program in atmospheric sciences and meteorology not listed above.
40.0601	Geology/ Earth Sciences, General	A program that focuses on the scientific study of the earth; the forces acting upon it; and the behavior of the solids, liquids and gases comprising it. Includes instruction in historical geology, geomorphology and sedimentology, the chemistry of rocks and soils, stratigraphy, mineralogy, petrology, geostatistics, volcanology, glaciology, geophysical principles, and applications to research and industrial problems.
40.0602	Geochemistry	A program that focuses on the scientific study of the chemical properties and behavior of the silicates and other substances forming, and formed by geomorphological processes of the earth and other planets. Includes instruction in chemical thermodynamics, equilibrium in silicate systems, atomic bonding, isotopic fractionation, geochemical modeling, specimen analysis, and studies of specific organic and inorganic substances.
40.0603	Geophysics and Seismology	A program that focuses on the scientific study of the physics of solids and its application to the study of the earth and other planets. Includes instruction in gravimetric, seismology, earthquake forecasting, magnetometry, electrical properties of solid bodies, plate tectonics, active deformation, thermodynamics, remote sensing, geodesy, and laboratory simulations of geological processes.
40.0604	Paleontology	A program that focuses on the scientific study of extinct life forms and associated fossil remains, and the reconstruction and analysis of ancient forms, ecosystems, and geological processes. Includes instruction in sedimentation and fossilization processes, fossil chemistry, evolutionary biology, paleoecology, paleoclimatology, trace fossils, micropaleontology, invertebrate paleontology, vertebrate paleontology, paleobotany, field research methods, and laboratory research and conservation methods.
40.0605	Hydrology and Water Resources Science	A program that focuses on the scientific study of the occurrence, circulation, distribution, chemical and physical properties, and environmental interaction of surface and subsurface waters, including groundwater. Includes instruction in geophysics, thermodynamics, fluid mechanics, chemical physics, geomorphology, mathematical modeling, hydrologic analysis, continental water processes, global water balance, and environmental science.
40.0606	Geochemistry and Petrology	A program that focuses on the scientific study of the igneous, metamorphic, and hydrothermal processes within the earth and the mineral, fluid, rock, and ore deposits resulting from them. Includes instruction in mineralogy, crystallography, petrology, volcanology, economic geology, meteoritics, geochemical reactions, deposition, compound transformation, core studies, theoretical geochemistry, computer applications, and laboratory studies.
40.0607	Oceanography, Chemical and Physical	A program that focuses on the scientific study of the chemical components, mechanisms, structure, and movement of ocean waters and their interaction with terrestrial and atmospheric phenomena. Includes instruction in material inputs and outputs, chemical and biochemical transformations in marine systems, equilibria studies, inorganic and organic ocean chemistry, oceanographic processes, sediment transport, zone processes, circulation, mixing, tidal movements, wave properties, and seawater properties.
40.0699	Geological and Earth Sciences/ Geosciences, Other	Any instructional program in geological and related sciences not listed above.
45.0701	Geography	A program that focuses on systematic study of the spatial distribution and interrelationships of people, natural resources, plant and animal life. Includes instruction in historical and political geography, cultural geography, economic and physical geography, regional science, cartographic methods, remote sensing, spatial analysis, and applications to areas such as land-use planning, development studies, and analyses of specific countries, regions, and resources.

Occupational Classifications

Standard Occupational Classification Codes

The U.S. Census Bureau of Labor Statistics and National Science Foundation (NSF) use the 2010 Standard Occupational Classification (SOC) codes (http://www.bls.gov/soc/) to classify geoscientists; however, each organization has a different focus for its surveying and data collection.

Data from the U.S. Census Bureau, U.S. Bureau of Labor Statistics and the Office of Personnel Management are coarse because the first two agencies focus on national population trends and the third agency focuses on trends across all sectors of the federal government. Data from the National Science Foundation has a finer resolution because it is focused on specific data topics within the science and engineering fields. Data from all of these sources are too coarse to establish precise trends for geoscientists.

In data classified by the SOC codes, some geoscientists are grouped in categories with other non-geoscience scientists and engineers. For example, soil scientists who study the chemical, physical, and mineralogical composition of soils are grouped with the Soil and Plant Scientists whose focus is on agriculture. Geotechnical engineers, who study the structural behavior of soil and rocks, perform soil investigations, design structure foundations, and provide field observations of foundation investigation and construction, are grouped with Civil Engineers who perform construction. Geoscientists at the professional or managerial level are grouped with either Engineering Managers or Natural Science Managers. Geoscience teachers at post-secondary institutions are grouped in the Environmental Science Teacher, Atmospheric, Earth, Marine, and Space Science Teacher, Geography Teacher, or Engineering Teacher categories.

The National Science Foundation's classification of geoscientists provides better resolution than the SOC codes; however, there are no categories for geographers, hydrologists, geoscience managers and soil scientists. Additionally, many of the challenges with identifying geoscientists that occur in the SOC codes (such as post-secondary geoscience teachers) also occur within the National Science Foundation's classification schema.

Appendix Table 2: Geoscientists are Found within the Following SOC Codes

SOC Code	SOC Title	Definition
11-9041	Architectural and Engineering Managers	Plan, direct, or coordinate activities in such fields are architecture and engineering or research and development in these fields. Excludes "Natural Sciences Managers"
11-9121	Natural Science Managers	Plan, direct, or coordinate activities in such fields as life sciences, physical sciences, mathematics, statistics, and research and development in these fields. Excludes "Architectural and Engineering Managers" and "Computer and Information Systems Managers"
17-2051	Civil Engineers	Perform engineering duties in planning, designing, and overseeing construction and maintenance of building structures and facilities, such as roads, railroads, airports, bridges, harbors, channels, dams, irrigation projects, pipelines, power plants, and water and sewage systems. Includes architectural, structural, traffic, ocean, and geo-technical engineers. Excludes "Hydrologists".
17-2081	Environmental Engineers	Research, design, plan or perform engineering duties in the prevention, control, and remediation of environmental hazards using various engineering disciplines. Work may include waste treatment, site remediation, or pollution control technology.
17-2151	Mining and Geological Engineers, Including Mining Safety Engineers	Conduct sub-surface surveys to identify the characteristics of potential land or mining development sites. May specify the ground support systems, processes and equipment for safe, economical, and environmentally sound extraction or underground construction activities. May inspect areas for unsafe geological conditions, equipment, and working conditions. May design, implement, and coordinate mine safety programs. Excludes "Petroleum Engineers".
17-2171	Petroleum Engineers	Devise methods to improve oil and gas extraction and production and determine the need for new or modified tool designs. Oversee drilling and offer technical advice.

SOC Code	SOC Title	Definition
19-1013	Soil and Plant Scientists	Conduct research in breeding, physiology, production, yield, and management of crops and agricultural plants or trees, shrubs. and nursery stock, their growth in soils, and control of pests; or study the chemical, physical, biological, and mineralogical composition of soils as they relate to plant or crop growth. May classify and map soils and investigate effects of alternative practices on soil and crop productivity.
19-1031	Conservation Scientists	Manage, improve and protect natural resources to maximize their use without damaging the environment. May conduct soil surveys and develop plans to eliminate soil erosion or to protect rangelands. May instruct farmers, agricultural production managers, or ranchers in best ways to use crop rotation, contour plowing, or terracing to conserve soil and water; in the number and kind of livestock and forage plants best suited to particular ranges; and in range and farm improvements, such as fencing and reservoirs for stock watering. Excludes "Zoologists and Wildlife Biologists" and "Foresters"
19-2021	Atmospheric and Space Scientists	Investigate atmospheric phenomena and interpret meteorological data, gathered by surface and air stations, satellites, and radar to prepare reports and forecasts for public and other data uses. Includes weather analysts and forecasters whose functions require the detailed knowledge of meteorology.
19-2041	Environmental Scientists and Specialists, Including Health	Conduct research or perform investigation for the purpose of identifying, abating, or eliminating sources of pollutants of hazards that affect either the environment or the health of the population. Using knowledge of various scientific disciplines, may collect, synthesize, study, report, and recommend action based on data derived from measurements or observations of air, food, soil, water, and other sources. Excludes "Zoologists and Wildlife Biologists", "Conservation Scientists", "Forest and Conservation Technicians", "Fish and Game Wardens", and "Forest and Conservation Workers".
19-2042	Geoscientists, Except Hydrologists and Geographers	Study the composition, structure, and other physical aspects of the Earth. May use geological, physics, and mathematics knowledge in exploration for oil, gas, minerals, or underground water; or in waste disposal, land reclamation, or other environmental problems. May study the Earth's internal composition, atmospheres, oceans, and its magnetic, electrical, and gravitational forces. Includes mineralogists, crystallographers, paleontologists, stratigraphers, geodesists, and seismologists.
19-2043	Hydrologists	Research the distribution, circulation, and physical properties of underground and surface waters; and study the form and intensity of precipitation, its rate of infiltration into the soil, movement through the earth, and its return to the ocean and atmosphere.
19-3092	Geographers	Study the nature and use of areas of the Earth's surface, relating and interpreting interactions of physical and cultural phenomena. Conduct research on physical aspects of a region, including land forms, climates, soils, plants, and animals, and conduct research on the spatial implications of human activities within a given area, including social characteristics, economic activities, and political organization, as well as researching interdependence between regions at scales ranging from local to global.
19-4041	Geological and Petroleum Technicians	Assist scientists or engineers in the use of electronic, sonic, or nuclear measuring instruments in both laboratory and production activities to obtain data indicating potential resources such as metallic ore, minerals, gas, coal, or petroleum. Analyze mud and drill cuttings. Chart pressure, temperature, and other characteristics of wells or bore holes. Investigate and collect information leading to the possible discovery of new metallic ore, minerals, gas, coal, or petroleum deposits.
19-4091	Environmental Science and Protection Technicians, Including Health	Perform laboratory and field tests to monitor the environment and investigate sources of pollution, including those that affect health, under the direction of an environmental scientist, engineer, or other specialist. May collect samples of gases, soil, water, and other materials for testing.
25-1032	Engineering Teachers, Postsecondary	Teach courses pertaining to the application of physical laws and principles of engineering for the development of machines, materials, instruments, processes, and services. Includes teachers of subjects such as chemical, civil, electrical, industrial, mechanical, mineral, and petroleum engineering. Includes both teachers primarily engaged in teaching and those who do a combination of teaching and research. Excludes "Computer Science Teachers, Postsecondary".
25-1051	Atmospheric. Earth, Marine, and Space Sciences Teachers, Postsecondary	Teach courses in the physical sciences, except chemistry and physics. Includes both teachers primarily engaged in teaching, and those who do a combination of teaching and research.
25-1053	Environmental Science Teachers, Postsecondary	Teach courses in environmental science. Includes both teachers primarily engaged in teaching and those who do a combination of teaching and research.
25-1064	Geography Teachers, Postsecondary	Teach courses in geography. Includes both teachers primarily engaged in teaching and those who do a combination of teaching and research.

Office of Personnel Management: Handbook of Occupations Groups and Families

The Office of Personnel Management released this Handbook in order to provide agencies with a starting point to classify positions.

Appendix Table 3: Geoscientists are Found within the Following OPM Handbook Codes

Code-Title	Description
0028-Environmental Protection Specialist Series	This series covers positions that involve advising on, managing, supervising, or performing administrative or program work relating to environmental protection programs (e.g., programs to protect or improve environmental quality, control pollution, remedy environmental damage, or ensure compliance with environmental laws and regulations). These positions require specialized knowledge of the principles and methods of administering environmental protection programs and the laws and regulations related to environmental protection activities.
0150-Geography Series	This series covers positions the duties of which involve professional work in the field of geography, including the compilation, synthesis, analysis, interpretation and presentation of information regarding the location, distribution, and interrelationships of and processes of change affecting such natural and human phenomena as the physical features of the earth, climate, plant, and animal life, and human settlements and institutions.
0401-General Natural Resources Management and Biological Science Series	This series covers positions that involve professional work in biology, agriculture, or related natural resource management when there is no other more appropriate series. Thus included in this series are positions that involve: 1) a combination of several professional fields with none predominant; or 2) a specialized professional field not readily identified with other existing series.
0457-Soil Conservation Series	This series covers positions involving the performance of professional work in the conservation of soil, water, and related environmental resources to achieve sound land use. Conservation work requires knowledge of: 1) soils and crops; 2) the pertinent elements of agronomy, engineering, hydrology, range conservation, biology, and forestry; and 3) skill in oral and written communication methods and techniques sufficient to impart these knowledge to selected client groups.
0470-Soil Science Series	This series covers positions that involve professional and scientific work in the investigation of soils, their management, and their adaptation for alternative uses. Such work requires knowledge of chemical, physical, mineralogical and biological properties and processes of the soils and their relationships to climatic, physiographic, and biologic influences.
0819-Environmental Engineering Series	This series covers positions managing, supervising, leading, and/or performing professional engineering and scientific work involving environmental programs and projects in the areas of: 1) environmental planning; 2) environmental compliance; 3) identification and cleanup of contamination; and 4) restoring and sustaining environmental conservation.
0880-Mining Engineering Series	This series covers positions managing, supervising, leading, and/or performing professional engineering and scientific work to explore, remove, and transport raw metals, nonmetallic minerals, and solid fuels from the earth. Mining engineering work involves: 1) a variety of mineral substances to include metal ores, nonmetallic minerals, and solid fuels and energy sources; 2) working with mining systems, including underground mining, surface mining, solution mining, and placer mining; and 3) traditional mining activities, including the heavy construction industry (involving rock excavation and support for highways, tunnels, dams, power stations, and underground chambers) and exploration and development of mineral deposits located under large bodies of water.
0881-Petroleum Engineering Series	This series covers positions managing, supervising, leading, and/or performing professional engineering and scientific work involved in the discovery and recovery of oil, natural gas (e.g. methane, ethane, propane, butane), and helium. The work includes: 1) exploration and development of oil and natural gas fields; 2) production, transportation, and storage of petroleum, natural gas, and helium; 3) investigation, evaluation, and conservation of these resources; 4) regulation of the transportation and sale of natural gas; 5) valuation of production and distribution facilities for tax, regulatory, and other purposes; and 6) research on criteria, principles. methods, and equipment involved in exploration and development activities.
1301-General Physical Science Series	This series includes positions that involve professional work in the physical sciences when there is no other more appropriate series, that is, the positions are not classifiable elsewhere. This series also includes work in a combination of physical science fields, with no one predominant.
1313-Geophysics Series	This series includes professional scientific positions requiring application of knowledge of the principles and techniques of geophysics and related sciences in the investigation, measurement, analysis, evaluation, and interpretation of geophysical phenomena and artificially applied forces and fields related to the structure, composition, and physical properties of the earth and its atmosphere.
1315-Hydrology Series	This series includes positions that involve professional work in hydrology, the science concerned with the study of water in the hydrologic cycle. The work includes basic and applied research on water and water resources; the collection, measurement, analysis, and interpretation of information on water resources; the forecast of water supply and water flows; and the development of new, improved or more economical methods, techniques, and instruments.
1321-Metallurgy Series	This series includes positions that require primarily professional education and training in the field of metallurgy, including ability to apply the relevant principles of chemistry, physics, mathematics, and engineering to the study of metals. Metallurgy is the art and science of extracting metals from their ores, refining them, alloying them and preparing them for use, and studying their properties and behavior as affected by the composition, treatment in manufacture, and condition of use.

Code-Title	Description
1340-Meteorology Series	This series includes positions that involve professional work in meteorology, the science concerned with the earth's atmospheric envelope and its processes. The work includes basic and applied research into the conditions and phenomena of the atmosphere; the collection, analysis, evaluation, and interpretation of meteorological data to predict weather and determine climatological conditions for specific geographical areas; the development of new of the improvement of existing meteorological theory; and the development or improvement of meteorological methods, techniques, and instruments. Positions in this occupation require full professional knowledge and application of meteorological methods, techniques, and theories.
1350-Geology Series	This series includes professional scientific positions applying a knowledge of the principles and theories of geology and related sciences in the collection, measurement, analysis, evaluation, and interpretation of geologic information concerning the structure, composition, and history of the earth. This includes the performance of basic research to establish fundamental principles and hypotheses to develop a fuller knowledge and understanding of geology, and the application of these principles and knowledge to a variety of scientific, engineering, and economic problems.
1360-Oceanography Series	This series includes professional scientific positions engaged in the collection, measurement, analysis, evaluation, and interpretation of natural and physical ocean phenomena, such as currents, circulations, waves, beach and near-shore processes, chemical structure and processes, physical and submarine features, depth, floor configuration, organic, and inorganic sediments, sound and light transmission, color manifestations, heat exchange, and similar phenomena (e.g. biota, weather, geological structure, etc.). Oceanographers plan, organize, conduct, and administer seagoing and land-based study and research of ocean phenomena for the purpose of interpreting, predicting, utilizing and controlling ocean forces and events, This work requires a fundamental background in chemistry, physics, mathematics, and appropriate knowledge in the field of oceanography.

Industry Classifications

North American Industry Classification System (NAICS)

The NAICS (https://www.census.gov/eos/www/naics/) is the federal government's standard industry classification system that groups employers into industries based on the activities in which they are primarily engaged. The United States, Canada, and Mexico developed the system to provide comparable statistics across the three countries. The NAICS is a comprehensive system covering the entire field of economic activities. There are 20 sectors in the NAICS and 1,065 detailed industries in the NAICS for the United States. The NAICS (United States version) is used by U.S. statistical agencies to facilitate the collection, tabulation, presentation, and analysis of data relating to business establishments. It allows for inter-agency comparison of statistical data describing the U.S. economy. The NAICS is used by the U.S. Census Bureau, U.S. Bureau of Labor Statistics, U.S. Bureau of Economic Analysis, and by the National Science Foundation.

The top-level categories for NAICS are outlined in following table. Geoscientists work in the Mining, Utilities, Construction, Manufacturing, Wholesale Trade, Transportation and Warehousing, Information, Finance and Insurance, Professional, Scientific, and Technical Services, Management of Companies and Enterprises, Administrative and Support and Waste Management and Remediation Services, Educational Services, and Public Administration industries.

Appendix Table 4: All Occupations Fall Within the Following NAICS Codes

NAICS Code	NAICS Industry Title
11	Agriculture, Forestry, Fishing and Hunting
21	Mining, Quarrying, and Oil and Gas Extraction
22	Utilities
23	Construction
31-33	Manufacturing
42	Wholesale Trade
44-45	Retail Trade
48-49	Transportation and Warehousing
51	Information
52	Finance and Insurance
53	Real Estate and Rental and Leasing
54	Professional, Scientific, and Technical Services
55	Management of Companies and Enterprises
56	Administrative and Support and Waste Management and Remediation Services
61	Educational Services
62	Health Care and Social Assistance
71	Arts, Entertainment, and Recreation
72	Acommodation and Food Services
81	Other Services (except Public Administration)
92	Public Administration

AGI's Working Definition of Geoscience Occupations

In light of how existing data sources define the geosciences, AGI has worked with its stakeholders to establish a working definition for the geoscience profession in order to improve compatibility of data across sources and time periods. With this definition, AGI and its partners will be able to capture the depth and breadth of the geoscience profession, clearly define it, and estimate employment trends. The resulting data can then be used in a proposal to federal data agencies to more accurately define the geosciences in federal data sources.

AGI's working definition of the geosciences is as follows:

Geoscientist

Subfields: Environmental Science, Hydrology, Oceanography, Atmospheric Science, Geology, Geophysics, Climate Science, Geochemistry, Paleontology

Studies the composition, structure, and other physical aspects of the Earth. Includes the study of the chemical, physical, and mineralogical composition of soils, analysis of atmospheric phenomena, and study the distribution, circulation, and physical and chemical properties of underground and surface waters. May study the Earth's internal composition, atmospheres, oceans, and its magnetic, electrical, thermal, and gravitational forces. May utilize knowledge of various scientific disciplines to collect, synthesize, study, report, and take action based on data derived from measurements or observations of air, soil, water, and other resources. May use geological, environmental, physics, and mathematics knowledge in exploration for oil, gas, minerals, or underground water; or in waste disposal, elimination of pollutants/hazards that affect the environment, land reclamation, or management of natural resources.

Geoscience Engineer

Subfield: Environmental

Designs, plans, or performs engineering duties in the development of water supplies and prevention, control, and remediation of environmental hazards utilizing various engineering disciplines. Work may include waste treatment, site remediation, pollution control technology, or the development of water supplies.

Subfield: Exploration

Determines the location and plans the extraction of coal, metallic ores, nonmetallic minerals, and building materials, such as stone and gravel. Work involves conducting preliminary surveys of deposits or undeveloped mines and planning their development; examining deposits or mines to determine whether they can be worked at a profit; making geological and topographical surveys; evolving methods of mining best suited to character, type, and size of deposits; and supervising mining operations. Devises methods to improve oil and gas well production and determines the need for new or modified tool designs. Oversees drilling and offers technical advice to achieve economical and satisfactory progress.

Subfield: Geotechnical

Studies structural behavior of soils and rocks, performs soil investigations, designs structure foundations, and provides field observations of foundation investigation and foundation construction.

Geoscience Manager

Plans, directs, or coordinates activities in such fields as geoscience engineering and geoscience. Engages in complex analysis of geoscience principles. Generally oversees one or more professionals, but may still be active in technical work.

Appendix B: Data Sources

AGI Data Sources:

GeoRef

AGI's GeoRef database contains over 2.9 million references to geoscience journal articles, books, maps, conference papers, reports and theses. GeoRef includes all geoscience publications that pertain only to surface and sub-surface processes. Publications pertaining to atmospheric and space sciences are excluded.

AGI's Directory of Geoscience Departments Database

AGI's Workforce Program has been collecting basic demographic information annually about all the geoscience programs at two-year and four-year institutions worldwide, along with other geoscience organizations and agencies for nearly 50 years, creating an extensive database. This database is used for the AGI publication, the Directory of Geoscience Departments, and for current data on the health of geoscience departments in the U.S. and abroad.

AGI's Geoscience Student Exit Survey

AGI collects data from students graduating with their bachelor's, master's, and doctoral geoscience degrees in order to ascertain their educational background, degree information, co-curricular experiences, and immediate future plans after graduation. Some of the data are presented within this report. For more information about this study and to see more of the most recent data, please visit http://www.americangeosciences.org/workforce/exit-survey.

Other Public Sources:

American Geophysical Union publications: http://preview.onlinelibrary.wiley.com/agu/journal/10.1002/(ISSN)2156-2202/

American Meteorological Society publications: http://journals.ametsoc.org/

Association for the Sciences of Limnology and Oceanography publication: http://www.aslo.org/lo/toc/index.html

ACT: https://www.act.org/

Baker Hughes: http://www.bakerhughes.com/

College Board: https://www.collegeboard.org/

Energy Information Administration: http://www.eia.gov/

National Association of Geoscience Teachers publication: http://nagt.org/nagt/jge/index.html

National Science Foundation's Budget Internet Information Systems: http://dellweb.bfa.nsf.gov/starth.asp

National Science Foundation's National Center for Science and Engineering Statistics: http://www.nsf.gov/statistics/

U.S. Bureau of Economic Analysis: http://www.bea.gov/

U.S. Bureau of Labor Statistics: http://www.bls.gov

U.S. Census Bureau: https://www.census.gov/

U.S. Department of Education's Integrated Postsecondary Education Database: http://nces.ed.gov/ipeds/

U.S. Department of Education's National Center of Education Statistics: http://nces.ed.gov/

U.S. Geological Survey: http://www.usgs.gov

U.S. Government's Open Data Site: http://www.data.gov/

U.S. Office of Personnel Management: http://www.opm.gov/

World Gold Council: http://www.gold.org/

AGI Geoscience Workforce Program
www.americangeosciences.org/workforce

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