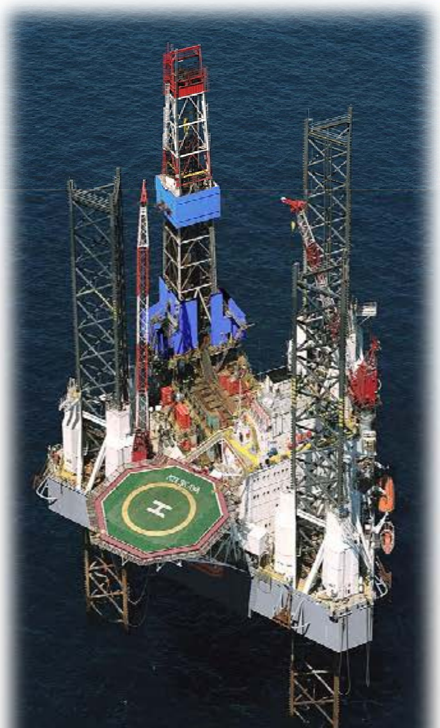
2009

Status of the Geoscience Workforce

Report Summary



American Geological Institute

February 2009

SERVING THE GEOSCIENCES WORLDWIDE

AGI

THE AMERICAN GEOLOGICAL INSTITUTE

Table of Contents

Introduction

According to the federal government, science and technology has been responsible for more than 50% of the economic growth in the U.S. since the end of World War II. This growth was driven by increased investment in science and technology fields undertaken in the post-war, space-race, and cold war years, building not only the human capital but also the institutional frameworks to sustain the technical capacity of the U.S. economy in the face of ever-changing threats.

External threats from global competition and fluid international trade are often identified as the major issues facing the U.S. workforce, but internal risks to our existing and future technical capacity are the most pressing and most addressable issues we face. The primary internal risk, often described as the "Great Crew Change", is an aging workforce juxtaposed against an anemic supply of qualified and trained scientists and engineers. The fundamental issue of a shortage of skilled talent in the U.S. was the driver behind the White House's American Competitiveness Initiative (ACI) and is now the core of federal R&D and education investment strategy.

The issue of the "Great Crew Change" and the way the government is addressing future American competitiveness is extremely complicated for the geosciences. Because of economic cycles, more than 50% of the workforce needed in natural resource industries in 10 years is currently not in the workforce. Additionally, because of the recent economic downturn, there are major constraints on immediate opportunities. However, the mid to long-term issue remains unchanged, and in a new economy, may be even more exacerbated.

It is unlikely that the supply of new entrants into the geosciences will fill these vacancies in the workforce. In fact, based on the American Geological Institute's (AGI's) statistics related to enrollments and degrees granted, less than 13% of the approximately 6,000 new U.S. geoscience bachelor's majors in the fall of 2008 will ever work in the geoscience field professionally. This number is particularly troubling given that only 28% of all science and engineering majors work in their field.

The nature of geoscience work is expected to change in the future across all employment sectors. For example, as oil and gas fields become smaller and more difficult to locate, geoscientists will need to employ new technologies for exploration and develop other avenues for energy production. Added to these challenges is a volatile commodities market that will put pressure on exploration and production teams to speed up their cycle.

Geoscientists will be expected to re-apply their skills from one field to the next as workforce demands change and society's needs shift. A geoscientist working on reservoir characterization for oil today, for example, may apply his or her skills and techniques to carbon sequestration in the future, or may utilize the principles of fluid dynamics learned from oil exploration to locate and characterize water resources. Across all fields, geoscientists will need to be equipped with a strong set of fundamental skills in geoscience and mathematics that can be transferred across industrial sectors and applied to different geoscience challenges in the future, whether it is water resources, energy, minerals, hazards and climate issues, or training the next generation of geoscientists.

Measurement, analysis, and reporting of all aspects of the geoscience workforce system are critical for decision makers to successfully support building the future capacity for geoscience in the United States. This report presents the first benchmark of the status of the geoscience profession. It includes analyses of the supply of the future geoscience workforce, the status of the current geoscience workforce, and of economic indicators of geoscience industries.

The report is based on original data collected by the American Geological Institute, and on existing data from federal data sources, professional membership organizations, and industry data sources. It provides a framework for identifying the strengths and weaknesses in the geoscience human capital system.

Defining the Geosciences in Federal Data Sources

Given its complexity, the geoscience occupation is difficult to define under existing nomenclature. This is due to the 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 the data collection (national occupation trends, science & engineering trends, education vs. occupation, internal classification codes, etc.), the characteristics of the population surveyed, and the focus of the organization.

Federal policy and funding is in part determined by the economic activity and employment trends of a given profession. Accurate measurement and analysis of the geoscience profession are thus central to successful decisions that support the improvement of the geosciences in the U.S. The lack of a consistent definition of geosciences across data sources is a major handicap for the geoscience profession, both for cultivating the future geoscience workforce and for characterizing geoscience economic drivers. Attracting new students into geoscience degree programs is influenced by federal statistics (current and projected employment numbers, salary information, funding, etc.) about the geosciences. Currently, the geoscience profession is poorly characterized by federal data sources. At best, geoscientists are spread across several occupational classifications that are vague in their definition. In addition, the lack of consistency makes establishing baseline metrics for the measurement of the geoscience contribution to the economy very difficult.

To address this issue, AGI is establishing a working definition for the geoscience profession in order to improve comparability of data across sources and time periods. Now that the national census is a rolling monthly survey, the Standard Occupational Classification (SOC) codes will now be updated every 5 to 10 years. This is an opportunity for AGI and its partners to edit the SOC codes so that they capture the depth and breadth of the geoscience profession, clearly define it, and estimate employment over at least 5 years. This data can then be included in a proposal to federal data agencies to more accurately represent the occupation.

AGI's Working Definition of Geoscience Occupations

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 atmosphere phenomenon, and study of 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 effect the environment, land reclamation, or management of natural resources.

Geoengineer

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 plan 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 determine the need for new or modified tool designs. Oversees drilling and offer technical advice to achieve economical and satisfactory progress.

Subfield: Geotechnical

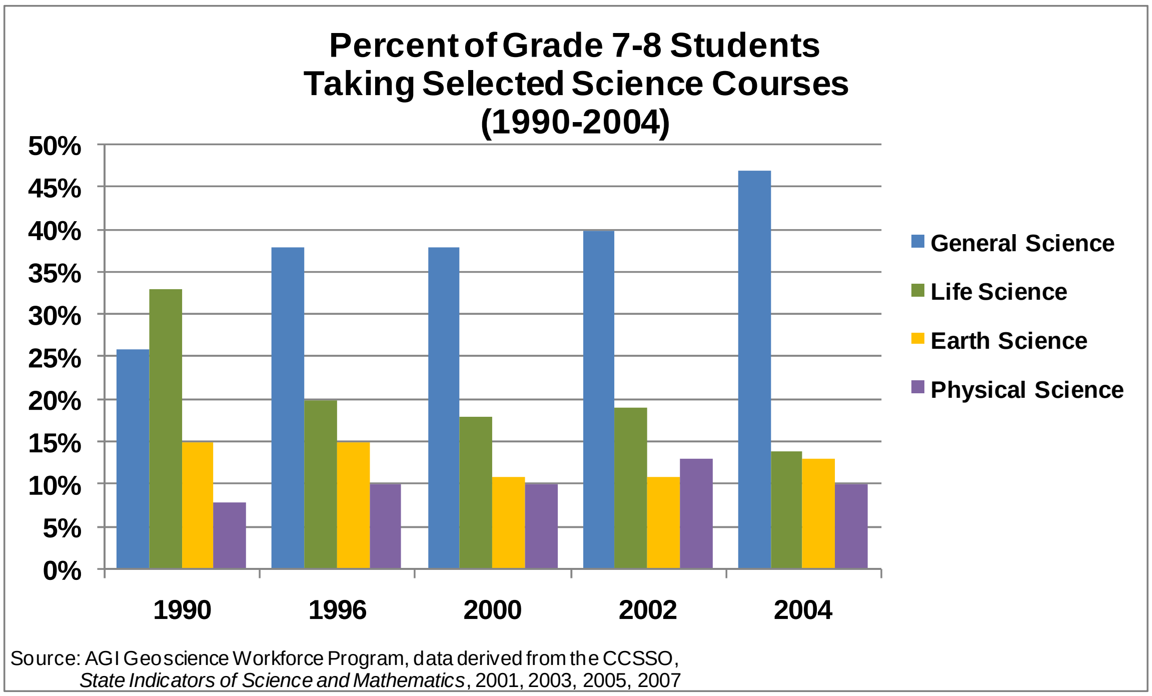
Studies the structural behavior of soil and rocks, perform soil investigations, design structure foundations, and provides field observations of foundation investigation and foundation construction.

Geomanager

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

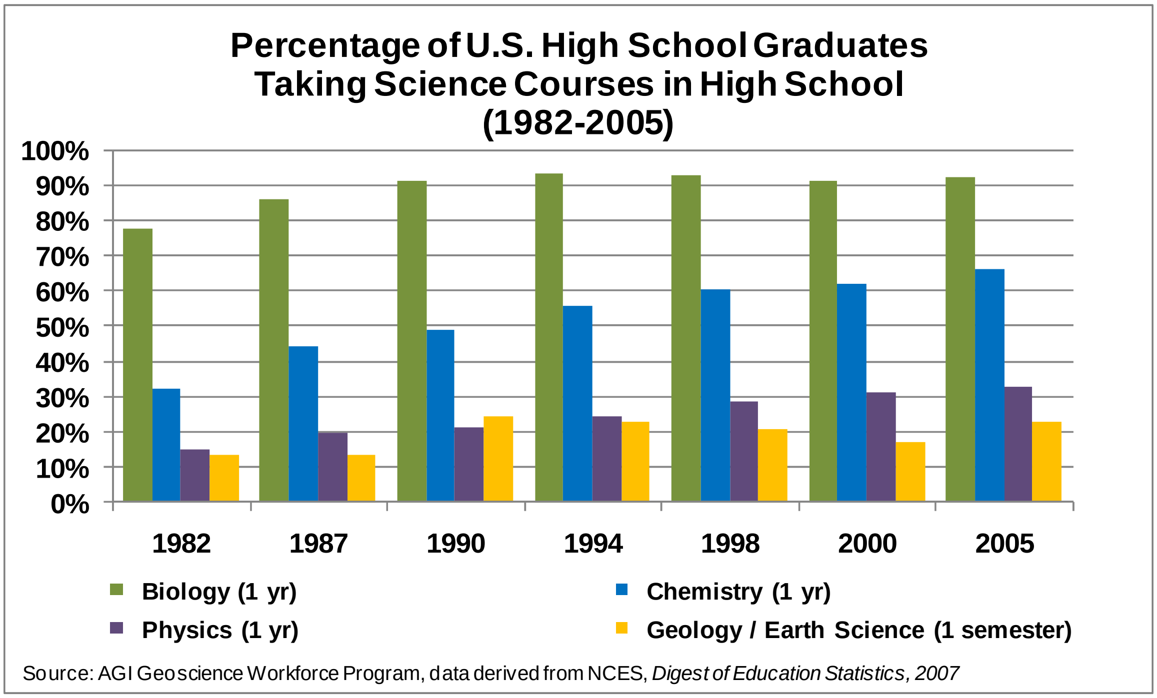
K-12 Geoscience Education

In the U.S., earth science education at the K-12 level is usually most intensive in grades 6 through 8 when national and state science standards mandate that students should learn about energy in the Earth system, geochemical cycles, and the origin and evolution of the universe and Earth. However, earth science education trends over the past 18 years in grades 7 and 8 indicate that only 11 to 15% of students take a specific earth science course. This may be because earth science is integrated into general science courses or because students fulfill their earth science requirements in grade 6.

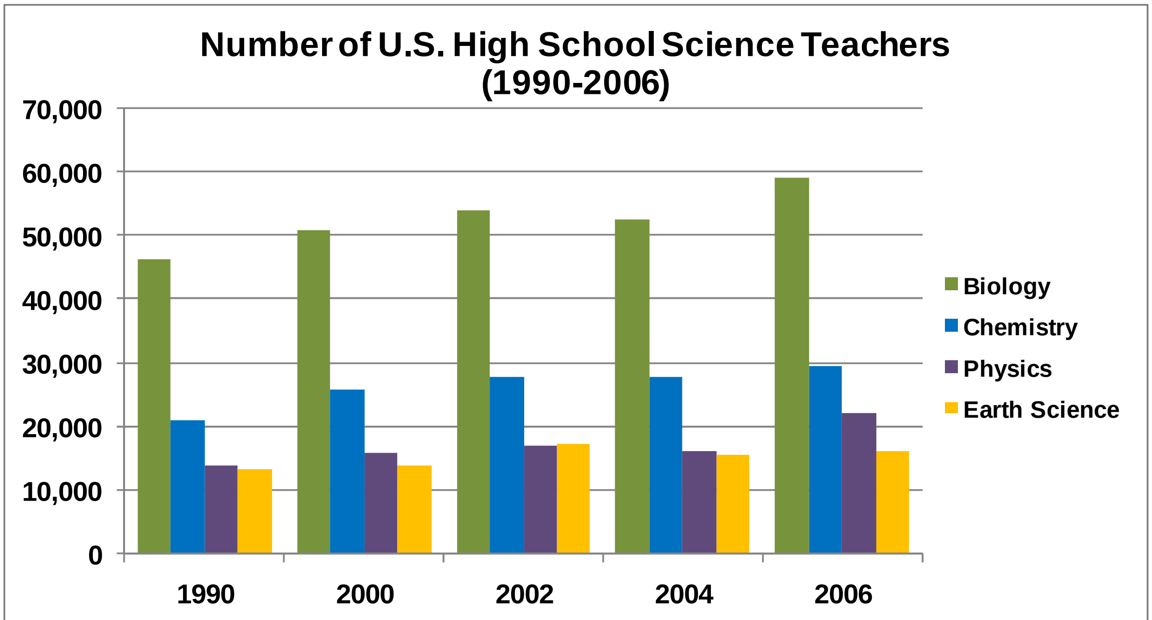


In high school, earth science was required for graduation by slightly more states in 2007 (7 states) than in 2002 (5 states). Although 3 states dropped their state-wide graduation requirement of earth science, 12 states that did not require earth science for graduation in 2002 now leave the decision to local school districts. Although earth science is not usually a required course in high school, the number of states that include it in the recommended high school curriculum has increased from 15 in 2002 to 24 in 2007. Additionally the number of states that omit it from their recommended curriculum has decreased from 10 in 2002 to 6 in 2007. If a high school student takes earth science, it is counted towards high school graduation requirements in 31 states.

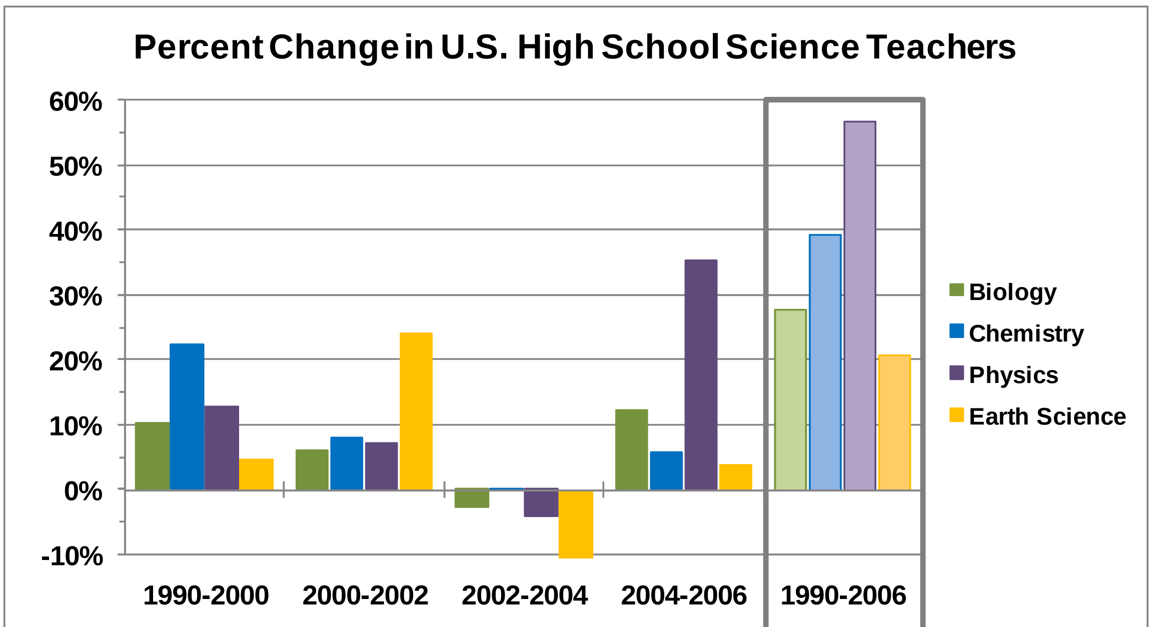
From 1982 to 2005, less than a quarter of each graduating high school class took earth science / geology courses. Although the percentage of graduating high school students who took earth science / geology courses increased from 13.6% in 1982 to 23.1% in 2005, it is still lower than the percentage of high school graduates taking other science courses. The percentage of high school graduates who took biology courses increased from 77% in 1982 to 92% in 2005, and the percentage of high school graduates who took chemistry courses increased from 32% in 1982 to 66% in 2005. Additionally, the percentage of high school graduates who took physics courses increased from 15% in 1982 to 33% in 2005.



For the past 18 years, there have been fewer high school teachers in earth science than in other science disciplines. The percentage of teachers in each discipline has grown over this period; however, earth science has had the slowest growth rate at 21%. Between 2000 and 2002, however, the growth in earth science teachers outpaced the other disciplines (24% compared to 7%). All science disciplines had a decline in the growth rate of teachers between 2002 and 2004, with earth science having the largest decline (10%).



Source: AGI Geoscience Workforce Program data derived from the CCSSO, *State Indicators of Science and Mathematics*, 2001, 2003, 2005, 2007

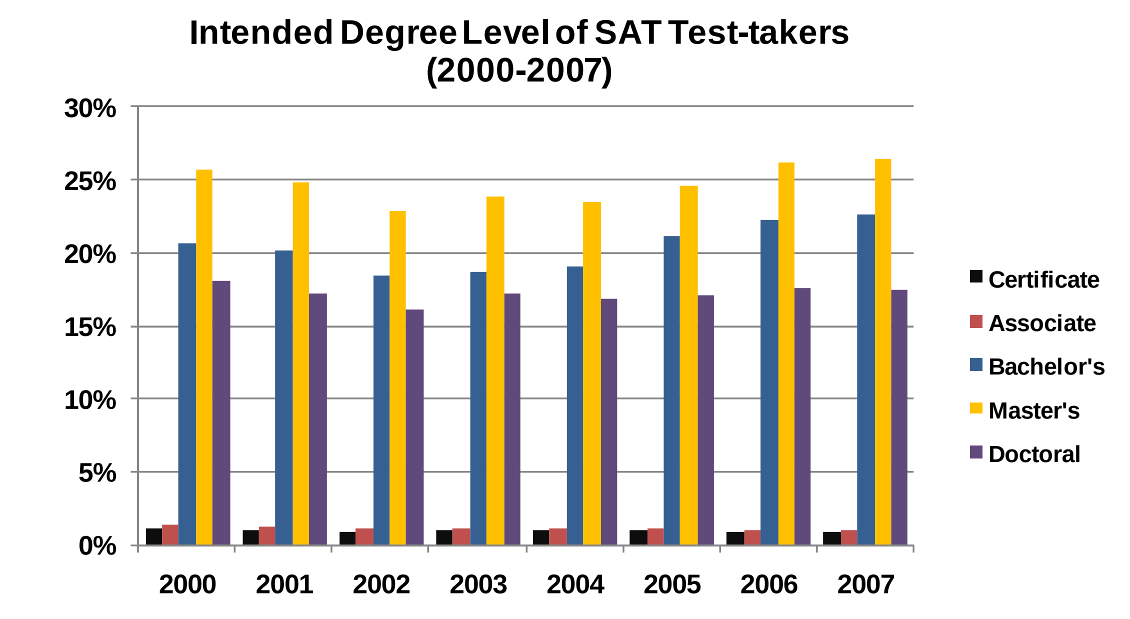


Source: AGI Geoscience Workforce Program data derived from the CCSSO, *State Indicators of Science and Mathematics*, 2001, 2003, 2005, 2007

With less than a quarter of all graduating high school students taking courses in earth science/geology, it is no surprise that college-bound students have consistently indicated a low interest in pursuing either physical science or interdisciplinary science as a college major. For the past 22 years, only 1.2% of all SAT test takers per year have indicated physical science or interdisciplinary science as their intended college major. However, those SAT test takers who indicated either of these college majors also scored 40 to 80 points higher than the national average on the Verbal section of the SAT, and 14 to 87 points higher than the national average on the Math section. Those indicating physical science as their intended college major scored 40 to 50 points higher on the Math section of the SAT than those indicating interdisciplinary science as their intended college major.

High school graduation is a critical juncture in a student's life. A report by the National Center for Education Statistics indicates that in 2004, 78% of graduating seniors planned to attend school in the year following graduation. Between 1972 and 1992, more graduating seniors indicated that they planned to end their post-secondary education with a Bachelor's degree. In 2004, this trend changed as more graduating seniors indicated that they planned to end their post-secondary education with a graduate degree (*Trends Among High School Seniors 1972-2004*, 2008). In 2007, the College Board stated that 44% of responding seniors indicated that they planned to obtain a graduate degree (26% Master's and 18% Ph.D.), and 23% intended to obtain a terminal Bachelor's degree (*College-Bound Seniors, Total Group Report*, 2007).

Additionally, 62.5% of graduating high school seniors indicated that by age 30 they expected to hold a professional occupation (i.e. accountant, artist, registered nurse, engineer, librarian, writer, social worker, actor, actress, athlete, politician, clergyman, dentist, physician, lawyer, scientist, college professor, etc.) (*Trends Among High School Seniors 1972-2004*, 2008). In the geosciences, as in many of these occupations, a Master's degree is considered a professional degree.



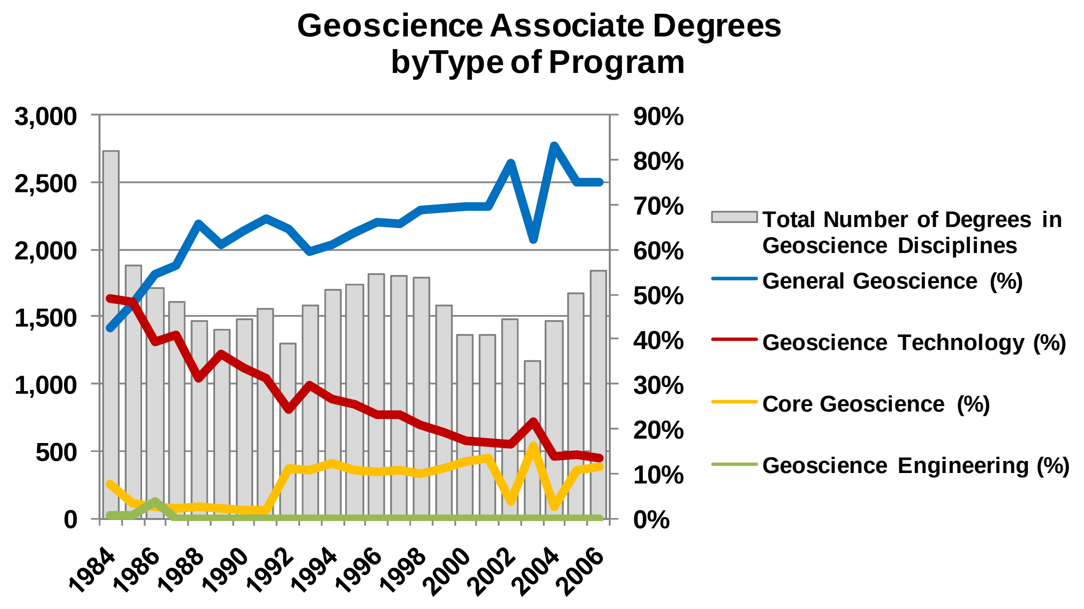
Source: AGI Geoscience Workforce Program, data derived from the College Board *College-Bound Seniors, Total Group Report*, 2000-2007

Geoscience Education at Community Colleges

Community colleges provide a transitional step between high school and four-year institutions for many college-bound students. The National Center for Education Statistic's report, "Special Analysis of Community College Students", indicates that approximately 30% of graduating seniors enroll in community colleges after high school graduation. Additionally, 66% of those seniors enrolling in community colleges intend to use community college as an intermediary step between high school and a four-year institution.

Since 1972, community college students have comprised approximately one-third the total college student population enrolled in credit courses within the United States. Thirty-five percent of these students are underrepresented minorities, and yet, the geosciences have little presence at the community college level. Only 14% of all community colleges have a degree program in the geosciences or related physical sciences. Considering that only 9% of geoscience Master's degree recipients and 4% geoscience Ph.D. recipients also have an Associate degree, community college students represent an important untapped resource of diverse talent for the geosciences.

Since 1985, the number of Associate degrees conferred in geoscience disciplines has varied between 1,200 and 1,800 with an increasing percentage of these degrees from general geoscience programs (physical science, environmental science, and natural science). Core geoscience programs (earth science/geology, paleontology, oceanography, atmospheric science, hydrology) have only produced approximately 10% of all Associate geoscience degrees since 1992. Additionally, the percentage of geoscience Associate degrees from geoscience technology programs has decreased significantly since 1984.

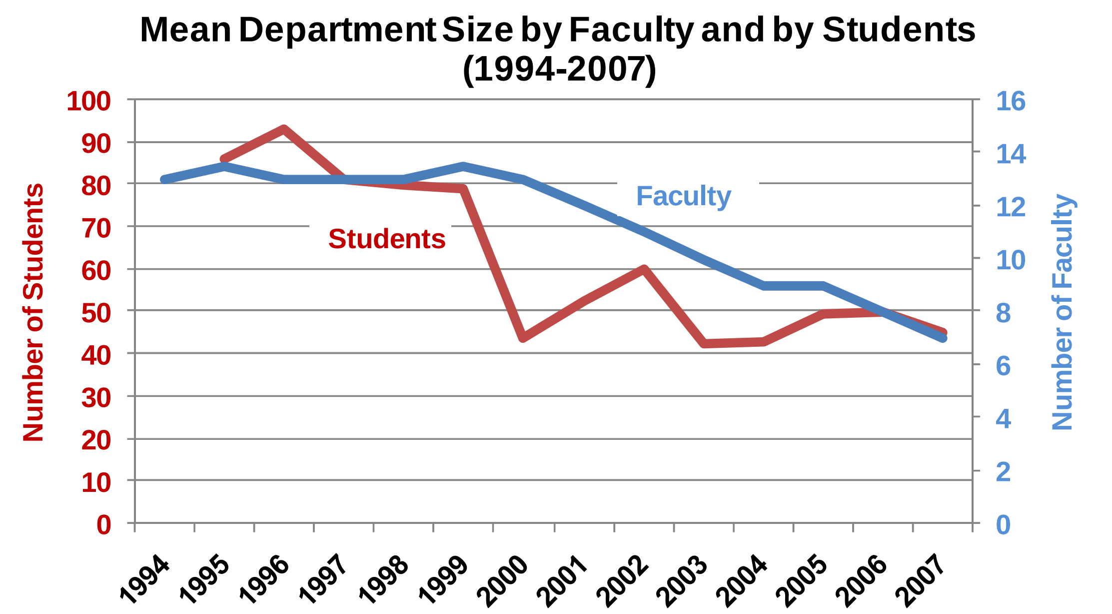


Source: AGI Geoscience Workforce Program, data derived from IPEDS

Geoscience Education at Four-Year Universities

Departments and Faculty

Geoscience departments at four-year universities can be found in every state. The states having the highest number of departments are California, New York, Pennsylvania, and Texas. Since 1999, the median size of departments has steadily decreased both in number of faculty (Professors, Associate Professors, Assistant Professors, and Instructors/Lecturers) and number of total students (undergraduate and graduate). In 2008, the median number of faculty per department was 8, and the median number of students was 45. Most geoscience departments have relatively low ratios of student to tenure track faculty (10:1 or less) which potentially increases the contact hours between students and faculty members.



Source: AGI Geoscience Workforce Program, data derived from AGI's *Directory of Geoscience Departments* and *2003 Report on the Status of Academic Geoscience Departments*, Katz, B.J., 2003.

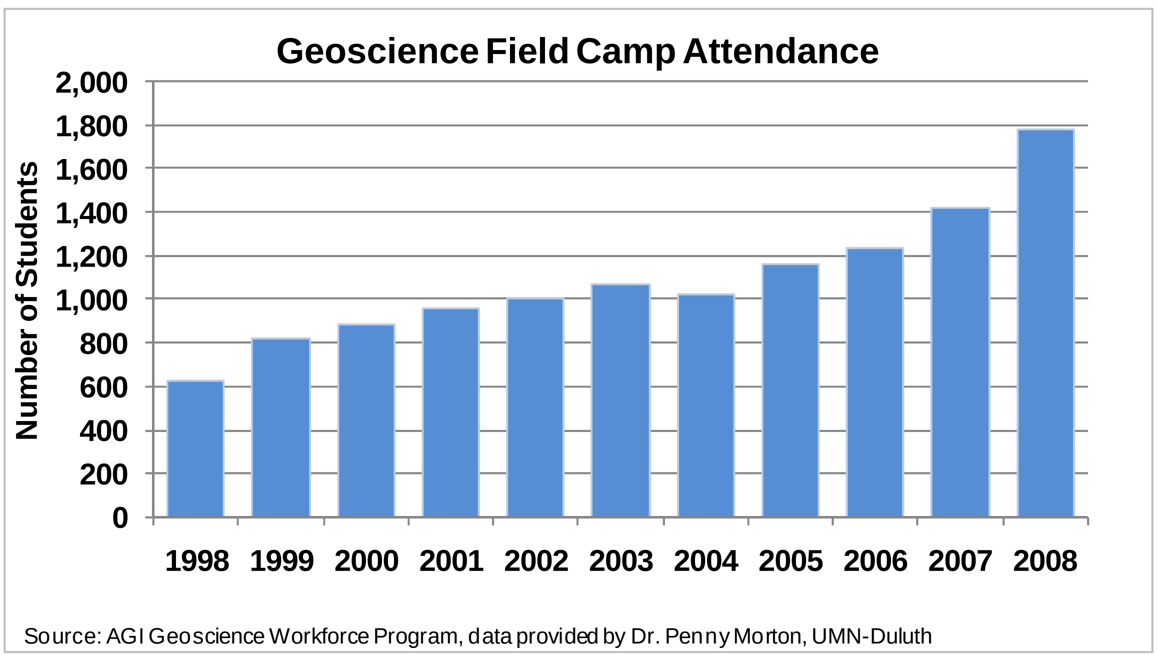
Currently, 56% of all faculty are tenured and 19% are untenured, but in tenure-track positions. Women comprise 14% of tenure-track faculty and 19% of non-tenure-track faculty in geosciences departments compared to 28% in tenure-track positions in all science & engineering fields. The level of female participation in faculty positions has not changed significantly in recent years.

At a national level, the percent distribution of faculty specialties has remained relatively constant since 1999. However, at a regional level, the Northeast and Midwest have experienced growth in the most number of specialties. The largest regional changes in faculty specialties by region were in Planetology, Economic Geology, and Geochemistry.

Field Camp

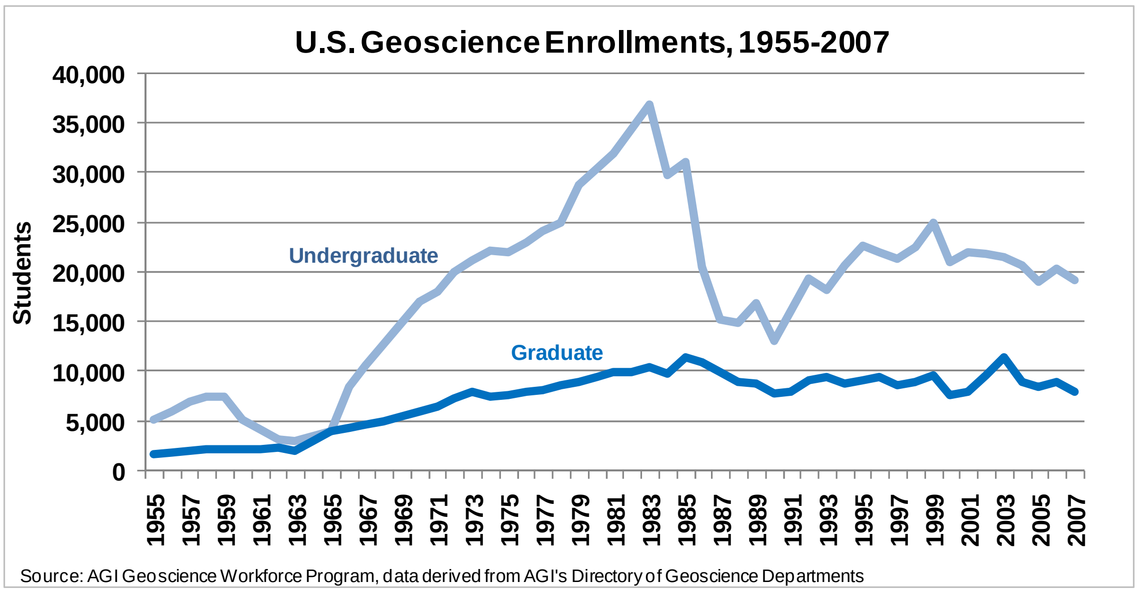
Over the past 10 years, there has been a decrease in the number of departments offering traditional summer field courses. These courses, or field camps, have traditionally served as a central part of undergraduate geoscience curricula. Employers across all sectors of the geosciences continue to either require or desire field camp or comparable field experience in new hires. The overall decline in field opportunities has increased the challenge of identifying fully-qualified new hires.

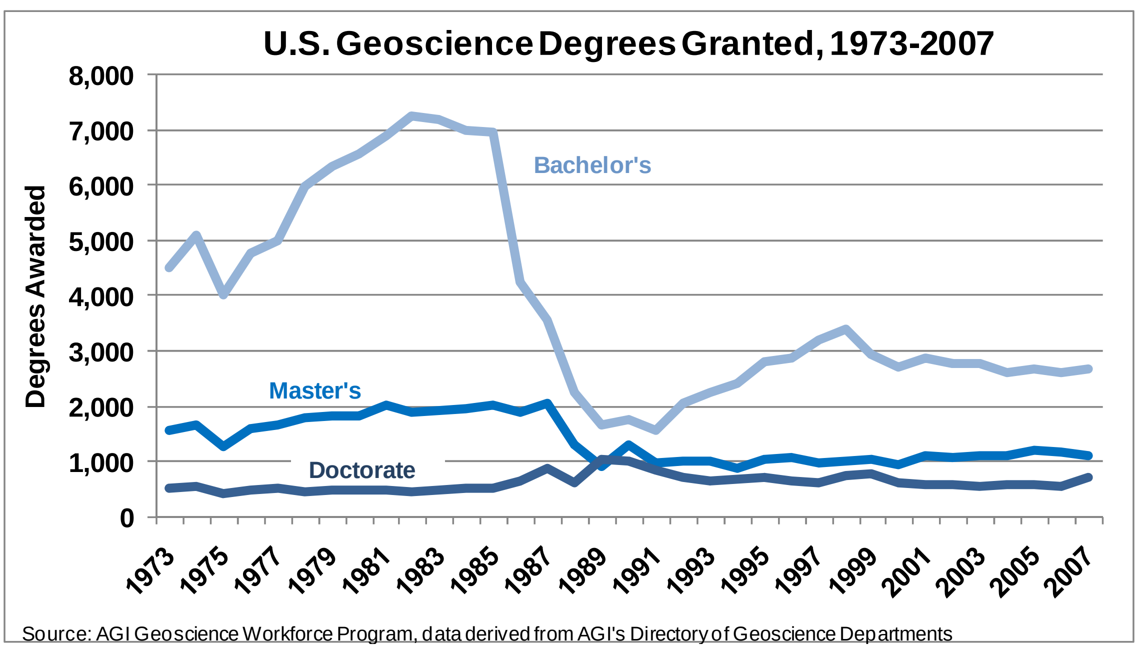
The current number of schools offering summer field camps represents less than 15% of the 695 schools listed in AGI's 2006 Directory of Geoscience Departments in the United States. In 1985 and 1995 close to 35% of schools offered summer field courses for geoscience students. There are several reasons for the decline in the number of departments offering traditional summer field camp experiences, including increased costs of liability insurance, changes in academic focus/priorities as departments merge with other disciplines (e.g. geography or environmental science), and increased costs to the department for student support and faculty salaries. However, despite the decrease in the number of geoscience departments offering summer field camps, total field camp attendance has increased over the past 10 years. At a regional level, the Northeast has experienced the largest percentage increase in attendance (76%) over the same period of time. However, the Midwest has consistently had the largest field camp attendance over the past 10 years.



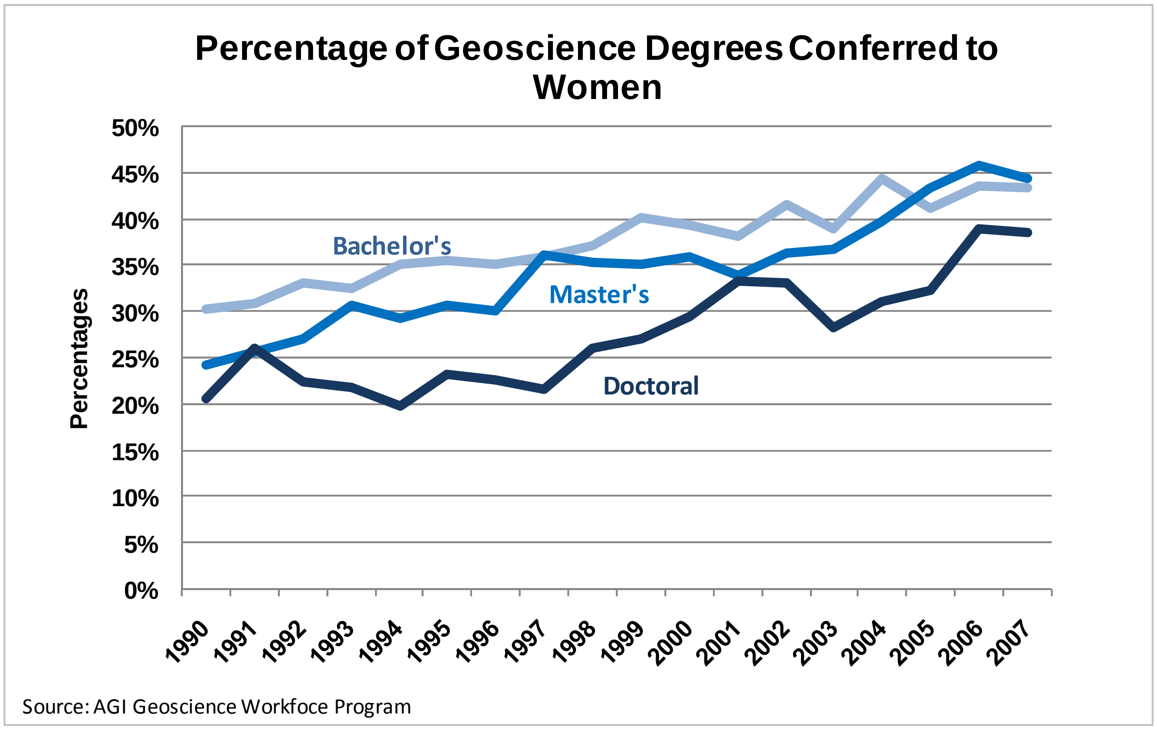
Enrollments and Degrees

The number of students enrolling in geoscience programs in U.S. colleges and universities has remained relatively steady over the past few years, with 19,216 undergraduates and 7,944 graduates enrolling in 2007. Degrees granted in the geosciences has remained relatively constant since 2000, with one exception of new doctorates in 2007 which increased by over 30%. This sharp increase mirrors the influx of entering graduate students in 2003 and 2004 following the bust of the dot-com bubble. When compared with other science & engineering fields, the geosciences have lower degree completion rates for Bachelor's degrees (13% compared to 59%), comparable rates for Master's degrees (20% compared to 19%) and higher doctoral degree completion rates (20% compared to 9%).

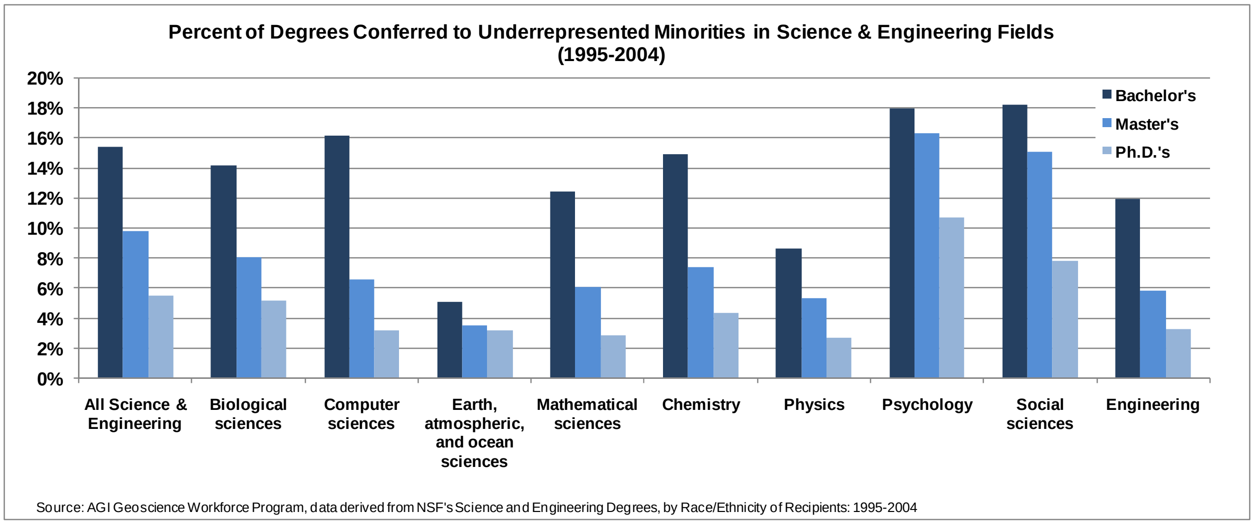




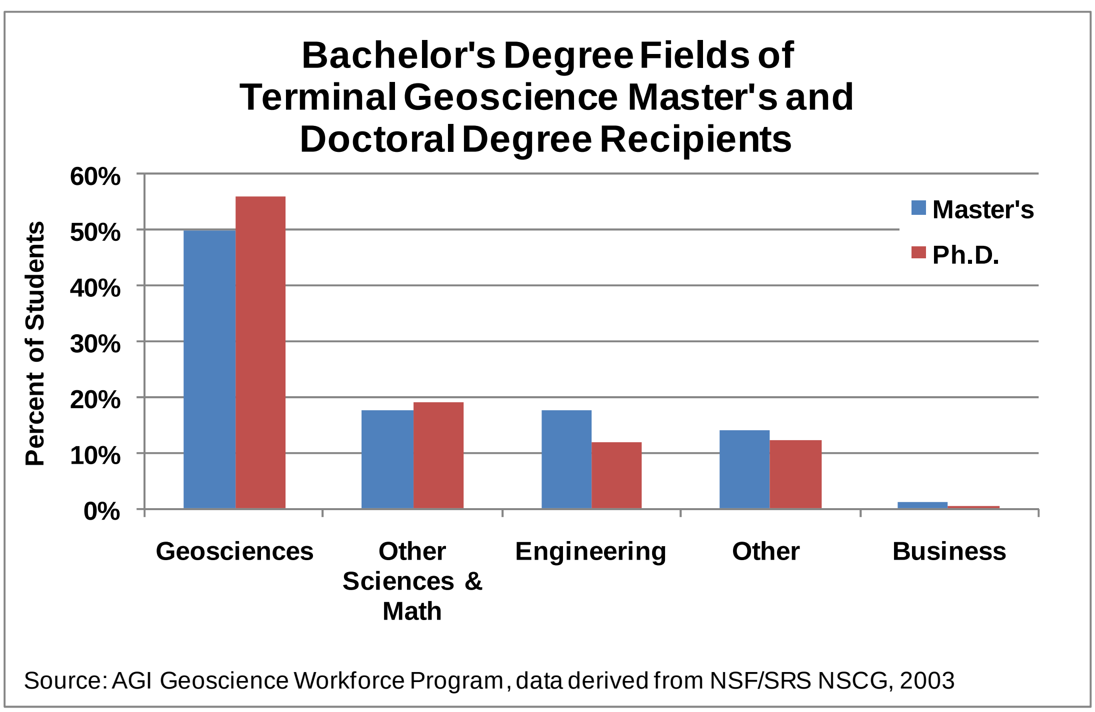
Although the trend in geoscience degrees granted has remained steady, the percentage of geoscience degrees conferred to women has increased over the past 20 years. In 2007, women earned 43% of all geoscience degrees.

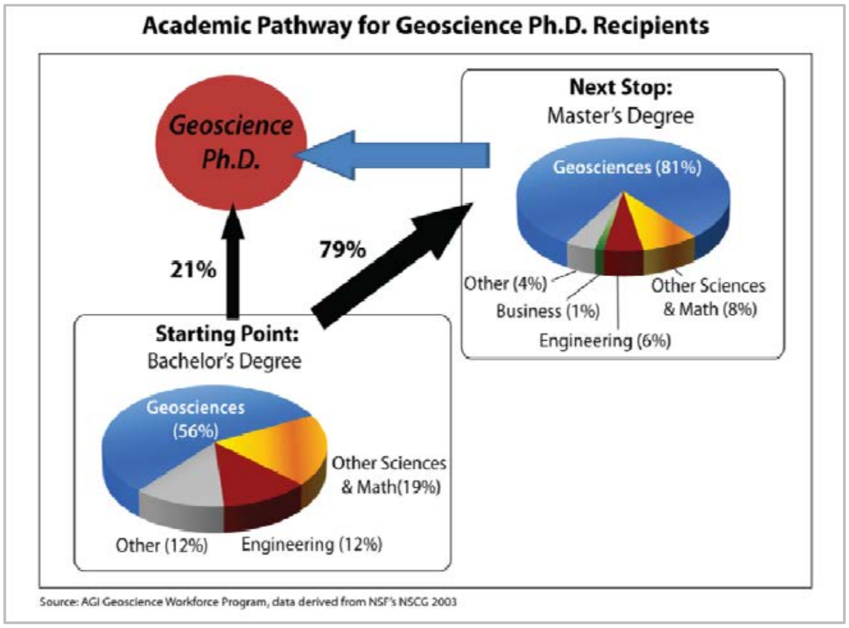


Underrepresented minorities earn a small percentage of geoscience degrees. When compared with other science & engineering fields, the geosciences confer the lowest percentage of bachelor's and master's degrees to underrepresented minorities. However, at the doctoral level, the geosciences confer a higher percentage of degrees to underrepresented minorities than do mathematics and physics and approximately the same percentage as engineering and computer science. Of all underrepresented minorities, Hispanics earn the largest percentage of geoscience degrees. This may be partly driven by the geographic distribution of geoscience departments in regions where there are large Hispanic enrollments at local universities, such as the southwestern U.S. This geographic distribution may also account for the low participation rates of African Americans in geoscience programs since there are few geoscience programs at universities and community colleges in regions where African American students attend universities, such as the southeastern U.S.



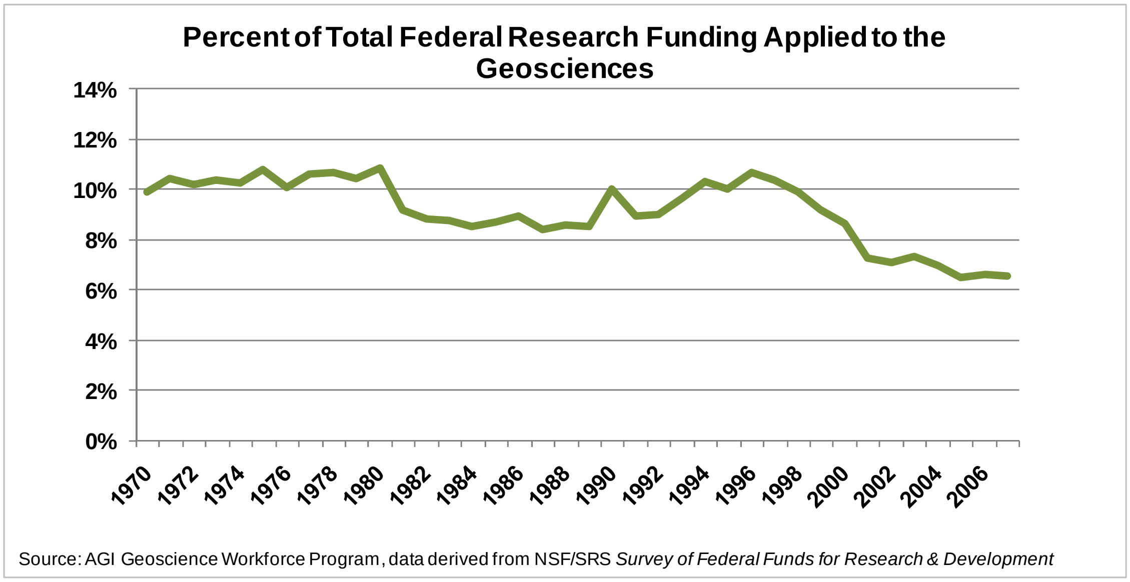
The academic backgrounds of individuals with geosciences master's or doctoral degrees are similar. Both groups have comparable percentages of Bachelor's degrees in business (~1%), engineering (12% to 17%), geosciences (50% to 56%), other science & mathematics (18% to 19%), and other degree fields (12% to 14%). Also, 9% of geoscience Master's degree recipients and 4% of geoscience doctoral degree recipients have an Associate degree. Fourteen percent of individuals with terminal geoscience Master's degree have a second Master's degree, and most geoscience doctorates (79%) have a Master's degree.

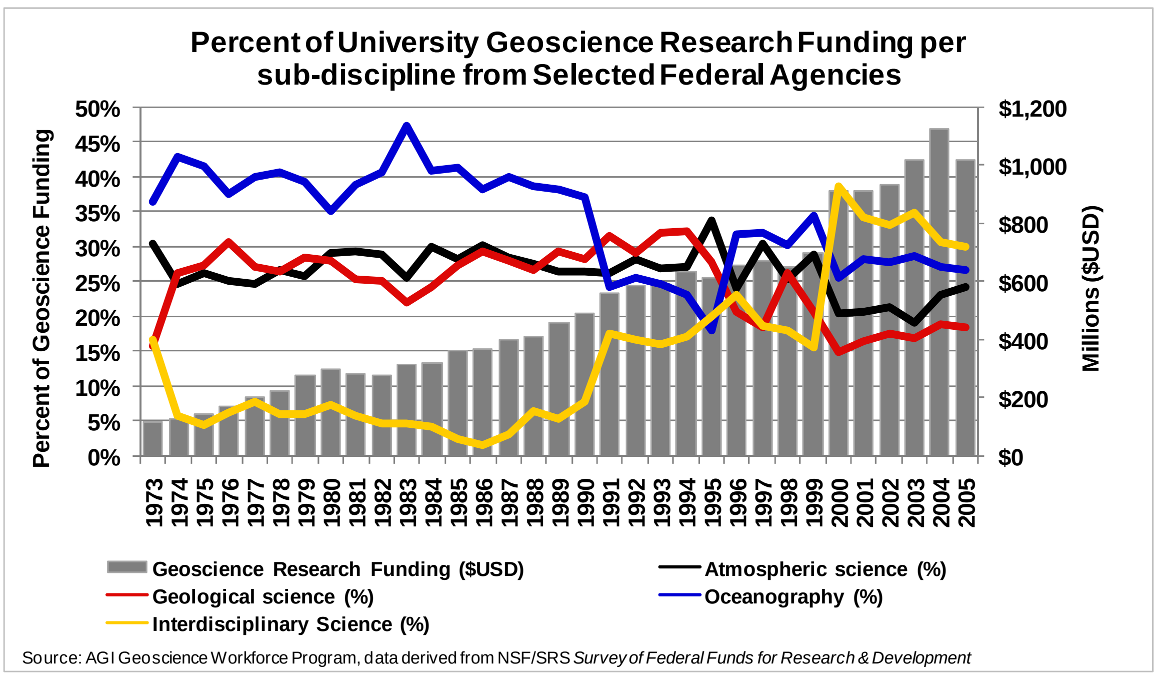


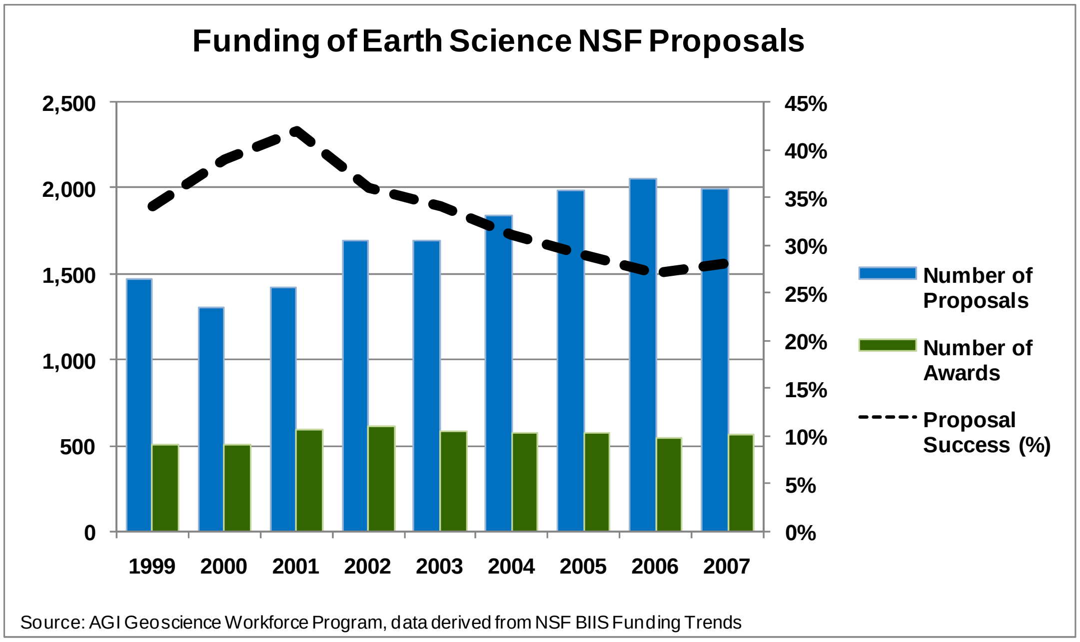


Funding Availability

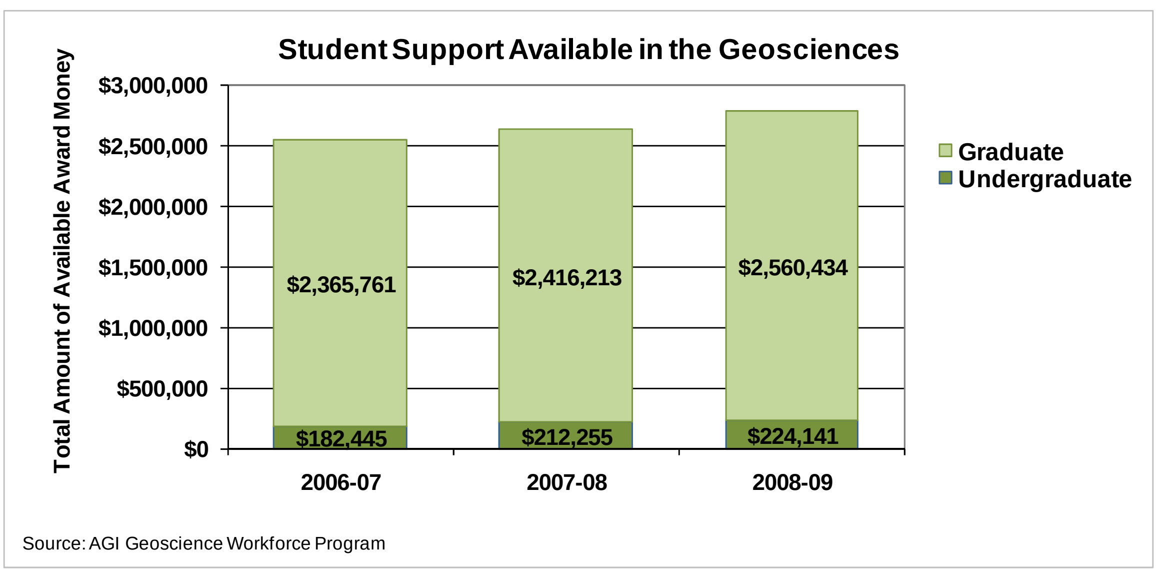
Research funding has become the key to the growth and health of most science programs at colleges and universities in the United States. One of the complicating trends along with declining faculty and student density is that the percentage of total federal funding applied to geoscience research has declined since 1980. Despite this trend, the total amount of research funding applied to the geosciences at universities has increased since 1973. Within the geoscience funding pool, interdisciplinary research has received the largest portion of geoscience funding since 2000 while research in geological sciences and atmospheric sciences has decreased since 1995. Since 1999, NSF reports that the proportion of geoscience funds applied to geological science research (Earth Science proposals and awards) has increased to just below 30%. However, the funding rate for Earth Science proposals submitted to the National Science Foundation has decreased steadily since 2001; the number of proposals has increased by 36% whereas the total number of Earth Science awards has only increased by 11%.


Percent of Total Federal Research Funding Applied to the Geosciences
14%
12%
10%
8%
6%
4%
2%
0%
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
Source: AGI Geoscience Workforce Program, data derived from NSF/SRS Survey of Federal Funds for Research & Development


Percent of University Geoscience Research Funding per sub-discipline from Selected Federal Agencies
Percent of Geoscience Funding
Millions ($USD)
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
$1,200
$1,000
$800
$600
$400
$200
$0
1973
2005
Geoscience Research Funding ($USD)
Atmospheric science (%)
Geological science (%)
Oceanography (%)
Interdisciplinary Science (%)
Source: AGI Geoscience Workforce Program, data derived from NSF/SRS Survey of Federal Funds for Research & Development



Additionally direct support for geoscience students has increased over the past two years. The trend is expected to continue in 2008 to 2009 with a projected 6% increase in available funds. These opportunities for student support include funds from government agencies (60%) and non-profit societies (40%, which includes support from private foundations and companies). Graduate student support comprises 91% of all awards in the 2007 to 2008 academic year: over $2.4 million spread across 570 individual awards. The largest student support program is the NSF Graduate Student Fellowship program. This program provided more than $1.13 million dollars in support to geoscience graduate students in 2007 from a total program budget of $40.5 million.

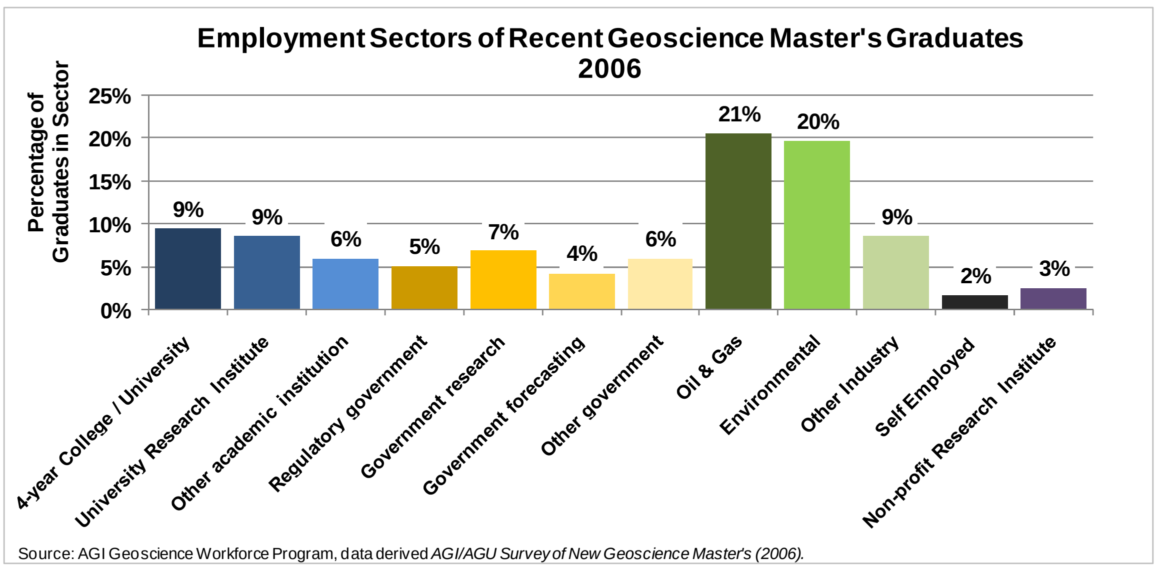


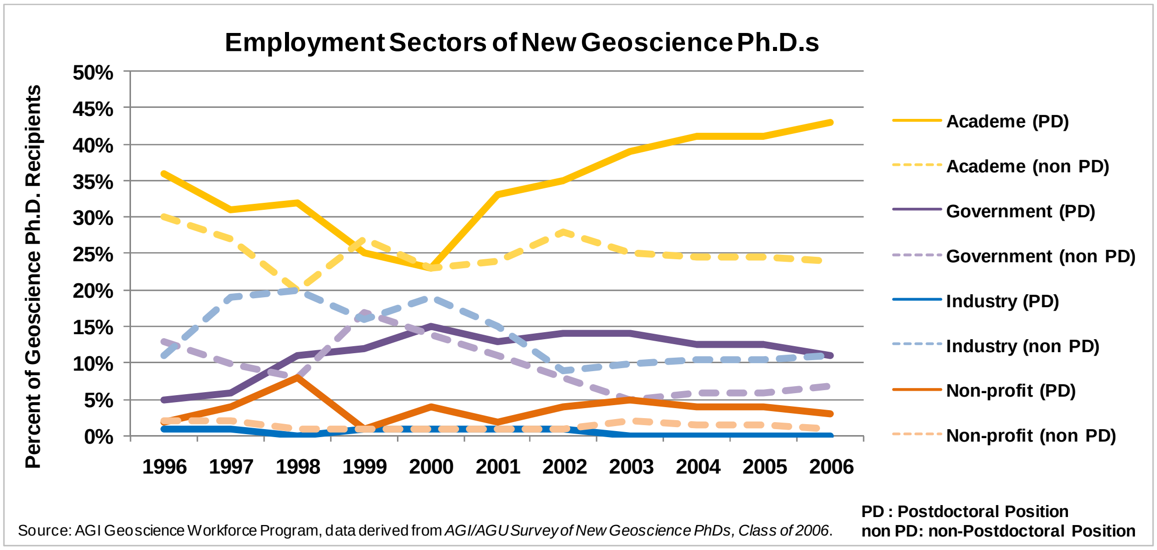
Trends in the Geoscience Workforce

Student to Professional Transition

Perceptions of career pathways can influence students' career choices. In an AGI/AGU survey of new Master's degree and Ph.D. recipients, 81% of doctoral geoscience students searched for jobs in academia, 45% in the government, and 31% in the private sector. This trend of preference for academia and government over the private sector is also evident in the attitudes of Ph.D. students towards these industries and in the employment sectors of recent graduates.

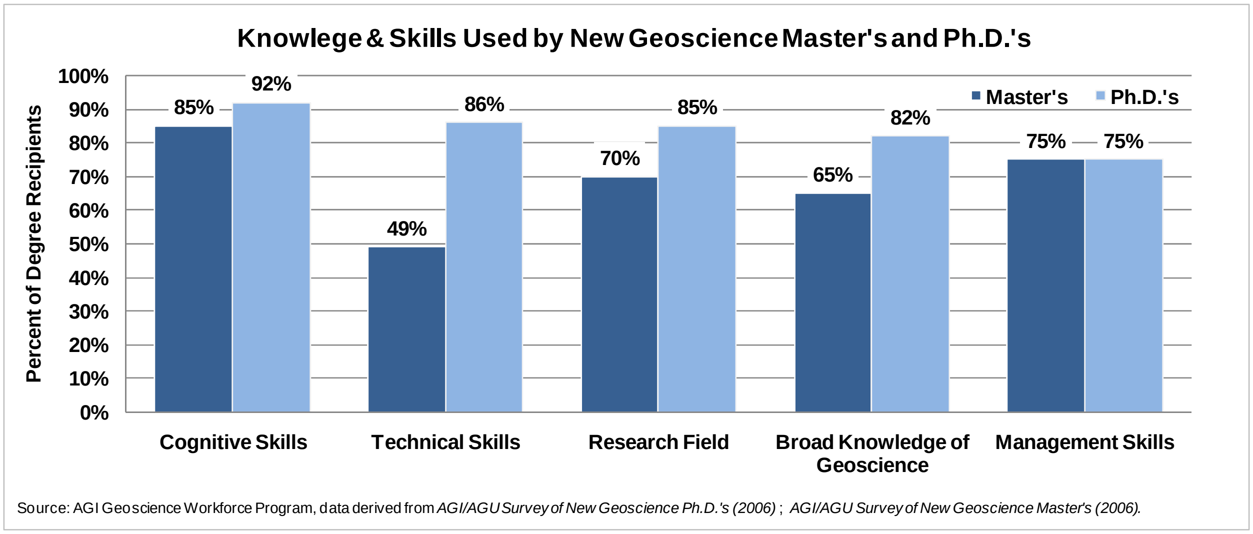
Geoscience Master's students however were less picky in their job search: 58% searched for jobs in academia, 55% in the government, and 35% in the private sector. As with geoscience doctoral students, the sectors in which geoscience Master's students searched for jobs were similar to their perceptions of different employment sectors. However, half of geoscience Master's graduates found initial employment in the private sector (21% oil & gas industry, 20% environmental industry, and 9% in other private sector industries). This may be driven by the high percentage of students with a positive perception of employment in the environmental industry (61%) and of the petroleum industry (42%).





Geoscience starting salaries were competitive with other science & engineering fields in 2007. Bachelor's geoscience graduates, generally employed in the environmental and hydrology industry, earned an average of $31,366 p.a. compared to $31,258 for life scientists and $32,500 for chemistry students. Recent Master's recipients saw the highest starting salaries in the oil & gas industry, with an average of $81,300 p.a., according to a new study of recent geoscience graduates by AGI and the American Geophysical Union. This salary level is significantly higher than the average starting salary of all science Master's degree recipients, who earned an average of $46,873 p.a. New doctorates in all fields of science earned an average of $62,059 p.a. in the private sector, while new geosciences doctorates commanded an average salary of $72,600.

Not surprisingly, a higher percentage of geoscience Ph.D. graduates use cognitive skills, technical skills, and use knowledge from their research field as well as a broad knowledge of geoscience. In part, this may be due to the fact that the majority of Ph.D. graduates enter into academia where these skills, developed during their academic training, are continued to be used. The majority of geoscience Master's graduates find work in the private sector or in government positions where specific technical skills may not be utilized as much as cognitive skills. Of note is the high percentage of geoscience Master's graduates that use knowledge from their research field and those who use a broad knowledge of the geosciences in their jobs.

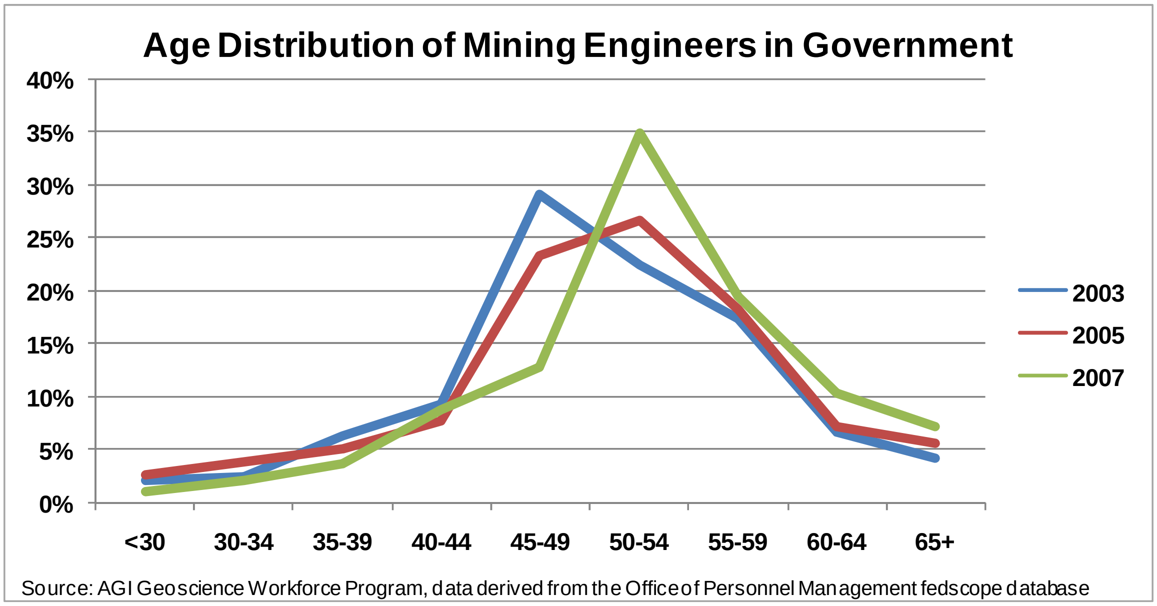


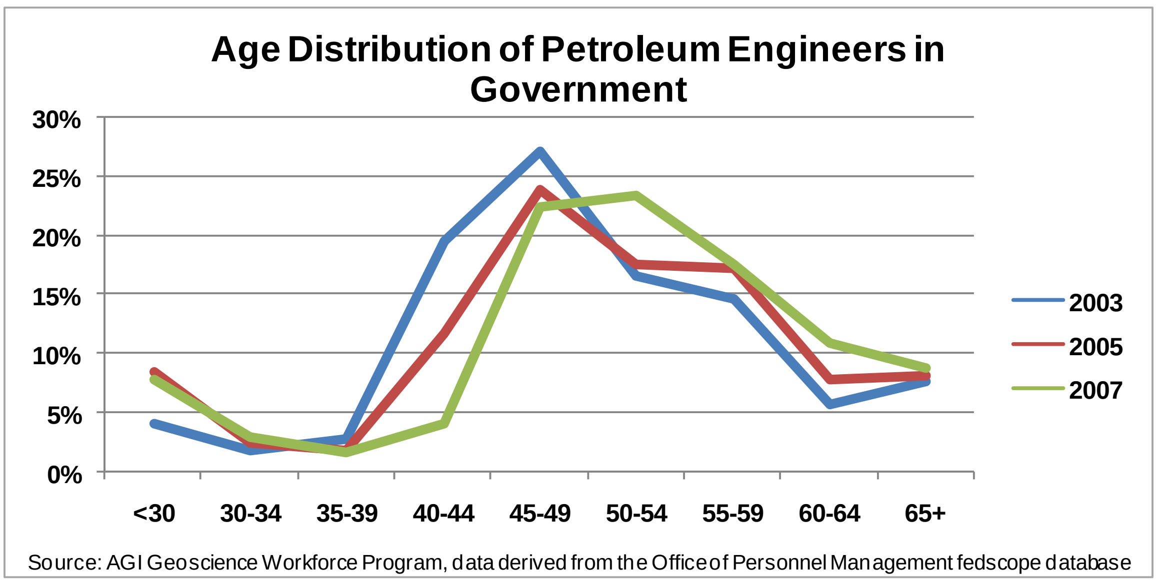
Geoscience Workforce Trends

Employment projections from the Bureau of Labor Statistics indicate an overall 19% increase in all geoscience jobs between 2006 and 2016. The increase varies among industry with the professional, scientific, and technical services industry having the highest increase in geoscience employment (47%).

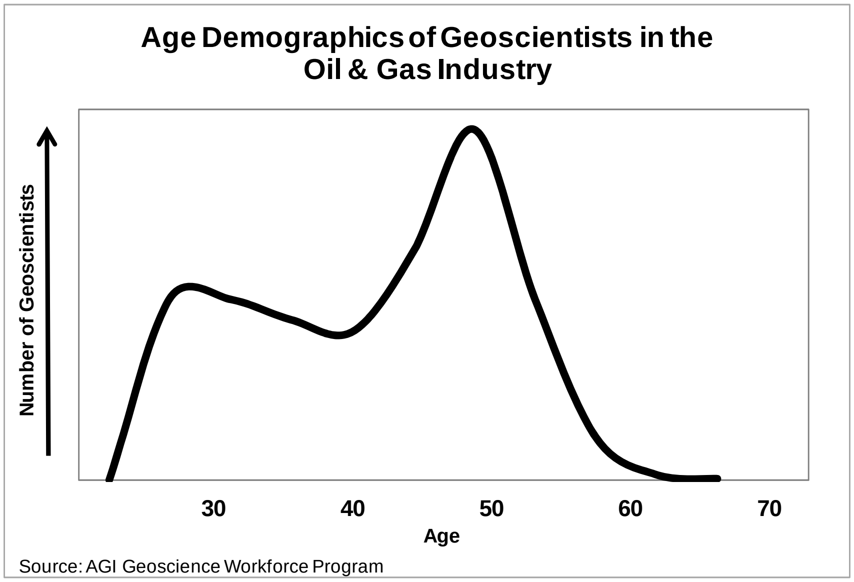
However, trends in the supply of new geoscience graduates have not increased over the past 10 years, and there is no indication that they will increase to meet the projected demand of geoscientists by 2016. Age demographic trends indicate that the majority of geoscientists in the workforce are within 15 years of retirement age. Data from federal sources, professional societies, and industry indicate the imbalance of the age of geoscientists in the profession. The percentage of geoscientists between 31 and 35 years of age is less than half of geoscientists between 51 to 55 years old.

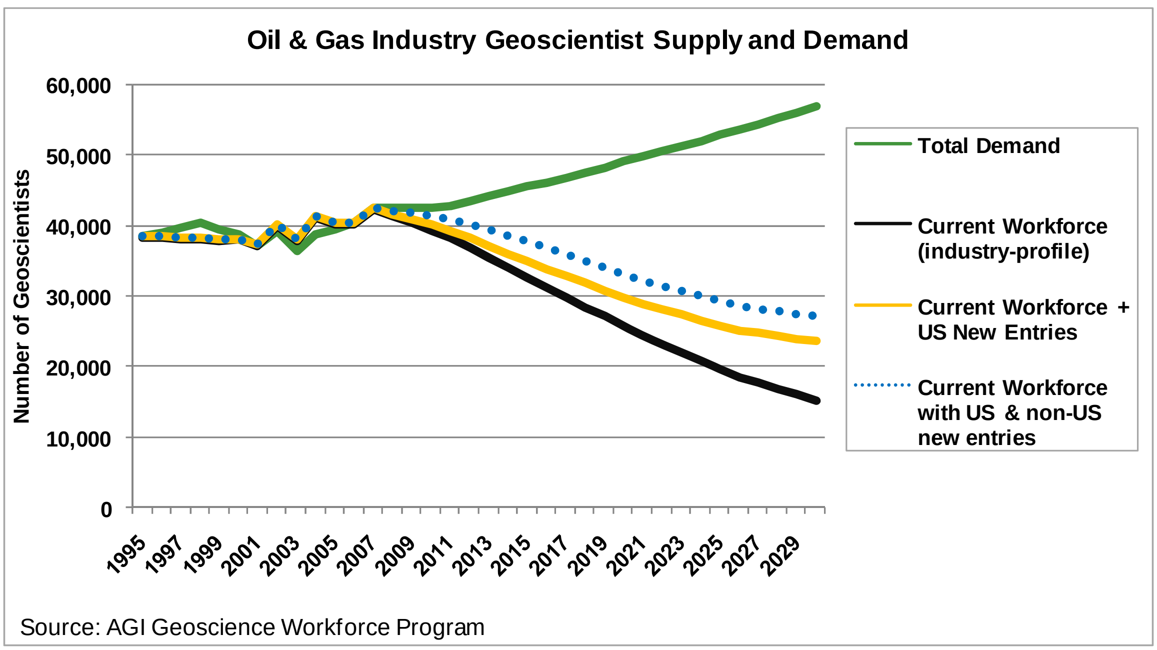
All geoscience occupations in the government, with the exception of meteorologists and oceanographers, experienced an age shift towards the 50 to 54 year old age group between 2003 and 2007. This shift is most pronounced in the age demographics of mining engineers and petroleum engineers.



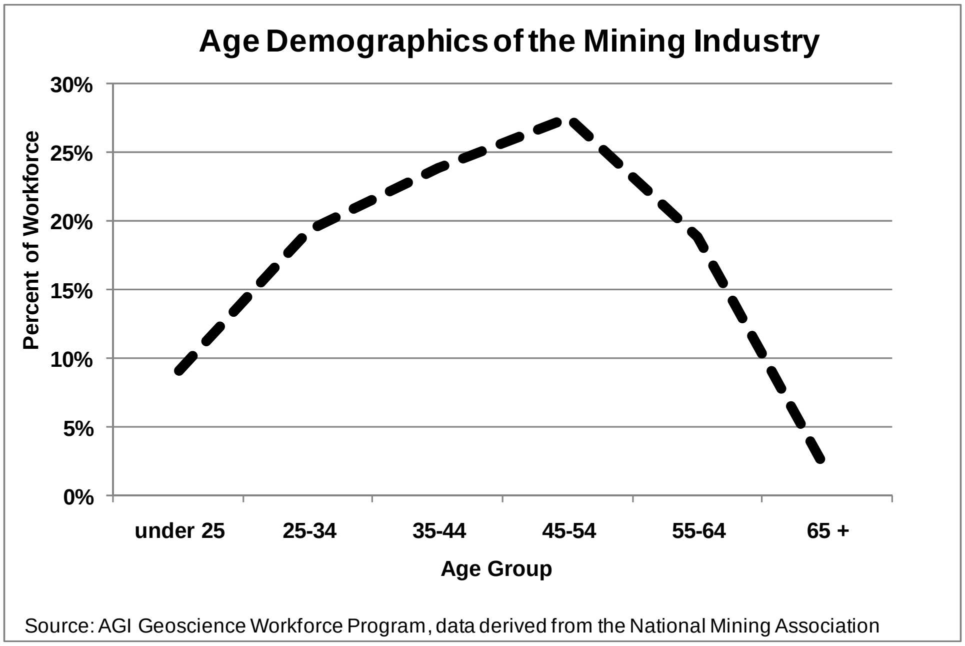


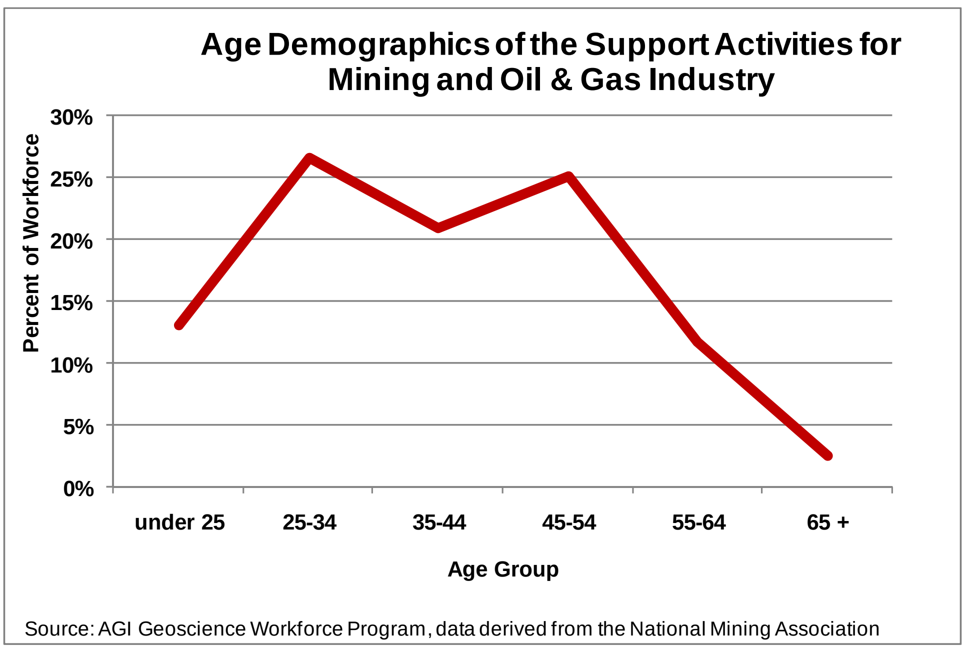
In oil & gas companies, which typically offer the highest salaries of all geoscience employing industries, the supply of new geoscientists falls short of replacement needs. The number of younger geoscientists in their early 30's is approximately half the number of those nearing retirement age. Additionally, the supply of geoscientists is not expected to meet the demand for geoscientists over the next 20 years. By 2030, the unmet demand for geoscientists in the petroleum industry is expected to be approximately 30,000 workers.



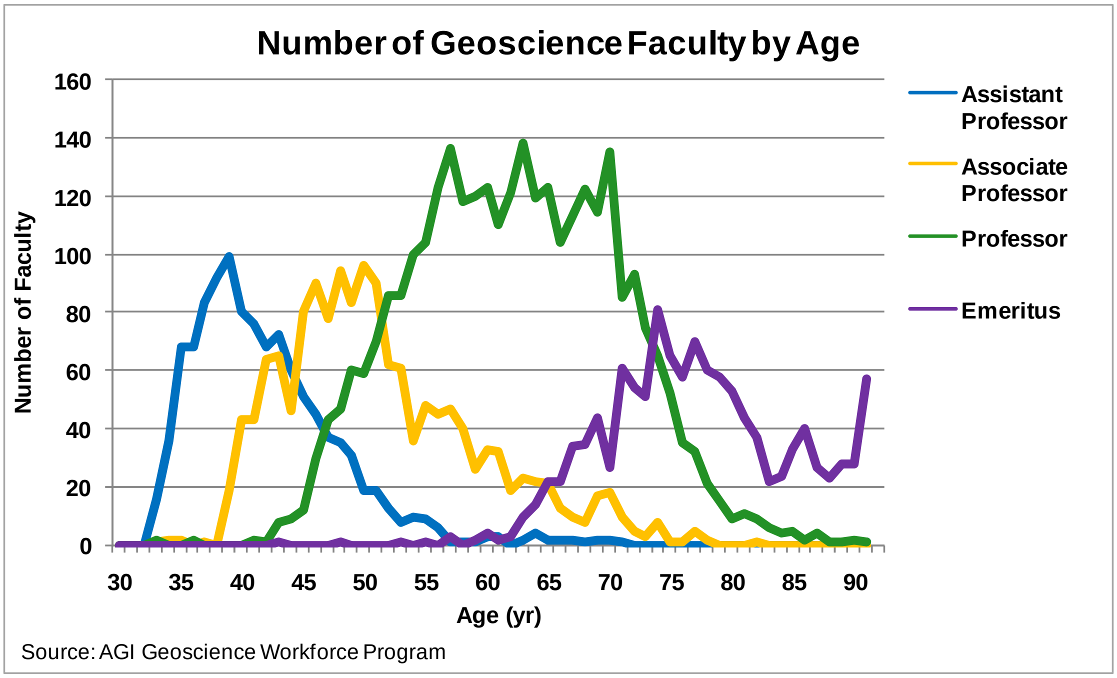


Support activities for mining and oil & gas is the only geoscience employment category with demographics that will provide for the replacement of the older generation of geoscientists who will retire within the next 15 years.





In academia, like other geoscience industries, those with full professorships are older (late 50's to mid 70's) and there are 30% fewer assistant and associate faculty than full professors. Over the next 10 to 15 years, the number of full professors is expected to decline and the number of emeritus faculty increase as full professors retire.

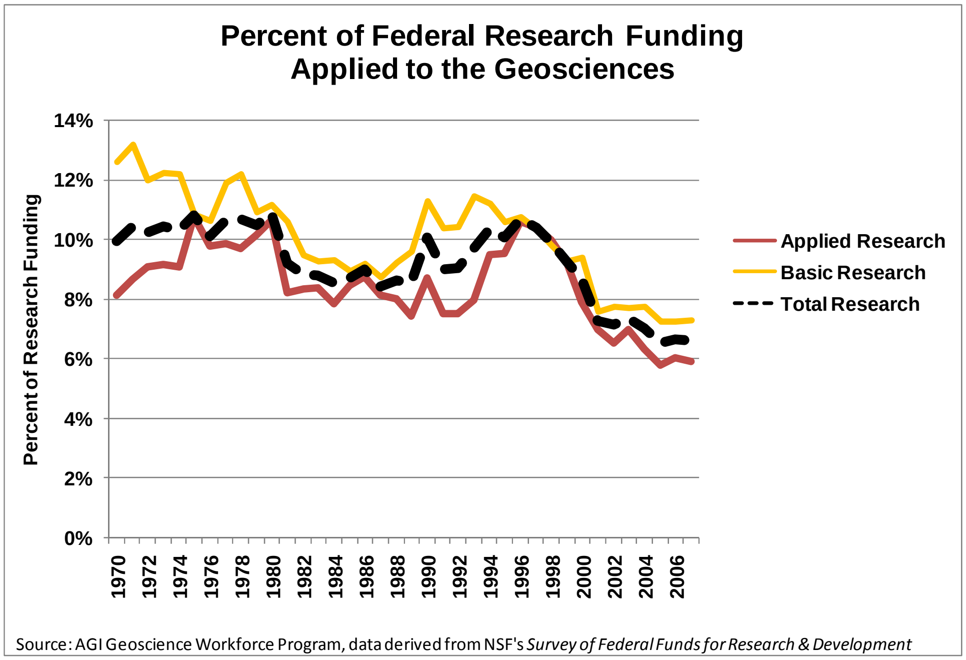


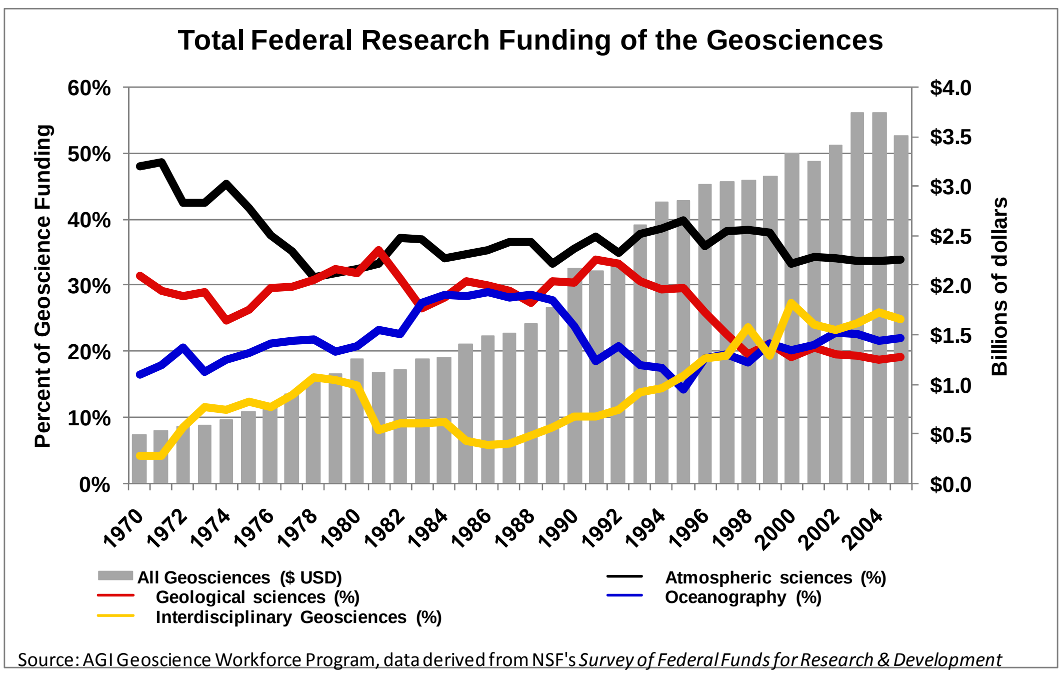
Geoscience Economic Metrics

The overall trend in economic metrics (funding, commodities, gross domestic product, productive activity, and market capitalization) pertaining to the geosciences indicate steady growth over the past decade despite some fluctuation due to the economic downturns over the past decade.

Funding

Overall, the total amount of federal research funding for geoscience research has increased steadily since 1970, however the percentage of all federal funding for research and development applied to the geosciences has decreased by 3% since 1998. Since 1970, the majority of total federal geoscience research funding has been applied to atmospheric science research. Of note is the increase in the percentage of funding applied to interdisciplinary geoscience research since 1986 which is most apparent in applied research funding data. Total federal research funds are allocated to federal agencies, industrial firms, universities and colleges, non-profit institutions, and federally funded research and development centers.

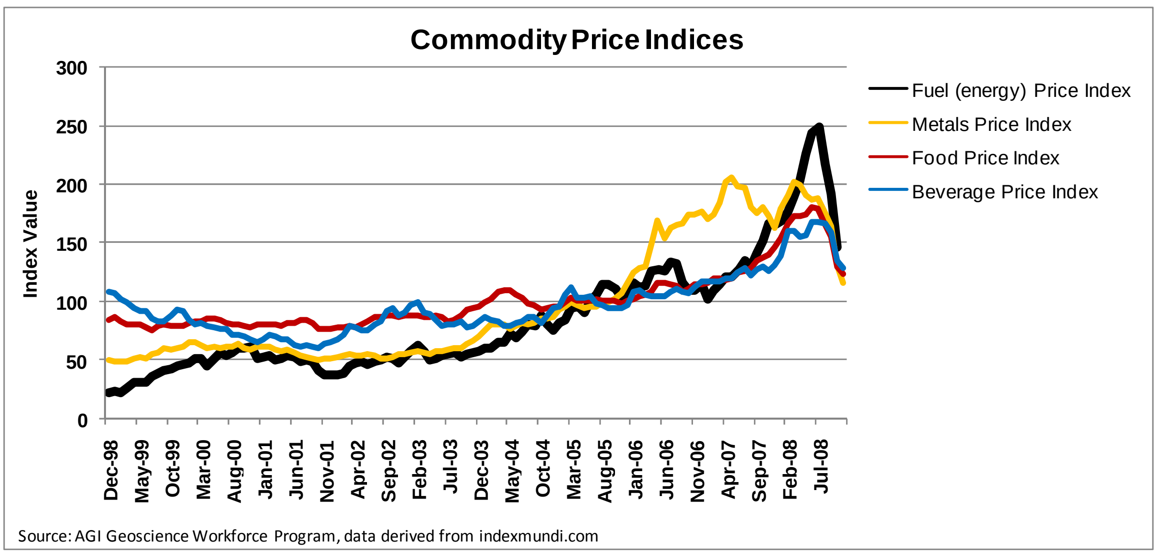




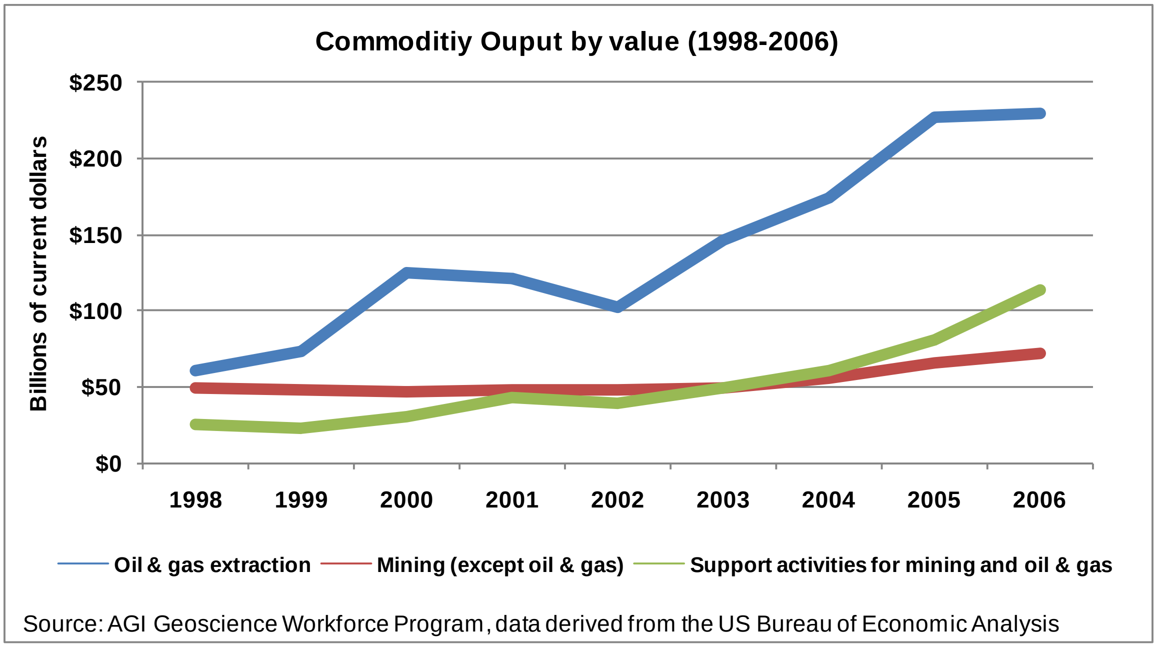
Information pertaining to industry funding of geoscience research is limited. Data pertaining to the trends in company research and development funds are available from the NSF / SRS Industry R&D Funding reports for the mining, extraction and support industries. Unfortunately, this data is aggregated so that distinct trends for these three industries cannot be investigated. However, of interest is the abrupt switch from development to research funding that occurred between 2001 and 2002. This trend is also coincident with the drop in commodity output, gross operating surplus, and taxes on production and imports for the oil & gas extraction industry, a reduction in GDP for all three industries, and a decrease in rig and well counts.

Commodities

A number of geoscience industries are responsible for generating important commodities that keep our society running, such as oil & gas and mining. All commodity price indices generally follow the energy (fuel) price index. However, it is interesting to note that there is some independence of metal price indices from energy price indices. Nickel, zinc, lead, and uranium peaked prior to oil, and tin and aluminum peaked at the same time as oil, thus creating a bi-modal peak in the metal price index.

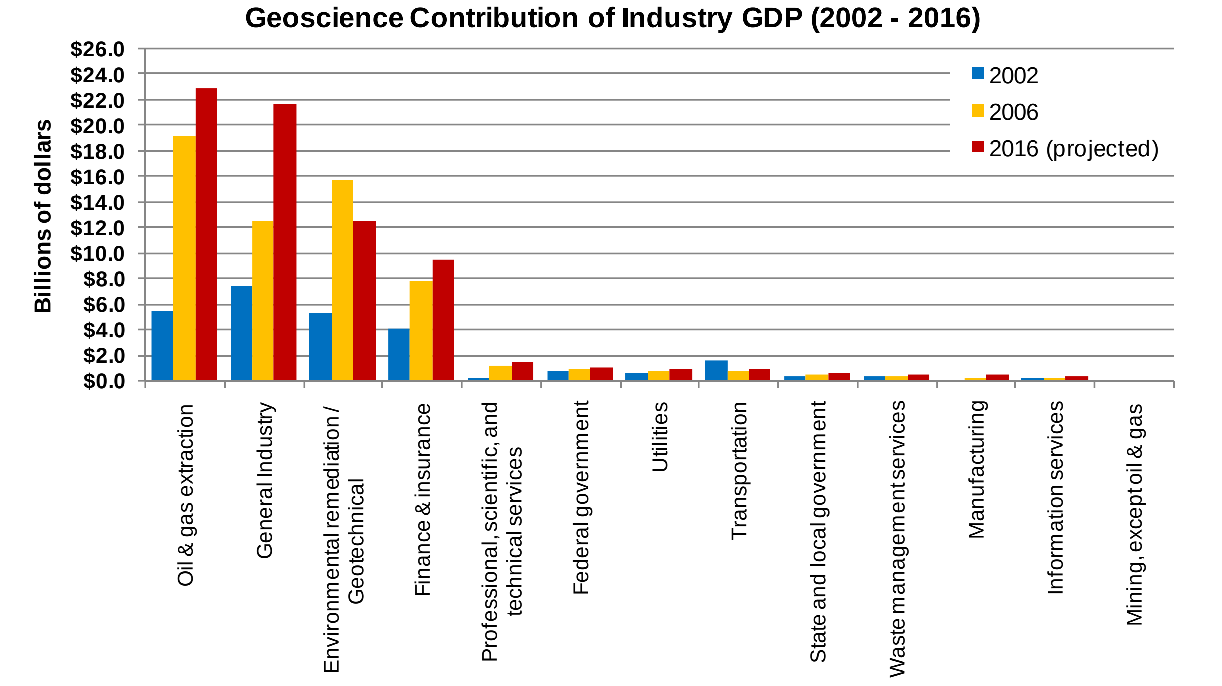


Total domestic commodity output data from 2002 through 2006 indicate a steady increase for both oil & gas extraction and for support activities for mining and oil & gas. Both industries show a drop in commodity output during the last recession between 2001 and 2002. Of note is the leveling off of commodity output for oil & gas extraction between 2005 and 2006 and the increase in output in the support activities for mining and oil & gas industry. Mining (except oil & gas) commodity output is relatively steady until 2003 when it begins to increase slightly until 2006. Interestingly, the support activities for mining and oil & gas industry has the lowest taxes and since 2004, higher commodity output and gross operating surplus than the mining (except oil & gas) industry.



Gross Domestic Product (GDP)

The geoscience component of GDP represents the direct first-order economic contribution of geoscientists to the U.S. economy. The geoscience component of industry gross domestic product more than doubled between 2002 and 2006. Total geoscience GDP in 2002 was $26.6 billion and in $60.7 billion in 2006. Additionally, the geoscience component of national GDP, which increased from 0.25% in 2002 to 0.46% in 2006. Total geoscience industry GDP is projected to increase to $73.8 billion by 2016 with all industries increasing except the Environmental remediation / Geotechnical industry. The Environmental remediation / Geotechnical industry is expected to contract by approximately 20% between 2006 and 2016, with GDP dropping from $15.7 billion in 2006 to $12.6 billion in 2016.

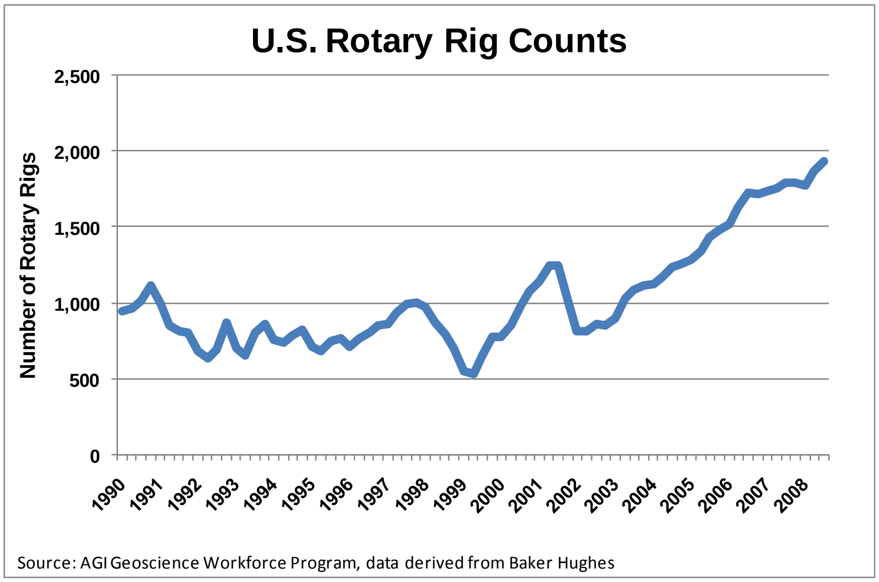


Source: AGI Geoscience Workforce Program, data derived from US Bureau of Economic Analysis, US Bureau of Labor Statistics, and AGI's Directory of Geoscience Departments

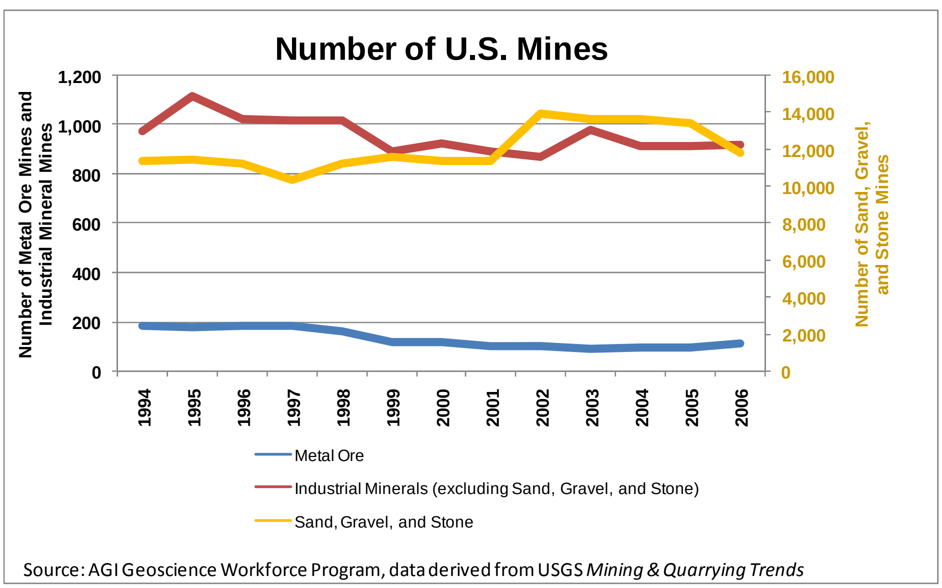
Industry	GDP 2002	GDP 2006	GDP 2016 (projected)
Oil & gas extraction	$5.46	$19.19	$22.93
General Industry	$7.35	$12.51	$21.67
Environmental remediation / Geotechnical	$5.39	$15.70	$12.55
Finance & insurance	$4.02	$7.93	$9.57
Professional, scientific, and technical services	$0.22	$1.26	$1.59
Federal government	$0.79	$0.95	$1.05
Utilities	$0.65	$0.75	$0.93
Transportation	$1.56	$0.75	$0.90
State and local government	$0.33	$0.56	$0.75
Waste management services	$0.32	$0.38	$0.56
Manufacturing	$0.07	$0.29	$0.49
Information services	$0.15	$0.22	$0.38
Mining, except oil & gas	$0.11	$0.11	$0.20
Management of companies and enterprises	$0.02	$0.04	$0.08
Educational services	$0.04	$0.07	$0.07
Support activities for mining and oil & gas	$0.06	$0.03	$0.04
Sum Total	**$26.55**	**$60.74**	**$73.76**
Geoscience Contribution to Total U.S. GDP	***0.25%***	***0.46%***	***0.40%***

Productive Activity

Productive activity in geoscience industries has increased steadily over the past decade. In the oil & gas industry, the number of rigs has increased steadily (with the exception of a drop during 2001-2002) since 1999. The majority of this increase can be attributed to the increase in onshore and natural gas rigs.

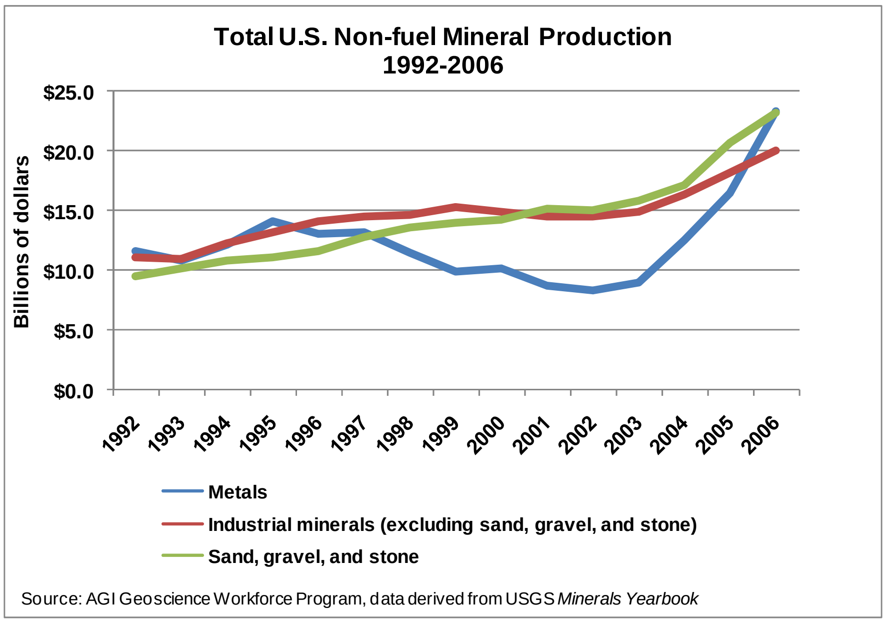


Unlike the oil & gas industry, the mining industry has not seen the same amount of productivity growth. The total growth in this industry was due solely to the increase of 2,000 U.S. sand, gravel, and stone mines. The number of U.S. mineral ore and industrial mineral mines (excluding sand, gravel, and stone mines) slowly decreased between 1997 and 2006.



Sand, gravel, and stone mines increased the amount of material handled between 1994 and 2006 by 1,018 million metric tons. Despite the decrease in the number of industrial mineral and metal ore mines, industrial mineral mines increased the amount of material handled by 810 million metric tons and metal ore mines reduced the material handled by 546 million metric tons between 1994 and 2006.

The value of non-fuel mineral production in the U.S. is primarily driven by industrial minerals (including sand, gravel, and stone). Since 2003, there has been a steady increase in U.S. non-fuel mineral production for both metals and industrial minerals. The dip in non-fuel metals production between 1997 and 2003 was driven by the sharp drop in commodity prices and U.S. exploration and operations.

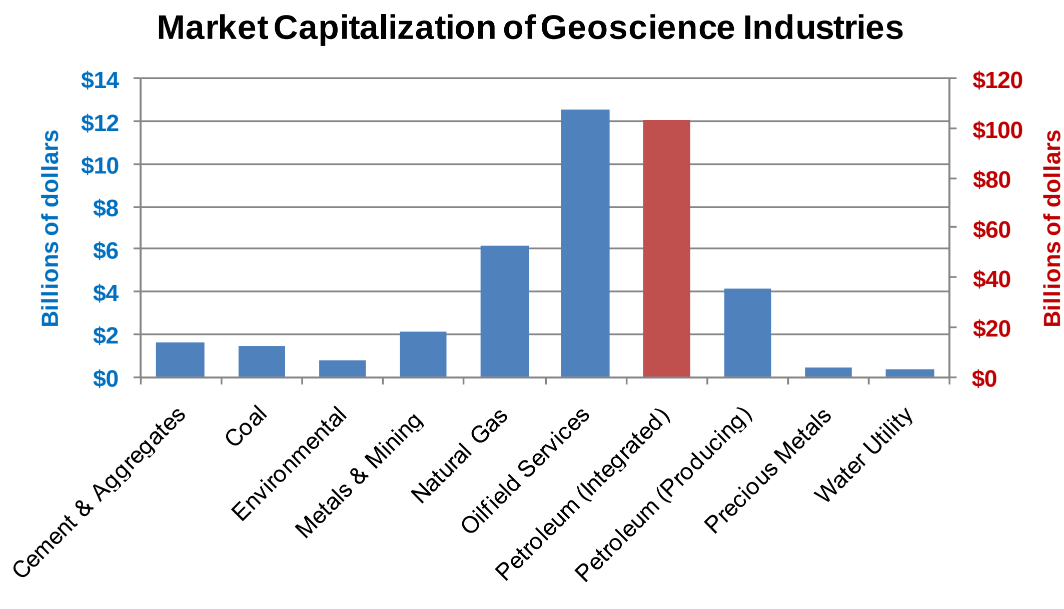


Market Capitalization

Market capitalization of geoscience industries was calculated based on a set of 77 major companies from the following industries:

- Cement & Aggregates
- Coal
- Environmental
- Metals & Mining
- Natural Gas
- Oilfield Services
- Petroleum (both Integrated and Producing)
- Precious Metals
- Water Utility

By far, integrated petroleum companies contribute the most (approximately $100 billion) to the total current market capitalization of geoscience industries, followed by oilfield services ($12 billion) and natural gas companies ($6 million). Water utilities and precious metal companies contribute the least to the total market capitalization at just under $1 billion.



Source: AGI Geoscience Workforce Program, data derived from Google Finance, (12/18/2008)

Future Directions for Geoscience Workforce Analysis

AGI has developed resources to both engage students in their environment and to present the geosciences in a socially-relevant context. These outreach activities address issues that have arisen from the initial data compiled in this report, and compliment ongoing data analysis efforts at AGI. For example, AGI has produced career information packets for prospective geoscience majors to assist geoscience departments in recruiting new students at the university level. In addition, AGI is directly reaching students through Web 2.0 applications such as Facebook and YouTube, and is developing outreach materials that target high school and community college students and their parents.

Future studies to assess the efficacy of these programs and to identify the reasons that students transfer into and out of geoscience programs are essential for understanding the dynamics involved in student recruitment and retention in geoscience programs. Specifically, the following longitudinal studies, surveys, and data collection are needed:

Initial Employment of Geoscience Graduates

AGI and AGU conducted surveys of graduating Ph.D. students since 1996, and most recently collected data on Master's and Ph.D. students from the class of 2006. These surveys must continue so AGI can continue to track the employment trends of recent graduates over time. Additionally, there is a need for longitudinal studies that track geoscience Bachelor's degree recipients in order to better understand the academic and career pathways of geoscience students.

Geoscience Student Pathways and Decision Points

Surveys given to students who transfer into and out of geoscience programs at both the undergraduate and graduate level will provide vital information about the timing of and reasons for these choices. Survey results can help guide future recruitment efforts as well as curriculum development.

Community colleges represent an untapped resource for geoscience education. Gaining insight into this education system will help increase outreach efforts to a large population of post-secondary students who otherwise may be unaware of the opportunities within the geosciences both in academic and career pathways. Community college surveys of geoscience programs will include data collection on faculty demographics, course curriculum, enrollments, degrees granted, minority demographics, and student career and educational pathways.

Workforce Demand Data

Thanks to successful collaborations with the oil & gas industry, AGI has been able to collect substantial age demographic data and create a more precise model for future geoscientist supply and demand in this industry. This type of data collection needs to be completed for the mining industry and environmental industry.

The “Status of the Geoscience Workforce” Report

The “Status of the Geoscience Workforce” report provides a comprehensive benchmark of the geoscience profession. The report is based on original data collected by the American Geological Institute as well as from existing data from federal data sources, professional membership organizations, and industry data sources. The report synthesizes all available data for the geosciences, from the supply and training of new students, to workforce demographics and employment projections, to trends in geoscience research funding and economic indicators. The report is available as a complete document, as well as on a per chapter basis. It will be available for download from AGI’s website: http://www.agiweb.org/.

Report Summary

This 32 page summary provides an in-depth summary of each chapter of the report.

Chapter 1: Trends in Geoscience Education from K-12 through Community College

This chapter examines the student participation in geoscience education at the K-12 level and includes data on state requirements for earth science education in middle and high school, and data pertaining to the number of earth science high school teachers. The chapter also examines trends in college bound students including SAT scores, aspirations for higher education, and choice of college major. Additionally, this chapter examines the availability of geoscience education at community colleges and examines the trends in Associate degrees conferred from geoscience programs at these institutions.

Chapter 2: Trends in Geoscience Education at Four-Year Institutions

This chapter summarizes all available data pertaining to geoscience enrollments, degrees conferred, field camp attendance, and funding of geoscience undergraduate and graduate students. The chapter also explores trends in department size, faculty numbers and research specialties, and funding of geoscience research at the university level.

Chapter 3: Geoscience Employment Sectors

This chapter explores the transition of geoscience graduates into the workforce, age demographics of the industries where geoscientists work, and projected workforce demand. Data pertaining to the current number of jobs and projected number of jobs in 2016 is also provided, as is current salary information for each profession.

Chapter 4: Economic Metrics and Drivers of the Geoscience Pipeline

This chapter provides data on productive activity (number of oil rigs, mines, etc.), commodity pricing and output, gross domestic product, and market capitalization of the industries where geoscientists work.

Appendix A: Defining the Geosciences

This appendix outlines how geoscience occupations and industries are defined in federal data sources. Additionally, the appendix details the working definition proposed by AGI for tracking the geoscience occupation.

Acknowledgements

The AGI Geoscience Workforce program would like to thank the AGI Foundation for funding of the program and this report. The AGI Geoscience Workforce Program would also like to thank the following people, organizations, companies, and industries that provided data for this report, including:

Dr. Penny Morton, University of Minnesota-Duluth, who provided all field camp attendance data; Barry Jay Katz, ChevronTexaco for the "*2003 Report on the Status of Academic Geoscience Departments*"; American Association of Petroleum Geologists (AAPG); American Geophysical Union; Baker Hughes; College Board; Council of Chief State School Officers (CCSSO); Econostats.com; Energy Information Administration; Google Finance; Indexmundi.com; InflationData.com; Industry and corporate data collaborators; Integrated Postsecondary Education Data System (IPEDS); Kitco.com; National Center for Education Statistics (NCES); National Ground Water Association (NGWA); National Mining Association; National Science Foundation Division of Science Resources Statistics; National Science Foundation Award Database; OANDA.com; Office of Personnel Management; Society of Economic Geologists (SEG); Society of Exploration Geophysicists (SEG); U.S. Bureau of Economic Analysis; U.S. Bureau of Labor Statistics; U.S. Department of Education; U.S. Geological Survey.

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Questions and More Information

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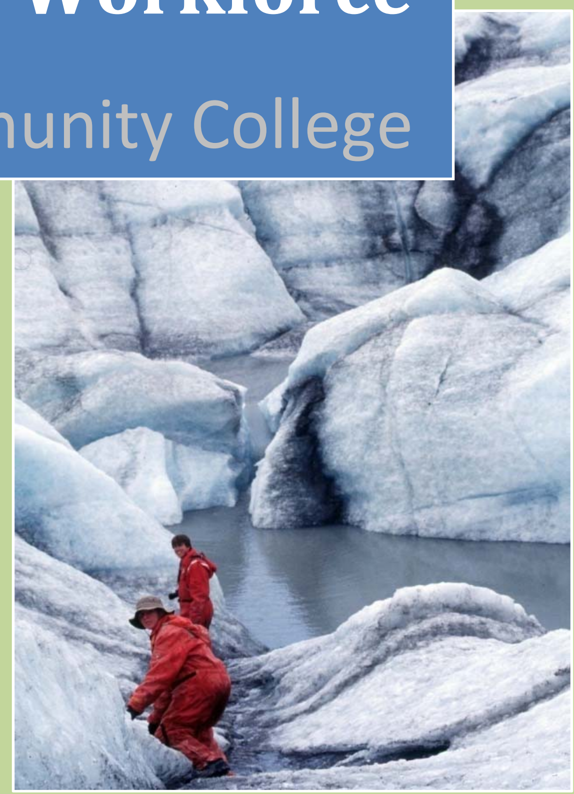
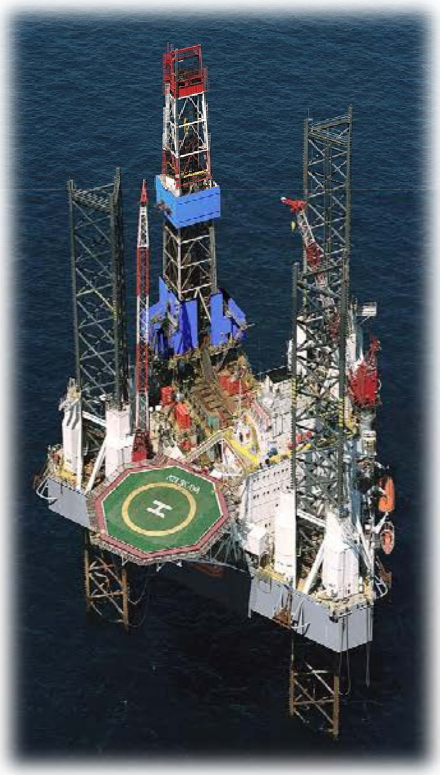
Status of the Geoscience Workforce

Chapter 1: K-12 through Community College





American Geological Institute

February 2009

Table of Contents

Getting Geoscientists into the Pipeline:
Trends in K-12 through Community College Geoscience Education

In the U.S., earth science education at the K-12 level is usually most intensive in grade 6 when national and state standards mandate that students should learn about energy in the Earth system, geochemical cycles, and the origin and evolution of the universe and Earth. However, earth science education trends over the past 18 years in grades 7 to 8 indicate that only 11 to 15 percent of students take a specific earth science course. This may be because earth science is integrated into general science courses or because students fulfill their earth science education requirements in grade 6.

Although earth science is primarily not a required science course in high school, the number of states that include it in the recommended high school curriculum has increased from 15 in 2002 to 24 in 2007. Additionally, the number of states that do not include it in their recommended curriculum has decreased from 10 in 2002 to 6 in 2007. If a high school student takes earth science, it is counted towards the high school graduation requirements in 31 states. For the past 26 years, the percentage of high school students taking earth science courses has never exceeded 25 percent. In comparison, since 1982, enrollments in chemistry and physics have increased to 66 percent and 33 percent respectively, and biology enrollments have remained at approximately 90 percent since 1990. Additionally, the percentage of high school science teachers in biology, chemistry, physics, and earth science has grown in the past 18 years; however, earth science has had the lowest growth rate at 21 percent.

Forty-four percent of college-bound high school students plan to obtain a graduate degree. However, for the past 22 years, only 1.2 percent of SAT test takers each year have indicated an interest in physical science (1%) or interdisciplinary science (0.2%) as a college major. Additionally, college-bound students indicating physical science as their intended college major have outperformed those indicating interdisciplinary science as their college major on both the Verbal and Math sections of the SAT since 1997.

Students at the community college level represent an untapped source of diverse talent for the geosciences. Nine percent of geoscience Master's degree recipients and 4 percent of geoscience Ph.D. recipients have Associate degrees. However, only 14 percent of all U.S. community colleges have degree programs in the geosciences or related physical sciences. Since 1986, the number of Associate degrees conferred by geoscience and related physical science programs has not exceeded 2,000 per year.

Did you know?

- The majority of states include earth science in the curriculum for grades 6 to 8.
- The number of states that require earth science has increased from 5 in 2002 to 7 in 2007.
- For the past 26 years, the percentage of high school students taking earth science courses has not exceeded 25 percent.
- Nine percent of geoscience Master's degree recipients and 4 percent of geoscience Ph.D. recipients have an Associate degree.
- Only 5 percent of U.S. community colleges offer programs in dedicated geoscience programs (i.e. earth science, geology, paleontology, oceanography, atmospheric science, hydrology).

Geosciences in K-12 Education

Earth Science Education in Grades K – 8

Earth and space science education in grades K-5 is integrated into the overall science curriculum. It typically includes such topics as weather, rocks, fossils, planets and earthquakes. Earth science education at the secondary level is usually most intensive in grades 6 through 8 when students learn about energy in the Earth system, geochemical cycles, and the origin and evolution of the universe and Earth. Earth science education trends over the past 18 years in grades 7 and 8 indicate that only 11 to 15 percent of students take a specific earth science course. This may be because earth science is integrated into general science courses or because students fulfill their earth science requirements in grade 6.

According to the AGI's 2007 "National Status Report on K-12 Earth Science Education", all states responding to the survey included earth science in their curriculum for grades 6 to 8. Three states, Oregon, Rhode Island, and Virginia, did not provide data pertaining to earth science education in the middle grades for the 2002 and the 2007 surveys. In 2002, Texas reported that it did not include earth science in its curriculum for grades 6 to8, and Louisiana, Montana, New Jersey, and West Virginia reported that they left the decision to the school districts. In 2007, all five of these states reported that earth science was part of the curriculum for grades 6 to 8.

Earth Science is taught either as a full-year course or is integrated into the science curriculum in grades 6 to 8, and in most states earth science is taught via both methods. However, in California, Idaho, Georgia, Louisiana, Maine, Minnesota, and South Dakota, earth science is taught only as a full-year curriculum. Texas and Oklahoma specified that they did teach earth science in the grades 6 to 8; however, they did not specify which method (full-year or integrated curriculum) was used. Kentucky and Delaware also specified that earth science was taught in grades 6 to 8, but did not specify how it was taught in 2007. Both of their responses to the 2002 survey indicated that earth science was taught using both methods (full-year and integrated curriculum).

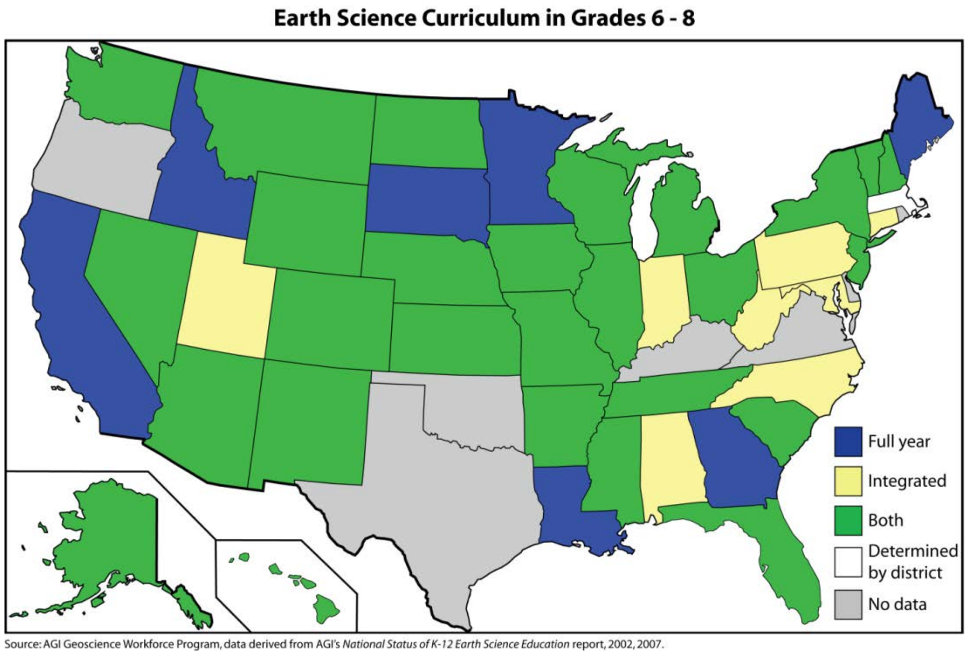


Figure 1.1: Earth Science Curriculum in Grades 6 - 8

Although earth science is taught in the middle grades, for the past 18 years, the trend indicates that only 11 to 15 percent of students in grades 7 and 8 take a specific earth science course. Much of this trend can be attributed to a change in the curriculum for grades 6 to 8 in which specific science courses have been integrated into a general science curriculum. Additionally, some students may fulfill the earth science requirement in grade 6.

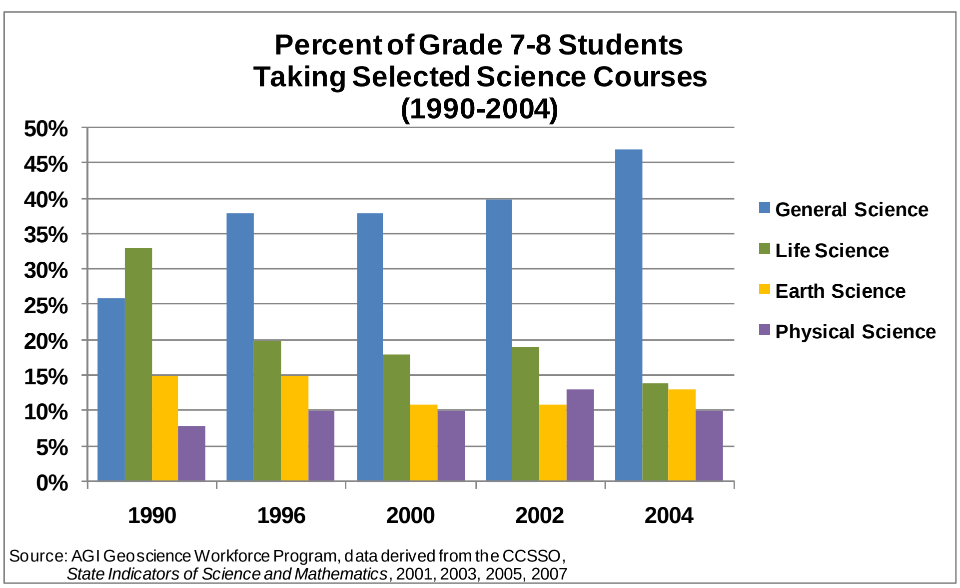


Figure 1.2: Percent of Students in Grades 7-8 Taking Selected Science Courses

Earth Science Education in High School

In high school, earth science is not required in the majority of states. In 2002, only five states required earth science in their high school science curriculum: Kentucky, North Carolina, New York, Pennsylvania, and Wyoming. In 2007, seven states reported that they required earth science in their high school science curriculum: Idaho, Kansas, Kentucky, Indiana, Michigan, North Carolina, and Louisiana. Of the 45 states that did not require earth science in their high school science curriculum in 2002, seventeen now leave the determination up to the school districts and five now require earth science in high school. New York, which required earth science in high school in 2002, now does not require it; however their high school graduation exams cover earth science material. Pennsylvania, which also required earth science for high school graduation in 2002, now leaves the determination up to the school districts.

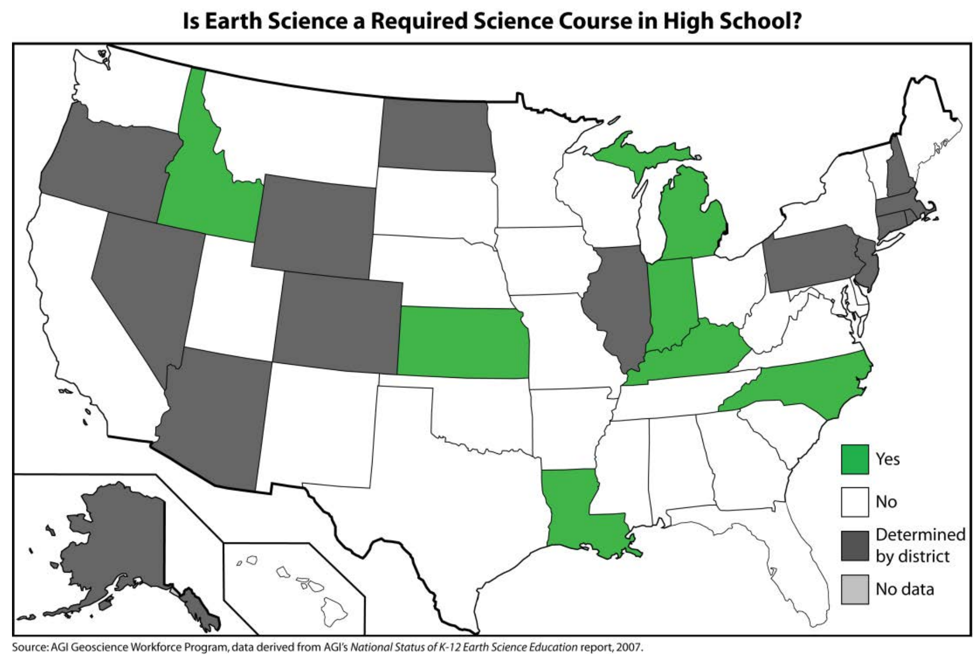


Figure 1.3: Is Earth Science a Required Science Course in High School?

	Is earth science a required course in high school?	
State	**2002**	**2007**
Alaska	No	Determined by district
Arizona	No	Determined by district
Colorado	No	Determined by district
Idaho	No	Yes
Illinois	No	Determined by district
Indiana	No	Yes
Kansas	No	Yes
Louisiana	No	Yes
Massachusetts	No	Determined by district
Michigan	No	Yes

State	Is earth science a required course in high school? 2002	2007
North Dakota	No	Determined by district
New Hampshire	No	Determined by district
New Jersey	No	Determined by district
Nevada	No	Determined by district
New York	Yes	No
Oregon	No	Determined by district
Pennsylvania	Yes	Determined by district
Rhode Island	No	Determined by district
Wyoming	Yes	Determined by district

Table 1.1: States that changed their Earth Science requirements for high school curriculum

Although earth science is primarily not required in high school, it is included in the recommended high school curriculum in twenty-five states, an increase from 14 states in 2002. Currently only six states do not include earth science in their recommended curriculum: Arkansas, Connecticut, Georgia, Iowa, Washington, and West Virginia. This is four states fewer than in 2002. Eight states that did not include earth science in their recommended high school curriculum in 2002 currently either do include it or leave the determination to the school district.

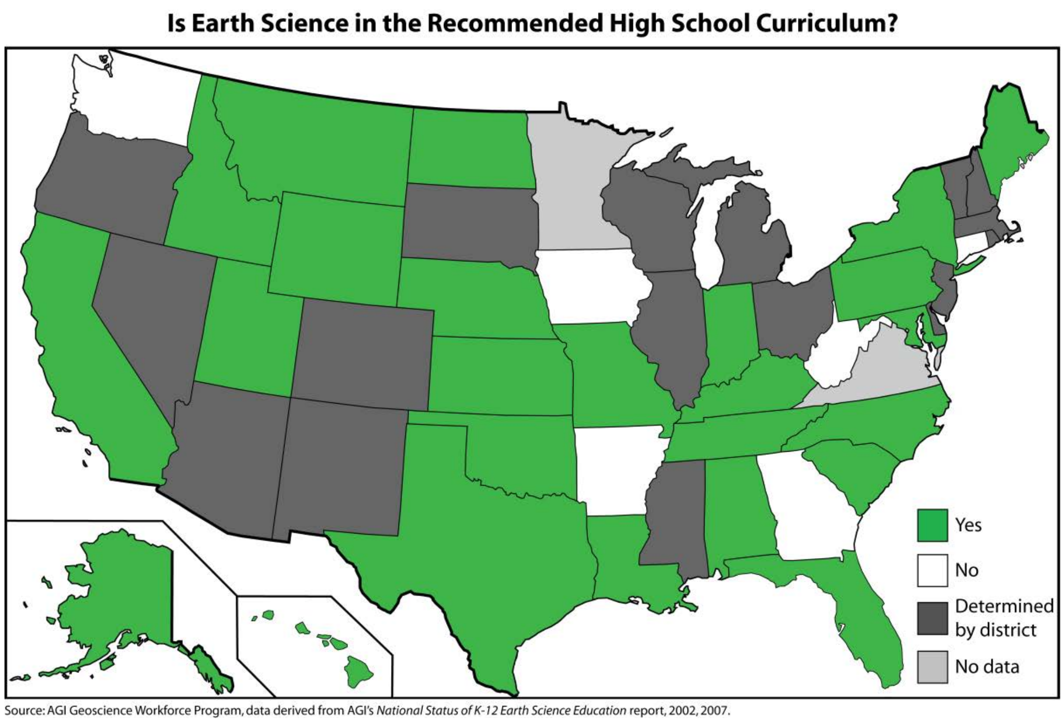


Figure 1.4: Is Earth Science in the Recommended High School Curriculum?

State	Is Earth Science in the recommended high school curriculum? 2002	2007
Colorado	No	Determined by district
Illinois	No	Determined by district
Kansas	No	Yes
Louisiana	No	Yes
Maine	Determined by district	Yes
Michigan	Yes	Determined by district
Mississippi	Yes	Determined by district
Nebraska	No	Yes
New	Yes	Determined by district
New Jersey	Yes	Determined by district
New Mexico	No	Determined by district
Vermont	No	Determined by district
Wisconsin	No	Determined by district
West Virginia	Yes	No

Table 1.2: States that changed their response between 2002 and 2007 for the question "Is earth science in the recommended high school curriculum?"

If a high school student takes earth science, it is counted towards the high school graduation requirements in most states. Washington and South Dakota only count the course if it has a lab component. Since 2002, ten states that did count earth science towards graduation requirements now leave the determination up to the school districts. South Carolina, which did not count earth science toward graduation requirements in 2002, now does, and Arkansas, which did count earth science towards graduation requirements in 2002, now does not. Texas reported that it did not count earth science courses towards high school graduation requirements in both 2002 and 2007.

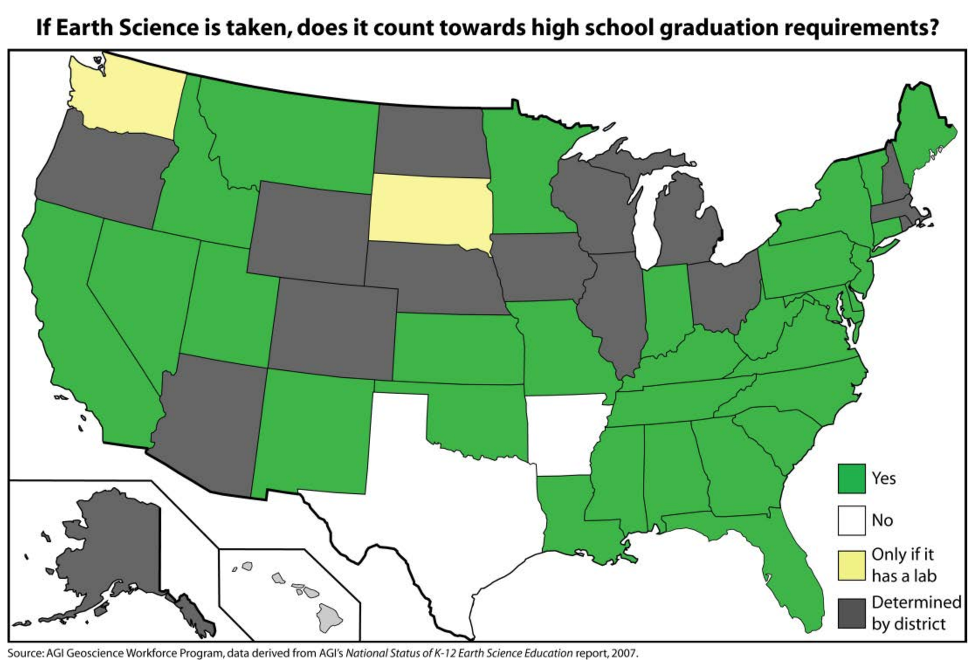


Figure 1.5: If Earth Science is taken, does it count towards high school graduation requirements?

State	If Earth Science is taken, does it count towards high school graduation requirements? 2002	2007
Alaska	Yes	Determined by district
Arkansas	Yes	No
Arizona	Yes	Determined by district
Colorado	Yes	Determined by district
Illinois	Yes	Determined by district
Massachusetts	Yes	Determined by district
Michigan	No	Determined by district
North Dakota	Yes	Determined by district
New Hampshire	No	Determined by district
Ohio	Yes	Determined by district
Oregon	Yes	Determined by district
South Carolina	No	Yes
Wisconsin	Yes	Determined by district
Wyoming	Yes	Determined by district

Table 1.3: States that changed their response between 2002 and 2007 for the question "If Earth Science is taken, does it count towards high school graduation requirements?"

Nationwide trends in grade 9 earth science enrollments indicate a net decline from 1996-1997 to 2003-2004. Fifty-six percent of states that provided data for all survey years reported a decline in grade 9 earth science enrollments, and 39 percent reported an increase.

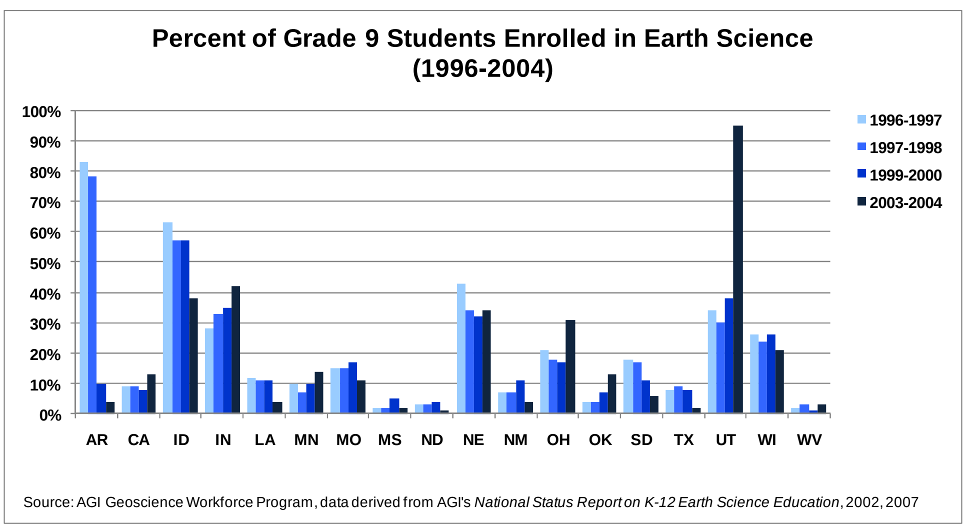


Figure 1.6: Trends in Grade 9 Earth Science Enrollments for Selected States. (Only states that reported values for all time periods are shown.)

Utah, New York, and Pennsylvania lead the nation in percentage of grade 9 student enrolled in Earth Science (Figure 1.6). Of the sixteen states shown in gray in Figure 1.6, fourteen did not reported data on grade 9 enrollments for any of the survey years. Two of the gray states shown in Figure 1.6, Maine and Delaware, last reportedgrade 9 enrollment percentages in 1996-1997 (58% and 15% respectively).

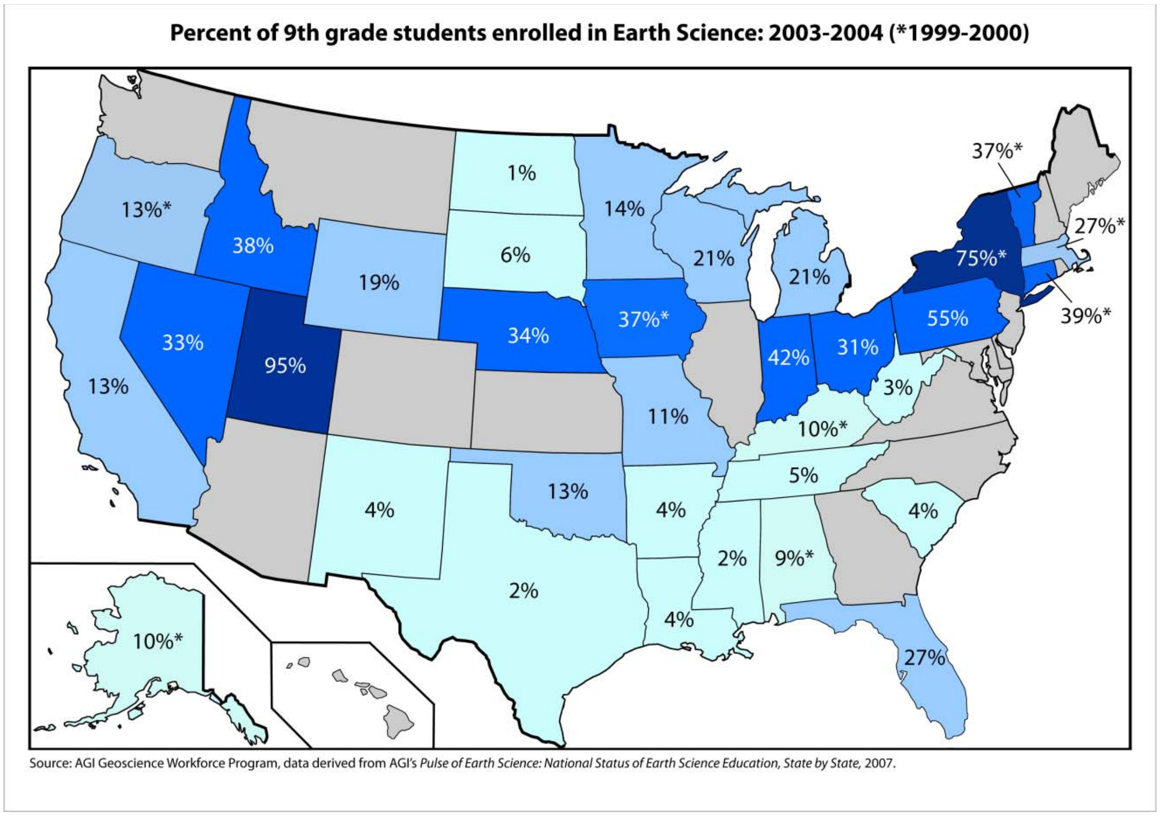


Figure 1.7: Percent of Grade 9 Students Enrolled in Earth Science Courses. States marked with (*) indicate percentages for the 1999-2000 school year. All other state values are for the 2003-2004 school year.

The NCES "Digest of Education Statistics" indicates a peak (25%) in the percent of high school students taking earth science / geology courses in 1990 followed by a decline to 17 percent in 2000. However, data from 2005 shows an increase of 7 percent. The percentage of high school students taking earth science courses is much less than those taking other science courses. The percentage of high school graduates who took biology courses increased from 77 percent in 1982 to 92 percent in 2005, and the percentage of high school graduates who took chemistry courses increased from 32 percent in 1982 to 66 percent in 2005. Additionally, the percentage of high school graduates who took physics courses increased from 15 percent in 1982 to 33 percent in 2005. In comparison, enrollments in earth science courses have never exceeded 25 percent in the past 26 years.

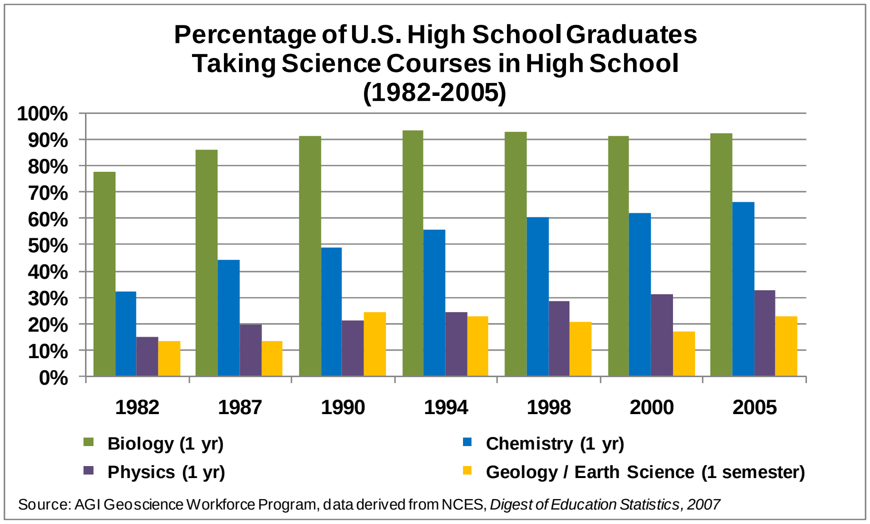


Figure 1.8: Percentage of High School Graduates Taking Science Courses in High School.

For the past 18 years, there have been fewer high school earth science teachers than other high school science teachers. The one exception occurred in 2002 when there were approximately 400 more earth science teachers than physics teachers. The percentage of teachers in each science discipline has grown over the past 18 years; however, earth science has had the slowest growth rate at 21 percent. Between 2000 and 2002 however, the growth in earth science teachers outpaced the other disciplines (24% compared to 7%). The growth rate of teachers in all science disciplines declined between 2002 and 2004, with earth science having the greatest decline (10%).

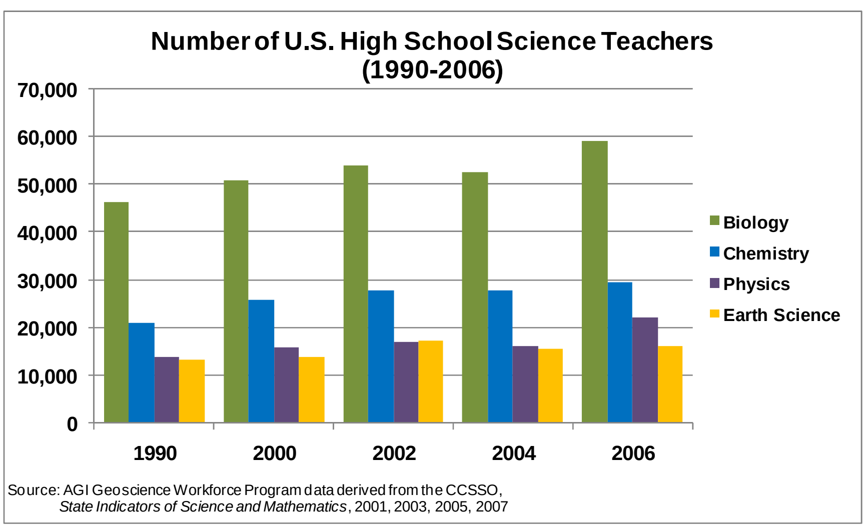


Figure 1.9: Number of High School Science Teachers.

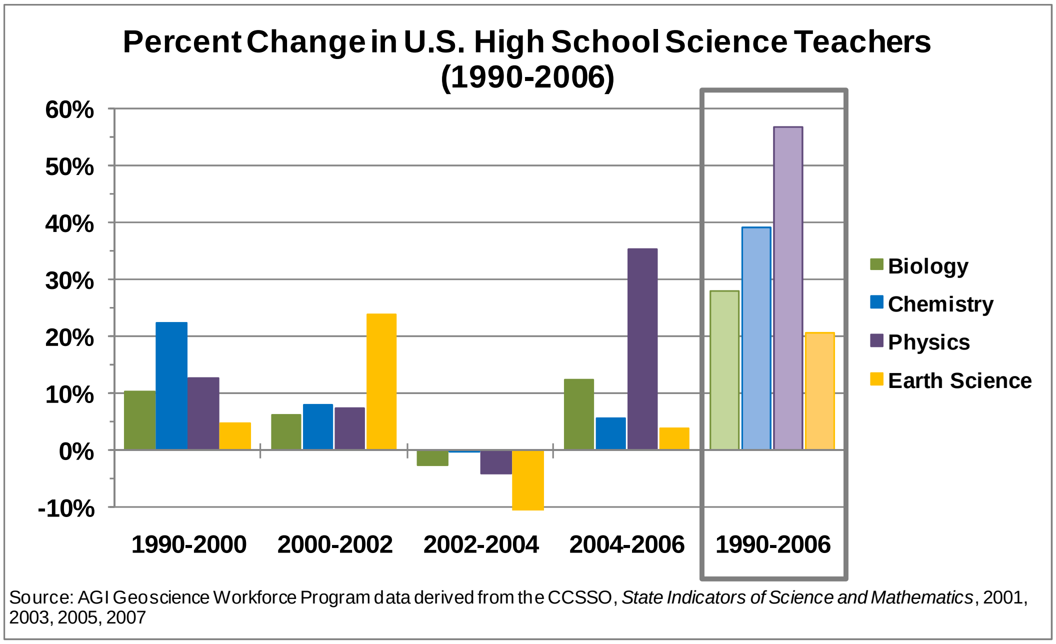


Figure 1.10: Percent Change in High School Science Teachers.

The percent of science teachers certified in their assigned field has decreased by 4 to 5 percent for biology, chemistry, and earth science from 1990 to 2006, and by 14 percent for physics. From 1990 to 2004, the percentage of certified high school earth science teachers has been consistently lower than the other science disciplines. In 2006, the percentage of certified physics teachers was 2 percent lower than the percentage of certified earth science teachers.

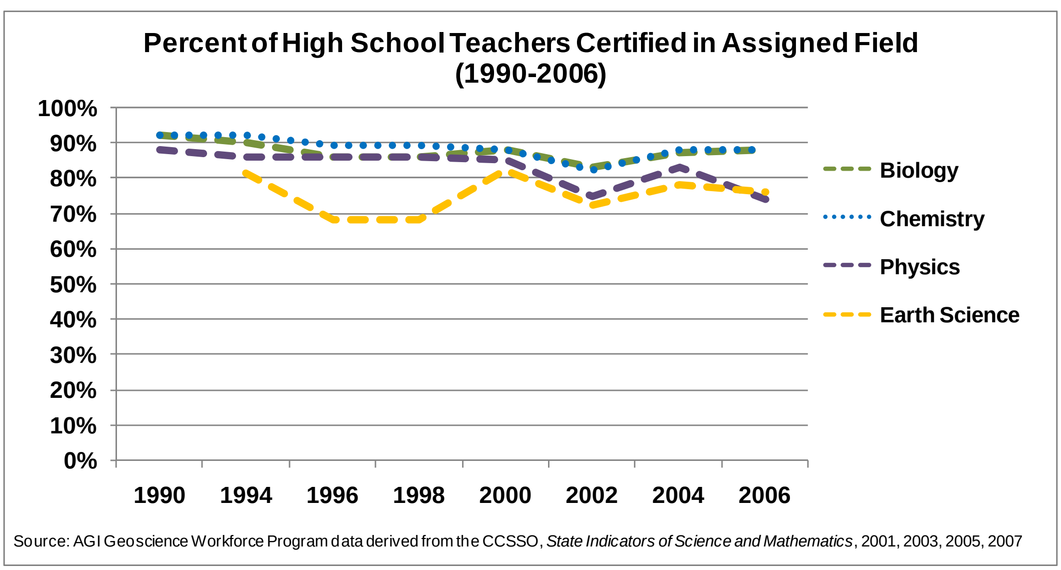


Figure 1.11: Percent of High School Teachers Certified in Their Assigned Field.

College-bound High School Students

The percentage of SAT test takers who have had course work or experience in geology / earth or space sciences has increased from 43 percent in 1996 to 49 percent in 2007. In the other natural sciences, the percentage of SAT test takers with course work or experience in biology has been approximately 97 percent since 1996. The percentage of SAT test takers with course work or experience in chemistry has increased from 84 percent in 1996 to 89 percent in 2007, and in physics the percentage has increased from 47 percent in 1996 to 54 percent in 2007. Mean Verbal and Math scores for those SAT test takers with course work or experience in geology / earth or space sciences has been consistently lower than those with course work or experience in the other Natural Sciences and lower than the average scores for the entire test group. SAT test takers with course work or experience in physics have the highest mean Verbal and Math SAT scores for all SAT test takers who have course work or experience in the Natural Sciences.

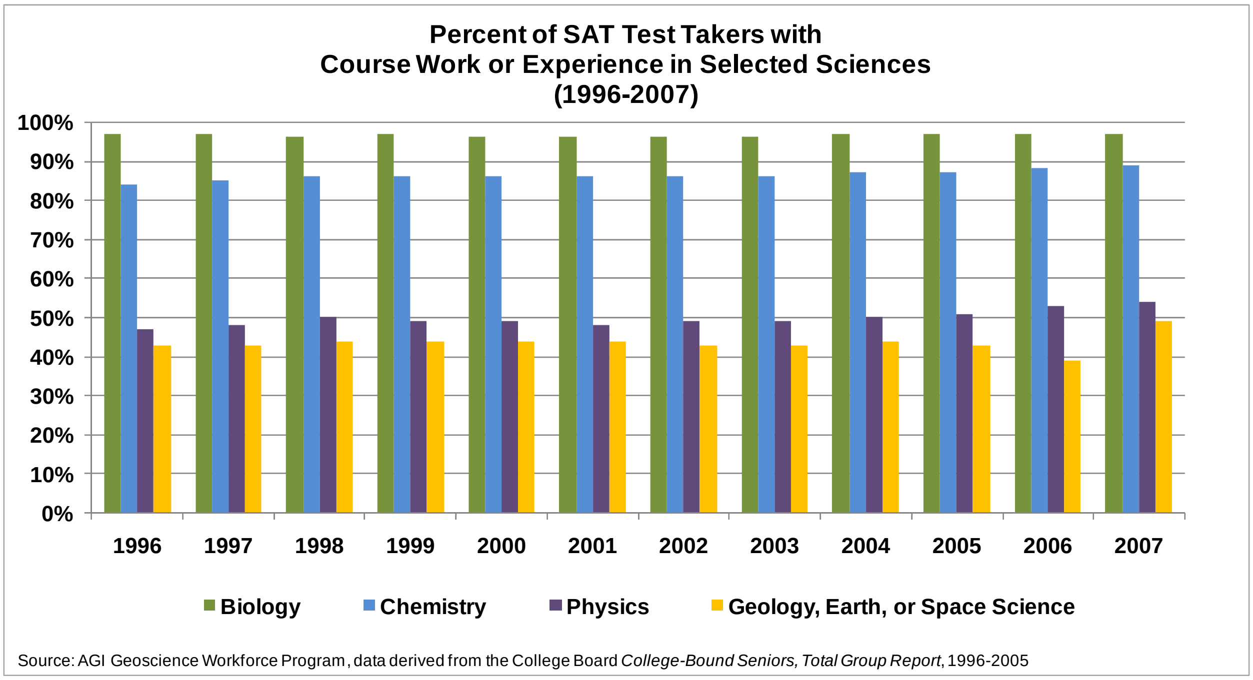


Figure 1.12: Percent of SAT Test-takers with Course Work or Experience in Selected Sciences

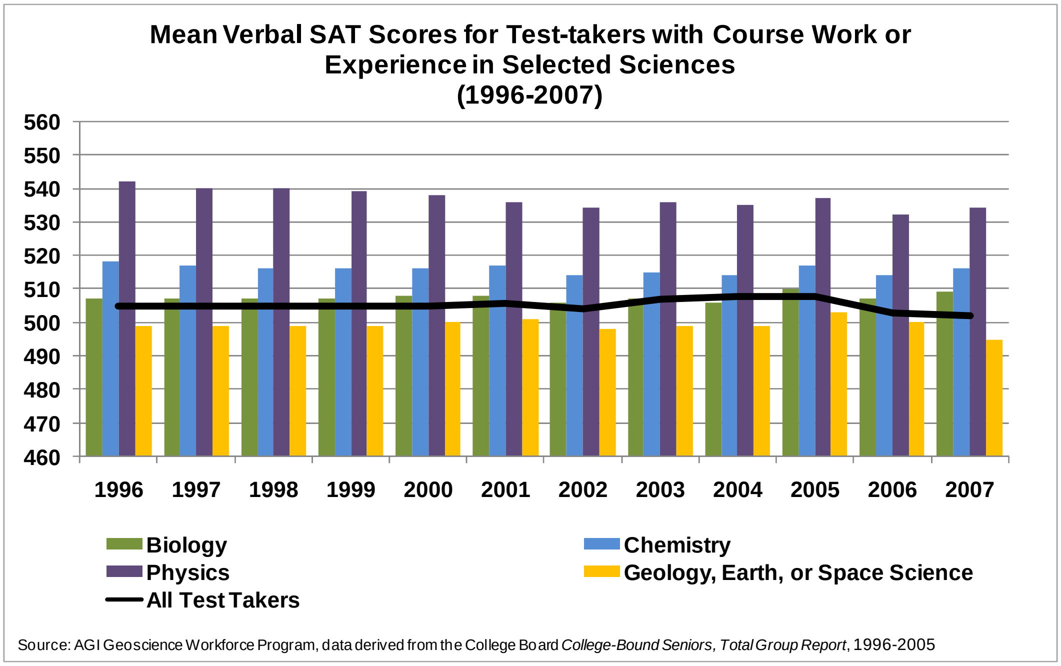


Figure 1.13: Mean Verbal SAT Scores for Test-takers with Coursework in Selected Sciences

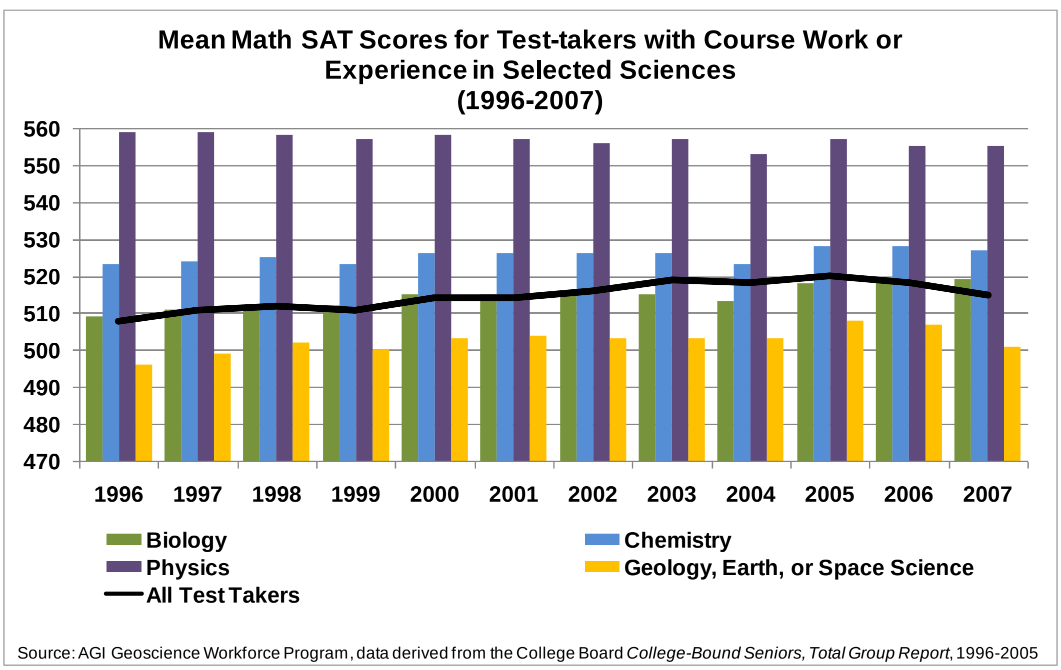
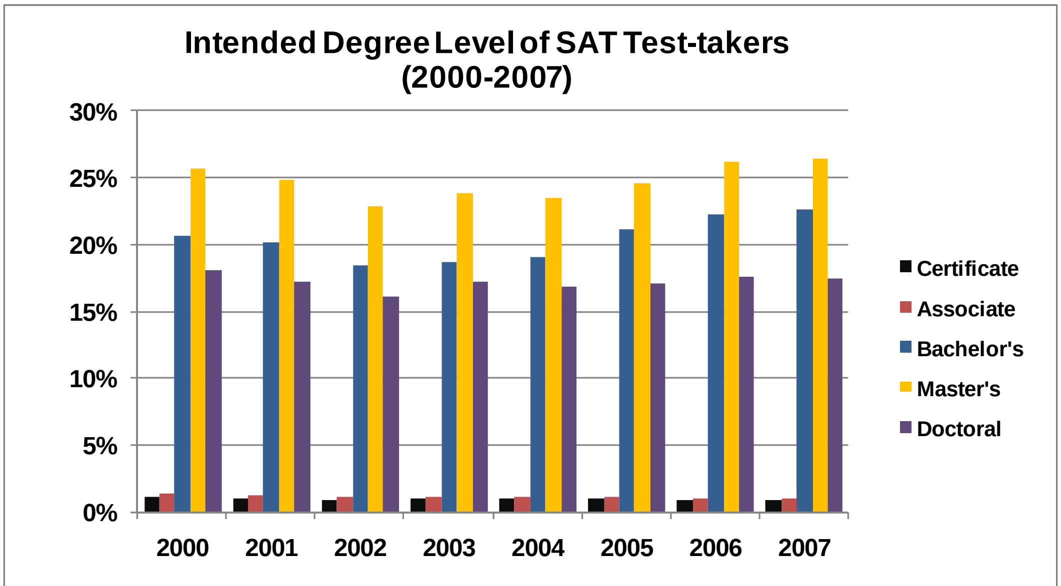


Figure 1.14 Mean Math SAT Scores for Test-takers with Coursework in Selected Sciences

High school graduation is a critical juncture in a student's life. A report by the National Center for Education Statistics indicates that in 2004, 78 percent of graduating seniors planned to attend school in the year following graduation (*Trends Among High School Seniors 1972-2004*, 2008). Between 1972 and 1992, more graduating seniors indicated that they planned to end their post-secondary education with a Bachelor's degree. In 2004, this trend changed as more graduating seniors indicated that they planned to end their post-secondary education with a graduate degree (*Trends Among High School Seniors 1972-2004*, 2008). In 2007, the College Board stated that 44 percent of responding seniors indicated that they planned to obtain a graduate degree (26% Master's and 18% Ph.D.), and 23 percent intended to obtain a terminal Bachelor's degree (*College-Bound Seniors, Total Group Report,* 2007).

Given that graduate degrees are generally necessary in science careers, it appears that the achievement of this level of education does not appear to be a significant hurdle in the minds of prospective students. Although the total number of students indicating either physical science or interdisciplinary science as their intended college major has increased from 16,061 in 1996 to 19,019 in 2007, the interest in these majors by SAT test takers has remained steady at 1.2 percent (1% for physical science, 0.2% for interdisciplinary science) for the past 22 years.



Source: AGI Geoscience Workforce Program, data derived from the College Board *College-Bound Seniors, Total Group Report*, 2000-2007

Figure 1.15: Intended Degree Level of College-bound high school seniors who took the SAT Test

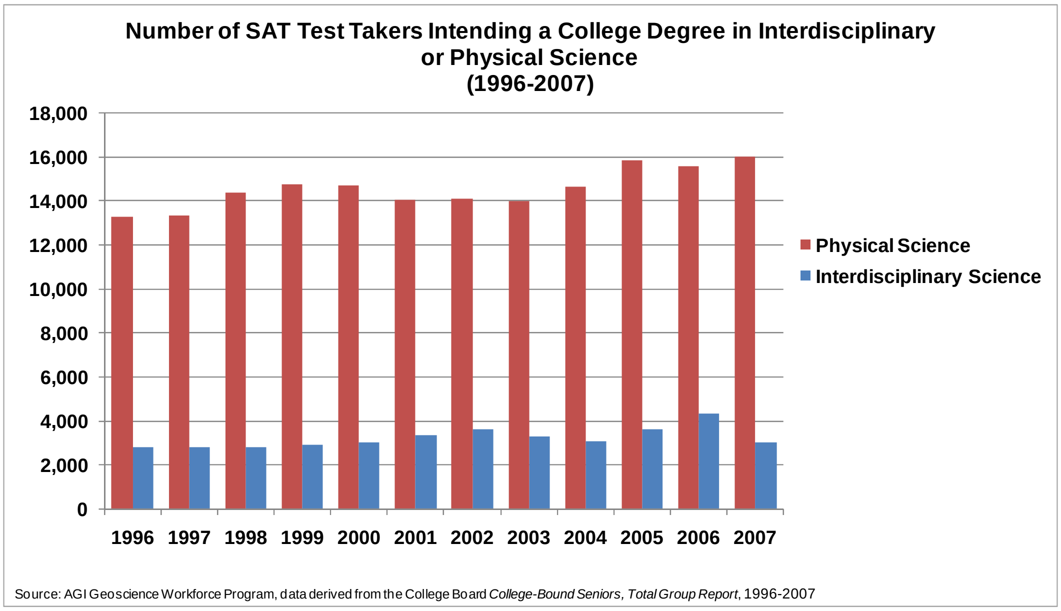


Figure 1.16: Number of SAT test-takers intending college degrees in Interdisciplinary or Physical Sciences.

College-bound students who indicated physical science as their intended college major have outperformed those indicating interdisciplinary science as their intended college major on both the Verbal and Math sections of the SAT since 1997. Overall there has been a decrease in both Verbal and Math scores for both groups of students, with larger declines in the Verbal section than in the Math section. From 1996 to 2006, mean Verbal and Math scores for those students who aim to major in interdisciplinary science have decreased more (Verbal: -34 points, Math: -21 points) than those who aim to major in physical science (Verbal: -18 points, Math: -6 points). In 2007, both group's scores increased from the previous year; however, the interdisciplinary science group's scores increased 40 points in the Verbal section and 52 points in the Math section.

The performance of these two groups in 2007 may be due to the restructuring of the SAT Test in 2006 in which the Verbal and Math sections were revised, and a new section, "Writing", was added. The Verbal section was renamed to "Critical Reading" and analogies were replaced with additional short and long reading passages. Additionally, algebra-II level questions were added to the Math section, and quantitative comparison questions were eliminated. The new writing section included essay and multiple choice questions pertaining to identifying errors and improving sentences and paragraphs. The College Board made these revisions in order to better assess students on the skills they learn in high school that they will later utilize in both their college years and future careers.

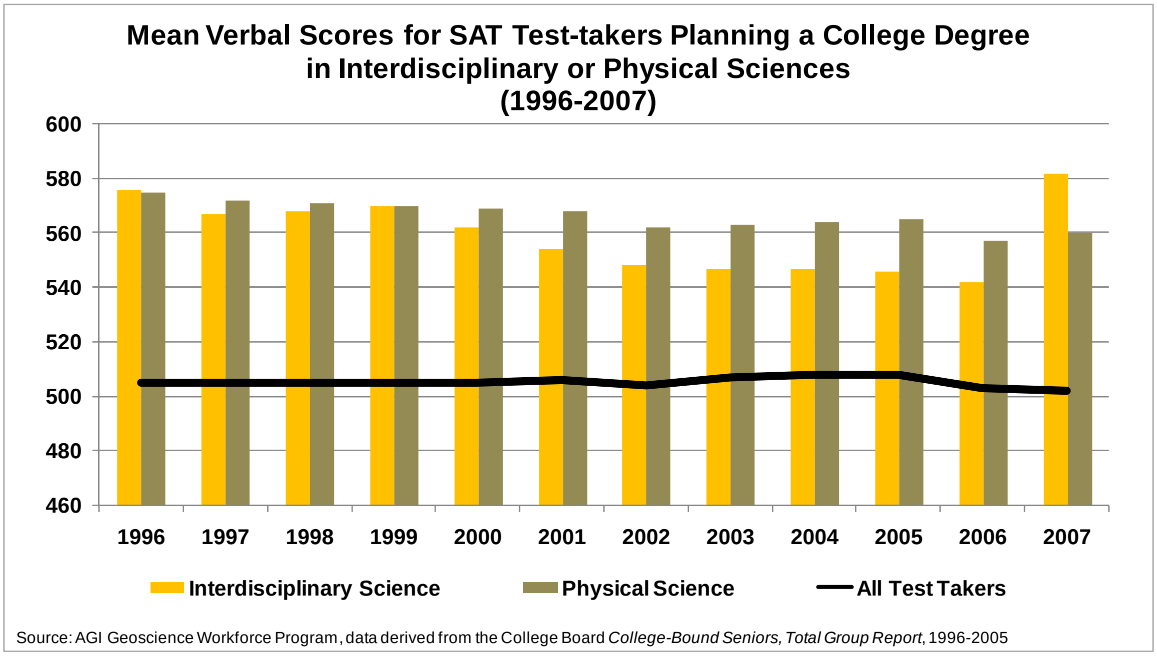


Figure 1.17: Mean Verbal SAT Scores for SAT test-takers intending college degrees in Interdisciplinary or Physical Sciences.

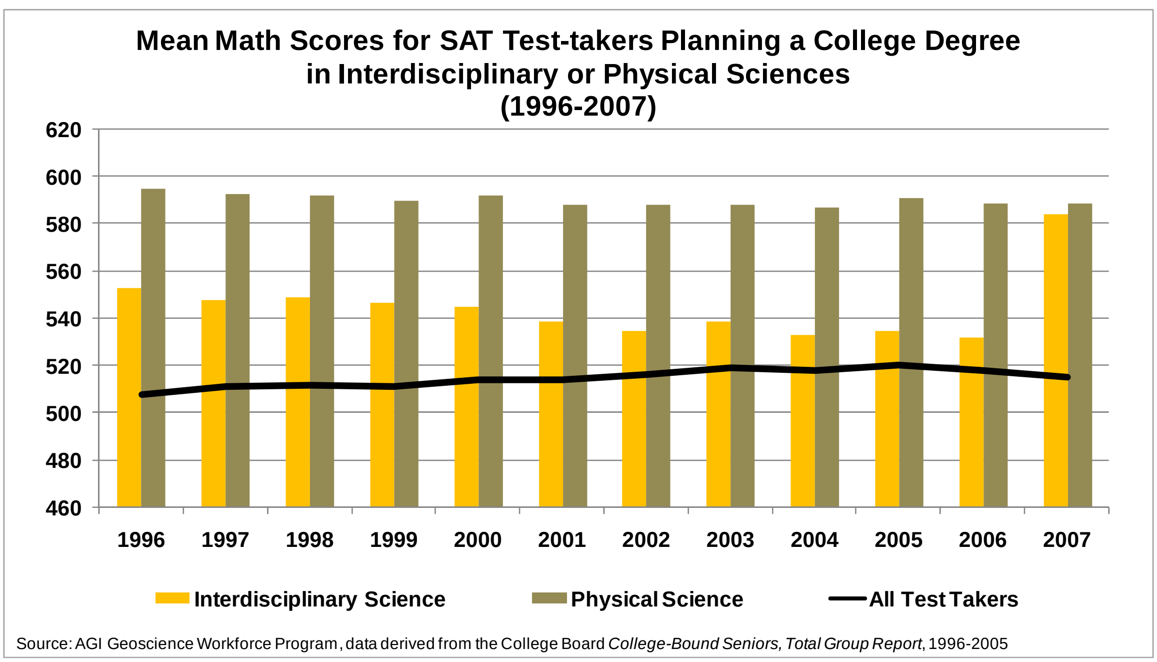


Figure 1.18: Mean Math SAT Scores for SAT test-takers intending college degrees in Interdisciplinary or Physical Sciences.

Geosciences in Community Colleges

Community colleges provide a transitional step between high school and four-year institutions for many college-bound students. The National Center for Education Statistics "Special Analysis of Community College Students" report indicates that approximately 30 percent of graduating seniors enroll in community colleges after high school graduation. Additionally, 66 percent of those seniors enrolling in community colleges intend to use community college as an intermediate step between high school and a four-year institution.

Since 1972, community college students have comprised approximately one-third the total college student population enrolled in credit courses within the United States. Currently, thirty-five percent of community college students are underrepresented minorities, and yet, the geosciences have little presence at the community college level. Only 14 percent (233) of all community colleges have degree programs in the geosciences or related physical sciences, and these schools are concentrated in California, Texas, and Washington. Considering that 9 percent geoscience Master's degree recipients and 4 percent of geoscience Ph.D. recipients have Associate degrees, community college students represent an important untapped resource of diverse talent for the geosciences.

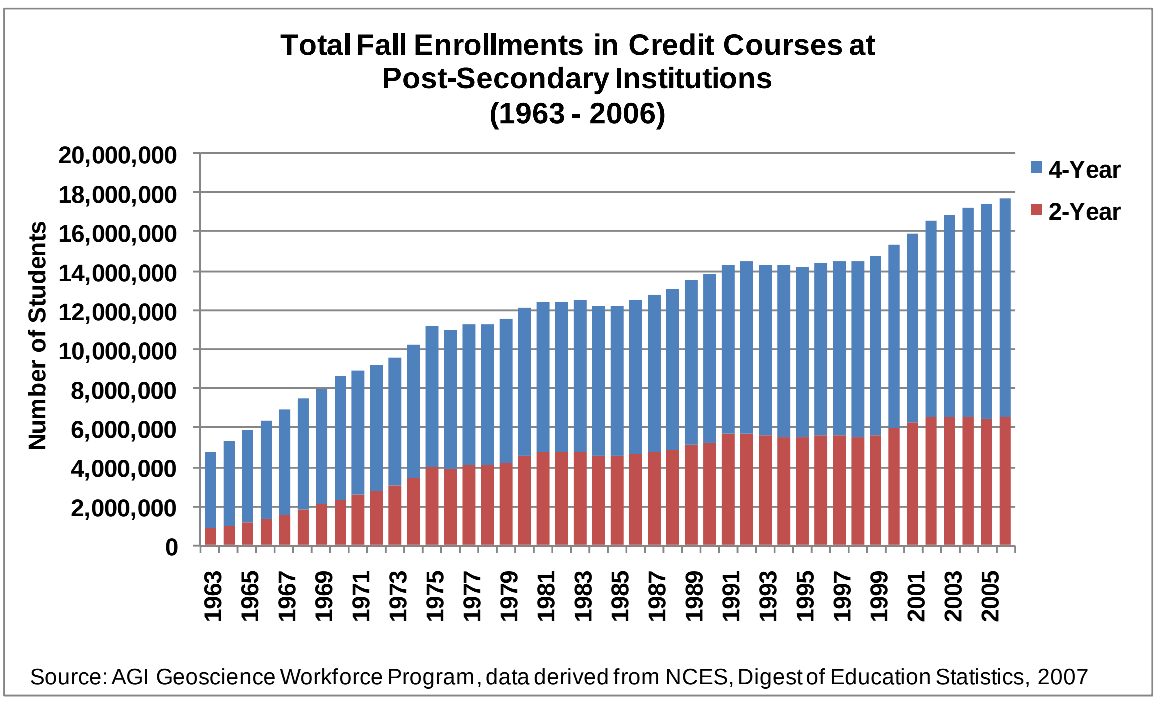


Figure 1.19: For-Credit Fall Enrollments at Post-secondary Institutions

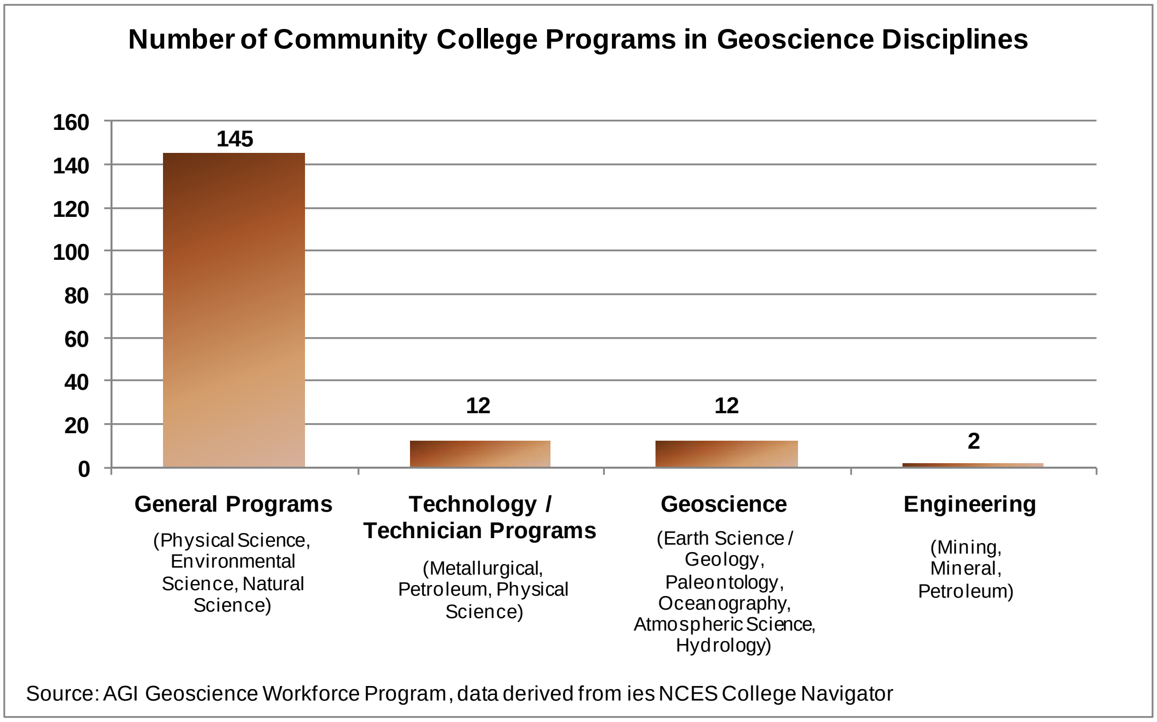


Figure 1.20: Number of Community Colleges that Offer Programs in Geoscience Disciplines

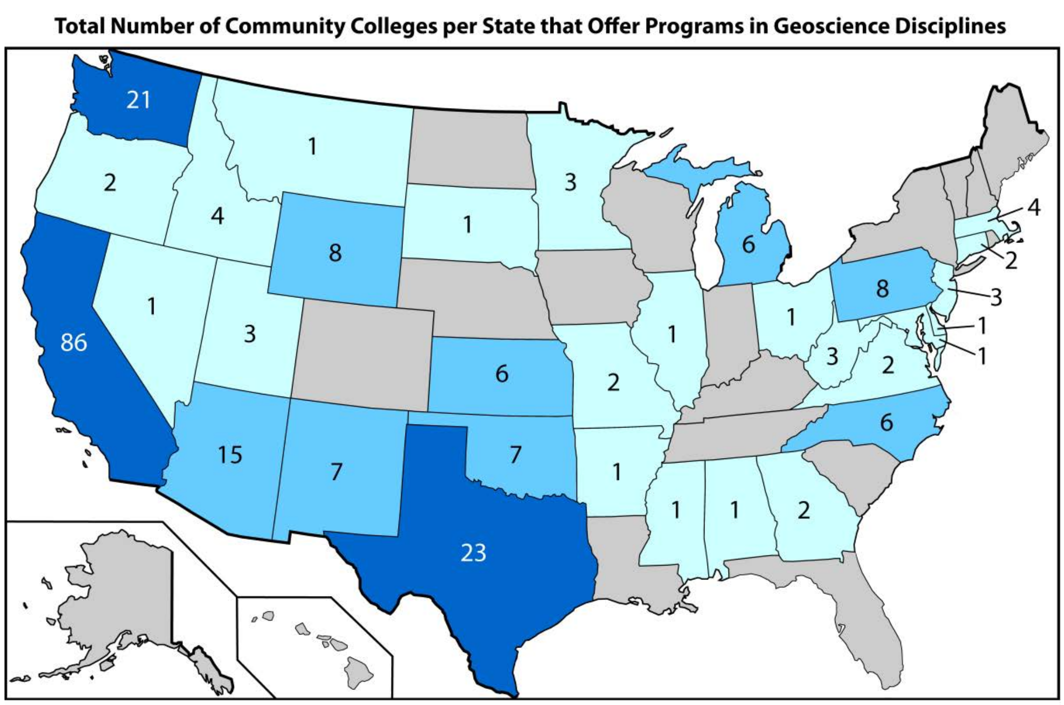


Figure 1.21: Geographic Distribution of Community Colleges that Offer Programs in Geoscience Disciplines

The majority of these 233 community colleges offer general programs that incorporate geoscience topics into their curriculum, and the majority of these physical science programs. Physical science programs are concentrated in California, Texas and Washington. Only 5 percent of all U.S. community colleges offer dedicated ("core") geoscience programs (76 colleges). The majority of schools with dedicated geoscience programs are located in the western states, and the states with the highest number of schools with core geoscience programs are located in California and Texas. Technical and engineering programs in geoscience disciplines are rare at community colleges, and are also primarily located in the western states.

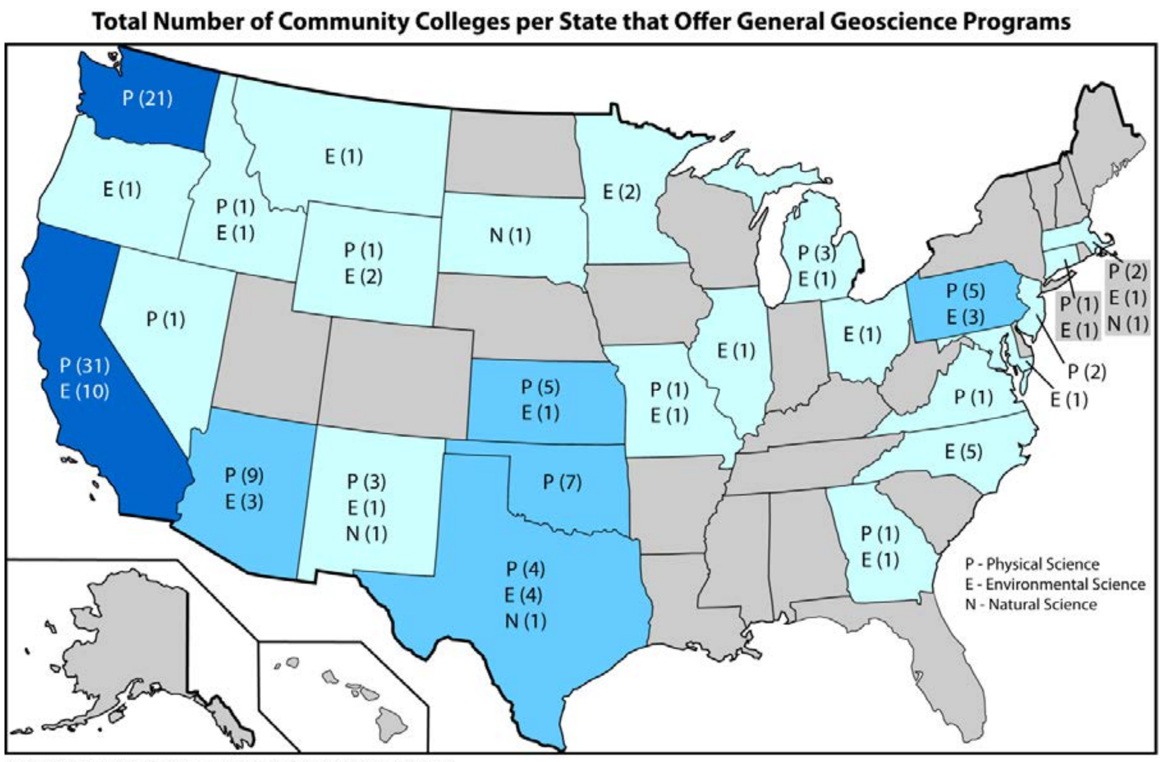


Figure 1.22: Geographic Distribution of Community Colleges that Offer General Geoscience Programs

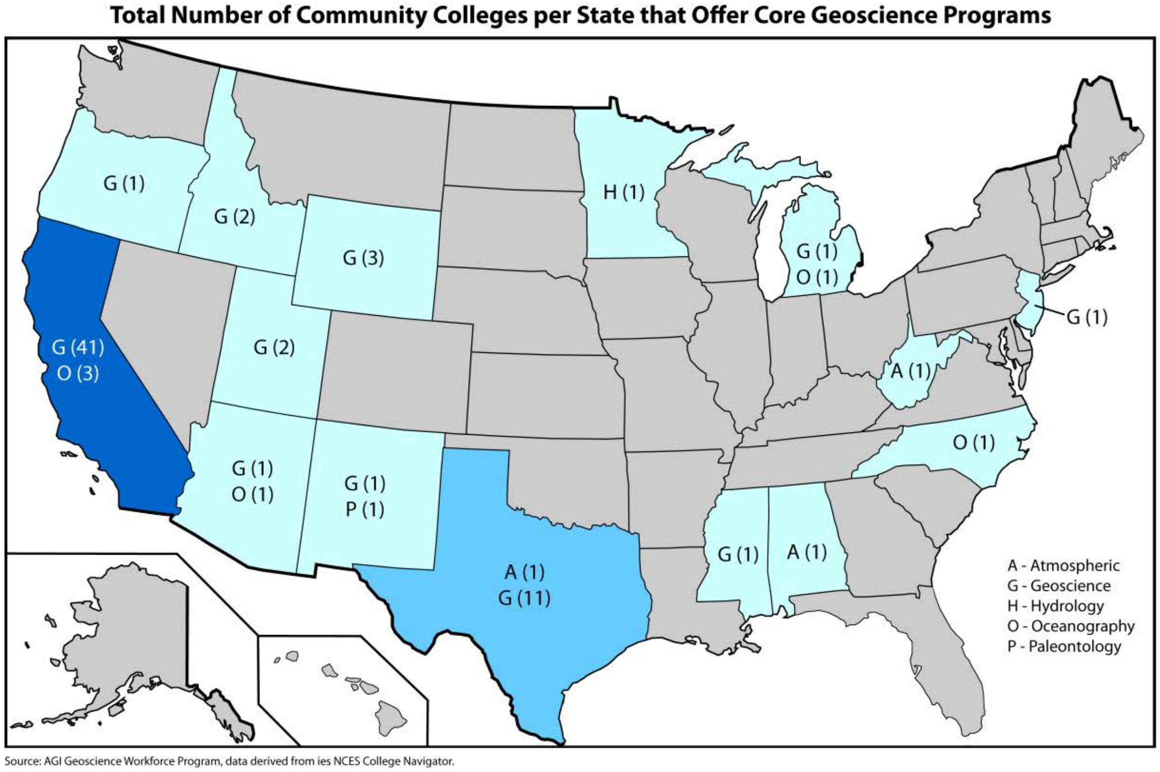


Figure 1.23: Geographic Distribution of Community Colleges that Offer Dedicated "Core" Geoscience Programs

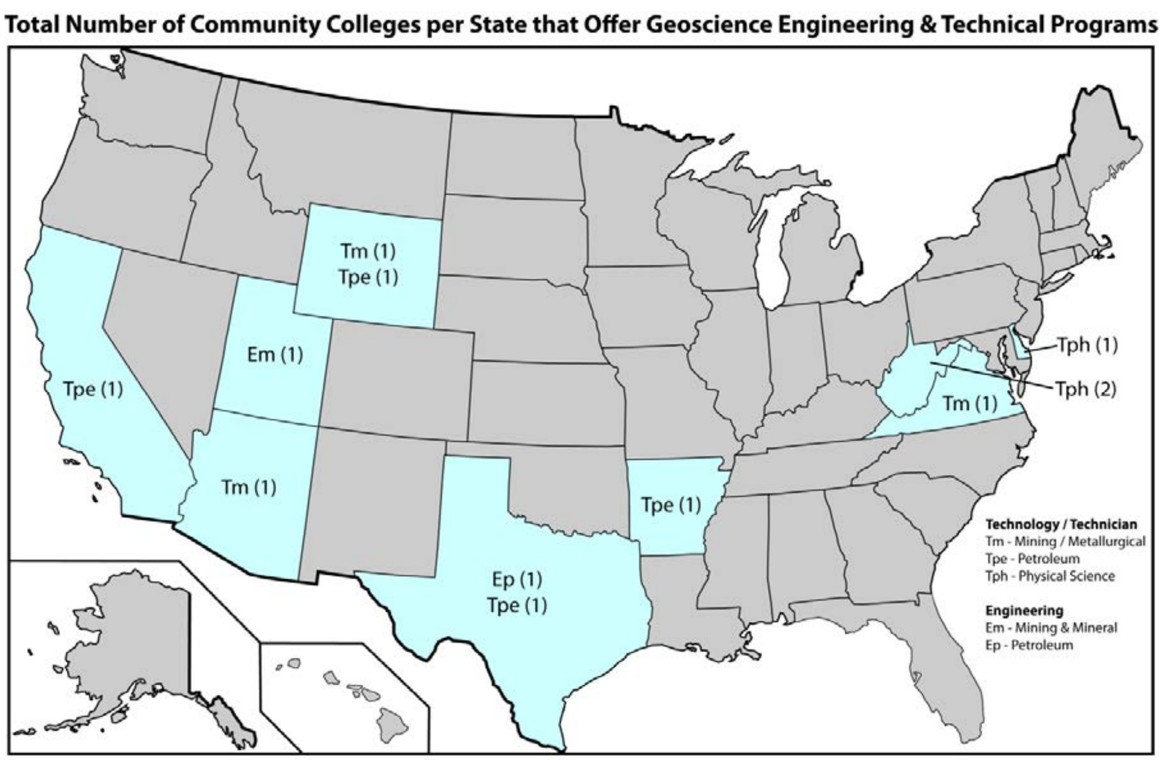


Figure 1.24: Geographic Distribution of Community Colleges that Offer Programs in Geoscience Engineering and Geoscience Technical Programs

Associate degrees in geoscience disciplines have not exceeded 2,000 per year since 1985. Degrees from dedicated (core) geoscience programs (geology, earth sciences, oceanography, atmospheric science, hydrology, etc.) have comprised approximately 10 percent of all geoscience-related Associate degrees since 1992. Of interest is increase in the percentage of degrees from general geoscience programs (physical science, environmental science, natural science) and decrease in geoscience technology degrees since 1984.

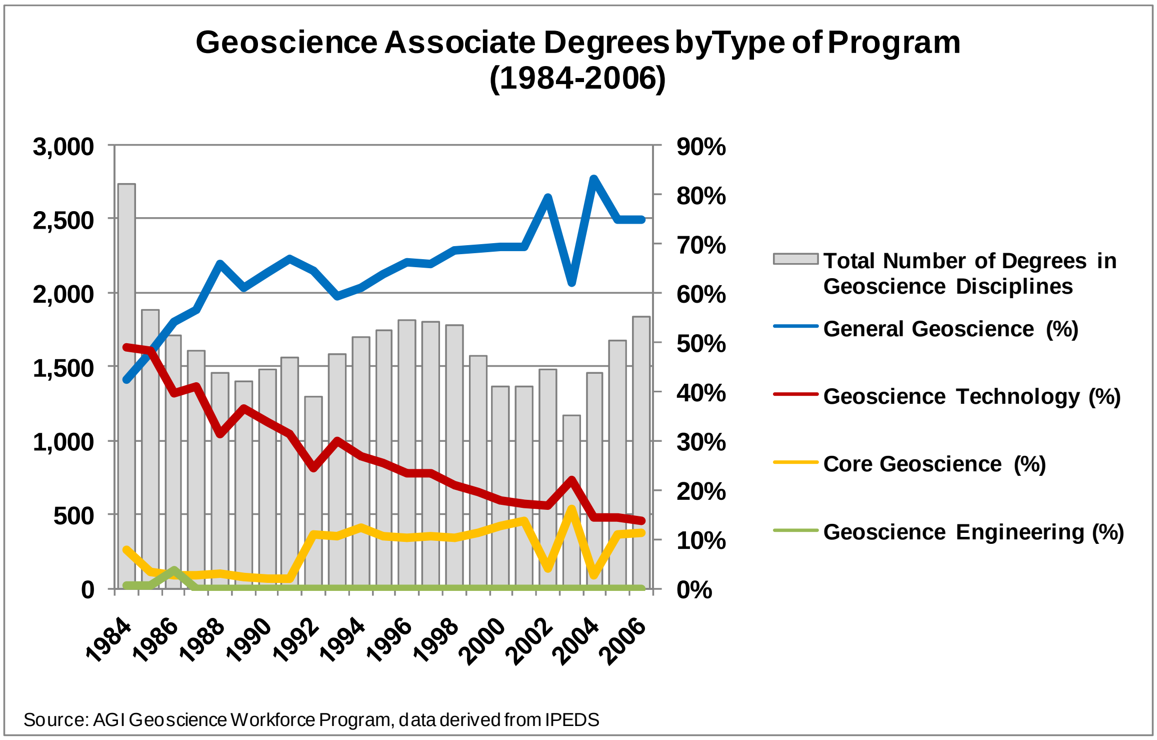


Figure 1.25: Trends in Geoscience Associate Degrees from Community Colleges

The “Status of the Geoscience Workforce” Report

The “Status of the Geoscience Workforce” report provides a comprehensive benchmark of the geoscience profession. The report is based on original data collected by the American Geological Institute as well as from existing data from federal data sources, professional membership organizations, and industry data sources. The report synthesizes all available data for the geosciences, from the supply and training of new students, to workforce demographics and employment projections, to trends in geoscience research funding and economic indicators. The report is available as a complete document, as well as on a per chapter basis. It will be available for download from AGI’s website: http://www.agiweb.org/.

Report Summary

This 32 page summary provides an in-depth summary of each chapter of the report.

Chapter 1: Trends in Geoscience Education from K-12 through Community College

This chapter examines the student participation in geoscience education at the K-12 level and includes data on state requirements for earth science education in middle and high school, and data pertaining to the number of earth science high school teachers. The chapter also examines trends in college bound students including SAT scores, aspirations for higher education, and choice of college major. Additionally, this chapter examines the availability of geoscience education at community colleges and examines the trends in Associate degrees conferred from geoscience programs at these institutions.

Chapter 2: Trends in Geoscience Education at Four-Year Institutions

This chapter summarizes all available data pertaining to geoscience enrollments, degrees conferred, field camp attendance, and funding of geoscience undergraduate and graduate students. The chapter also explores trends in department size, faculty numbers and research specialties, and funding of geoscience research at the university level.

Chapter 3: Geoscience Employment Sectors

This chapter explores the transition of geoscience graduates into the workforce, age demographics of the industries where geoscientists work, and projected workforce demand. Data pertaining to the current number of jobs and projected number of jobs in 2016 is also provided, as is current salary information for each profession.

Chapter 4: Economic Metrics and Drivers of the Geoscience Pipeline

This chapter provides data on productive activity (number of oil rigs, mines, etc.), commodity pricing and output, gross domestic product, and market capitalization of the industries where geoscientists work.

Appendix A: Defining the Geosciences

This appendix outlines how geoscience occupations and industries are defined in federal data sources. Additionally, the appendix details the working definition proposed by AGI for tracking the geoscience occupation.

Acknowledgements

The AGI Geoscience Workforce program would like to thank the AGI Foundation for funding of the program and this report. The AGI Geoscience Workforce Program would also like to thank the following people, organizations, companies, and industries that provided data for this report, including:

Dr. Penny Morton, University of Minnesota-Duluth, who provided all field camp attendance data; Barry Jay Katz, ChevronTexaco for the "*2003 Report on the Status of Academic Geoscience Departments*"; American Association of Petroleum Geologists (AAPG); American Geophysical Union; Baker Hughes; College Board; Council of Chief State School Officers (CCSSO); Econostats.com; Energy Information Administration; Google Finance; Indexmundi.com; InflationData.com; Industry and corporate data collaborators; ***Integrated Postsecondary Education Data System*** (***IPEDS***); Kitco.com; National Center for Education Statistics (NCES); National Ground Water Association (NGWA); National Mining Association; National Science Foundation Division of Science Resources Statistics; National Science Foundation Award Database; OANDA.com; Office of Personnel Management; Society of Economic Geologists (SEG); Society of Exploration Geophysicists (SEG); U.S. Bureau of Economic Analysis; U.S. Bureau of Labor Statistics; U.S. Department of Education; U.S. Geological Survey.

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Questions and More Information

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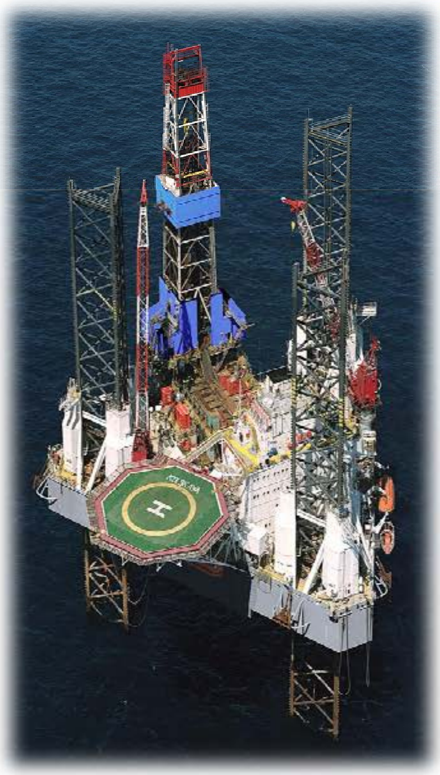
2009

Status of the Geoscience Workforce

Chapter 2: Four-Year Colleges and Universities



American Geological Institute

February 2009

Table of Contents

The Academic Geoscience Pipeline:

Trends in Geoscience Education at Four-Year Institutions

The academic sector is unique in that it serves as both a consumer and a primary supplier of geoscience human capital. Thus, the condition of geoscience academic departments, including the size of their student body and faculty, directly affect the size and expertise of the future geoscience workforce. Because a Master's degree is considered the professional degree in geoscience occupations, there is approximately a 5 year lag effect on the geoscience workforce for students who graduate with a geoscience Master's degree. Students with Bachelor's degrees in geoscience disciplines have limited job opportunities, and although there are opportunities available to geoscience doctorates in non-academic employment sectors, over 80 percent of geoscience doctorates pursue careers in academia. As a result, there is approximately a 10 to 15 year lag effect on the geoscience academic workforce depends upon the length of time that geoscience doctorates spend in post-doctoral positions before they begin a faculty position.

Geoscience departments at four-year universities can be found in every state. The states with the highest number of departments are California, New York, Pennsylvania, and Texas. Since 1999, however, the median size of departments has steadily decreased both in number of faculty (Professors, Associate Professors, Assistant Professors, and Instructors/Lecturers) and number of total students (undergraduate and graduate). In 2008, the median number of faculty per department was 8, and the median number of students was 45. Additionally, most geoscience departments have relatively low ratios of student to tenure track faculty (10:1 or less) which potentially increases the contact hours between students and faculty members.

The number of students enrolling in geoscience programs in U.S. colleges and universities has remained relatively steady over the past few years, with 19,216 undergraduates and 7,944 graduates enrolling in 2007. Degrees granted in the geosciences has remained relatively constant since 2000, with one exception of new doctorates in 2007 which increased by over 30 percent. This sharp increase mirrors the influx of entering graduate students in 2003 and 2004 following the bust of the dot-com bubble. When compared with other science & engineering fields, the geosciences have lower degree completion rates for Bachelor's degrees (13% compared to 59%), comparable rates for Master's degrees (20% compared to 19%) and higher doctoral degree completion rates (20% compared to 9%).

The composition of degree holders is an important measure of disciplinary health. The ability to attract the maximum level of competency to a profession is dependent upon its ability to recruit across gender, racial, and economic divides.

Did you know?

- Forty-three percent of geosciences degrees were conferred to women in 2007.
- Hispanics earn the highest percentage of geosciences degrees for all underrepresented minorities.
- Nine percent of geoscience Masters degree recipients and 4 percent of geoscience Ph.D. recipients have an Associate degree.
- Despite the decline in the number of schools offering summer field camps, total attendance has increased by 280 percent over the past 10 years.
- 11 schools account for 64 percent of all geoscience NSF Graduate Fellows.
- 10 universities have produced 25 percent of all geoscience faculty in the U.S.

Did you know?

- Women comprise 14.2 percent of tenure-track faculty in the geoscience, compared to 28 percent in all science & engineering fields.
- Overall, faculty specialties remained constant; however, since 1999 there have been changes within sub-disciplines and across geographic regions.
- The percent of total research funding applied to the geosciences has declined since 1980.
- Since 2000, the largest portion of geoscience research funding at universities has been applied to interdisciplinary geoscience research.
- Since 2001, the number of NSF Earth Science proposals has increased by 36 percent while the number of NSF Earth Science awards has only increased by 11 percent.

The disparity between whole-population level of specific populations and their representation in the profession can be viewed as a first order proxy of the recruitment and sustainability of a discipline. In the geosciences, women currently earn 43 percent of all geoscience degrees, but comprise only 14.2 percent of tenure-track geoscience faculty and 18.6 percent of non-tenure track geoscience faculty. In comparison, women comprise 28 percent of all science & engineering tenure-track faculty positions.

Compared to the success story of female student graduates, the participation of underrepresented minorities in the geosciences is extremely poor. Compared with other science & engineering fields, the geosciences confer the lowest percentage of Bachelor's and Master's degrees to underrepresented minorities. However, at the doctoral level, the geosciences confer a higher percentage of degrees to underrepresented minorities than do mathematics, engineering, physical sciences, and computer science. The percentage of all science & engineering degrees conferred to Hispanics and non-Hispanic African Americans is 8 percent, whereas the percentage of geoscience degrees conferred to these minorities is approximately 2 percent. In comparison, Hispanics and non Hispanic African Americans comprise 29 percent of the U.S. population (14% Hispanic and 15% non-Hispanic African American). The percentage of degrees conferred to Native Americans and Alaskan Natives from all science & engineering programs and from geoscience programs is approximately the same (0.8%). These minorities comprise only 2 percent of the U.S. population.

Overall, Hispanics earn the largest percentage of geoscience degrees conferred to underrepresented minorities. This may be partly due to the geographic distribution of geoscience departments which are located in regions where there are large Hispanic populations. This geographic distribution may also account for the low participation rates of African Americans in geoscience programs. There are few geoscience programs at universities and community colleges in areas where there are large populations of African Americans. Underrepresented minorities currently comprise 31 percent of the US population. By 2050, they will comprise 48 percent of the U.S. population, with Hispanics comprising 30 percent of the total U.S. population. Considering that the composition of degree holders within a discipline is an important measure of disciplinary health, the geosciences have much to do to increase the participation rate of underrepresented minorities.

Individuals who hold terminal geosciences Master's or doctoral degrees have similar academic backgrounds. Both groups have comparable percentages of Bachelor's degrees in business (~1%), engineering (12% to 17%), geosciences (50% to56%), other science & mathematics (18% to 19%), and other degree fields (12% to 14%). Fourteen percent of individuals with terminal geoscience Master's degree have a second Master's degree, and 79 percent of geoscience doctorates have earned a Master's degree. Additionally, 9 percent of geoscience Master's degree recipients have and 4 percent of geoscience doctoral degree recipients have earned an Associate degree.

Since 1970, GeoRef indicates that the majority of theses and dissertations pertain to geology topics. Of note is the increase in geoscience theses and dissertations pertaining to interdisciplinary research that began in 1986 and peaked in 2000. This trend is concurrent with an increase in the percentage of geoscience federal funding applied to interdisciplinary research at the university level during the same period.

Field camp is historically central to undergraduate geoscience education. There are currently 90 schools that offer summer field camps at least once every two years. This number marks a 60 percent decrease in the number of departments offering traditional summer field courses. There are several reasons for the decline in the number of departments offering traditional summer field camp experiences, including the rising costs of liability insurance and the changing face of geoscience departments in smaller schools that are combining with geography and environmental science programs. Also, summer field camps increase overall departmental expenses. However, despite the decrease in the number of geoscience departments offering summer field camps, total field camp attendance has increased over the past 10 years. At a regional level, the Northeast has experienced the largest increase in attendance (76%) over the past 10 years, but the Midwest consistently has had the largest field camp attendance for the past 10 years.

Between 1999 and 2008, the numbers of Emeritus and Assistant Professors remained the same, but the number of all other faculty dropped. Currently, 56 percent of all faculty are tenured, while 19 percent are untenured, but in tenure-track positions. Women comprise 14 percent of tenure-track faculty, and 19 percent of non-tenure-track faculty in geosciences departments compared to 28 percent in tenure-track positions in all science & engineering fields. The level of female participation in faculty positions has not changed significantly in recent years.

At a national level, the distribution of faculty specialties has remained relatively constant since 1999. However, at a regional level, the Northeast and Midwest have experienced growth in the most number of specialties. The largest changes in faculty specialties by region were in Planetology, Economic Geology, and Geochemistry.

Overall the percent of total federal funding applied to geoscience research has been declining since 1980. However, the absolute amount of research funds applied to geoscience research at universities has increased. Interdisciplinary research has received the largest portion of these funds since 2000 while funding for geological science and atmospheric science research has decreased since 1995. Since 1999, NSF the proportion of funds applied to earth science research (earth science proposals and awards) has increased to just below 30 percent, while the majority of funding under the NSF geoscience directorate has been applied to both oceanographic and atmospheric science research. However, the funding rate for earth science proposals submitted to NSF has decreased steadily because the number of proposals has increased by 36 percent while the total number of earth science awards has only increased by 11 percent since 1999.

Direct support for geoscience students has increased for the last two years. The trend looks to continue in 2008-2009 with a projected 6 percent increase in available funds. These opportunities for student support include funds from government agencies (60%) and non-profit organizations (40%, which includes support from private foundations and companies).Graduate student support comprises 91 percent of all awards in the 2007-2008 academic year: over $2.4 million distributed among 570 individual awards. The largest student support program is the NSF Graduate Student Fellowship program. This program provided more than $1.13 million (from a total program budget of $40.5 million) in support to geoscience graduate students during 2007.

Geoscience Departments

Trends in the Status of Geoscience Departments

Although geoscience departments at four-year universities can be found in every state, the states with the highest number of departments are California, New York, Pennsylvania, and Texas. Since 1999, however, the median size of departments has steadily decreased both in number of faculty (Professors, Associate Professors, Assistant Professors, and Instructors/Lecturers) and number of total students (undergraduate and graduate). Additionally, most departments have relatively low ratios of student to tenure track faculty which does place geoscience programs with potentially favorable student to faculty ratios from a teaching perspective.

Departments not only compete for students, but also for funding. California leads the nation in the number of undergraduate students enrolled in geoscience departments and is second to Texas for enrolling graduate students in geoscience departments. Texas, which leads the nation in enrolling the most graduate geoscience students, is second to California in enrolling undergraduate geoscience students.

State-level enrollment trends tend to be driven by local factors. In some cases, a strong influence in the local economy related to geosciences, such as resource companies, often supports greater enrollment levels, while in other cases, secondary education systems with upper-level earth science courses or states with a large number of institutions often support a large geoscience major population. In other cases, productive departments with faculty that are consistently winning federal grants allow departments to develop programs that attract and enroll graduate students. Whereas the local economy and large number of institutions may be influential at the undergraduate level, the productivity of a department may be more influential in attracting graduate students.

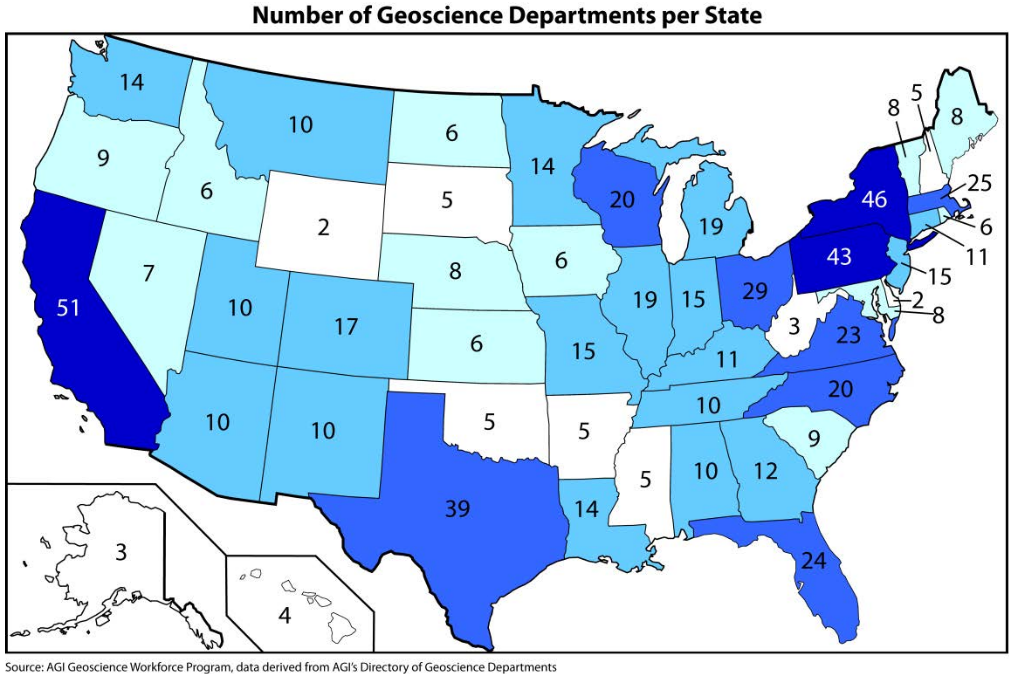


Figure 2.1: Number of Geoscience Departments per State

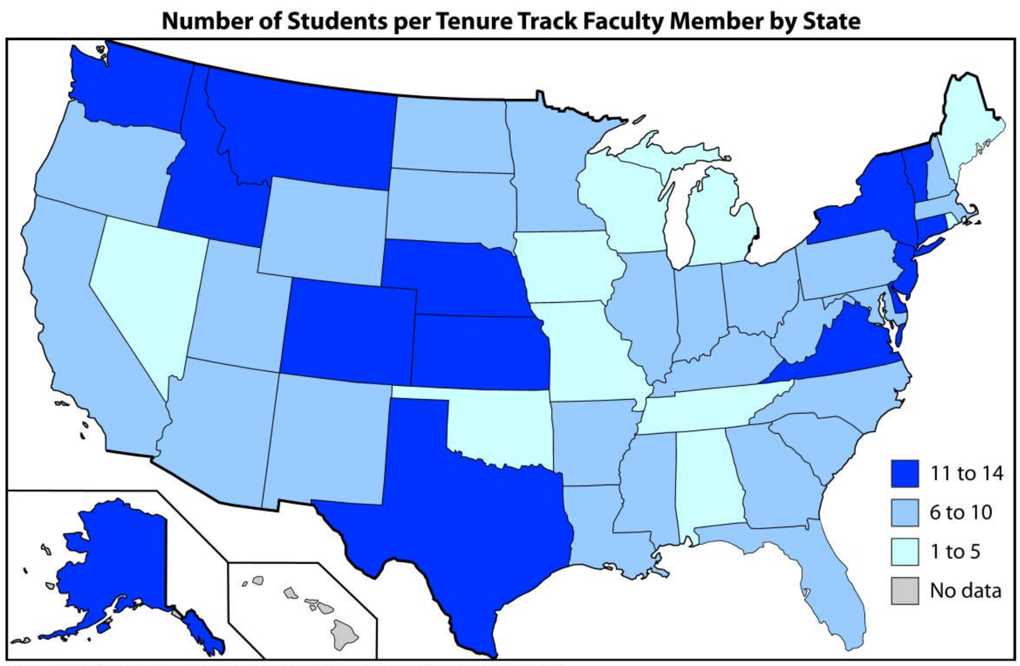


Figure 2.2: Number of Students per Tenure Track Faculty Member by State

State	Number of 4-year Universities with Geoscience Departments	Total Number of Geoscience Departments in the State	State	Number of 4-year Universities with Geoscience Departments	Total Number of Geoscience Departments in the State
New York	45	46	**New Mexico**	7	10
California	39	51	**Oregon**	7	9
Pennsylvania	39	43	**Maine**	7	8
Texas	32	39	**Nebraska**	6	8
Ohio	24	29	**Vermont**	6	8
Massachusetts	23	25	**Utah**	5	10
North Carolina	17	20	**Maryland**	5	8
Illinois	17	19	**Idaho**	5	6
Michigan	17	19	**Iowa**	5	6
Florida	15	24	**Kansas**	5	6
Virginia	15	23	**Rhode Island**	5	6
Wisconsin	15	20	**Arkansas**	5	5
Indiana	14	15	**Mississippi**	5	5
Colorado	12	17	**Arizona**	4	10
Missouri	12	15	**North Dakota**	4	6
New Jersey	12	15	**New Hampshire**	4	5
Minnesota	12	14	**South Dakota**	4	5
Georgia	11	12	**Nevada**	3	7
Louisiana	10	14	**Oklahoma**	3	5
Connecticut	10	11	**West Virginia**	3	3
Tennessee	10	10	**Hawaii**	2	4
Washington	9	14	**Alaska**	2	3
Kentucky	9	11	**District of Columbia**	2	3
Alabama	9	10	**Delaware**	1	2
South Carolina	8	9	**Wyoming**	1	2
Montana	7	10			

Table 2.1: Distribution of Geoscience Departments in the United States (Source: AGI Geoscience Workforce Program, 2008)

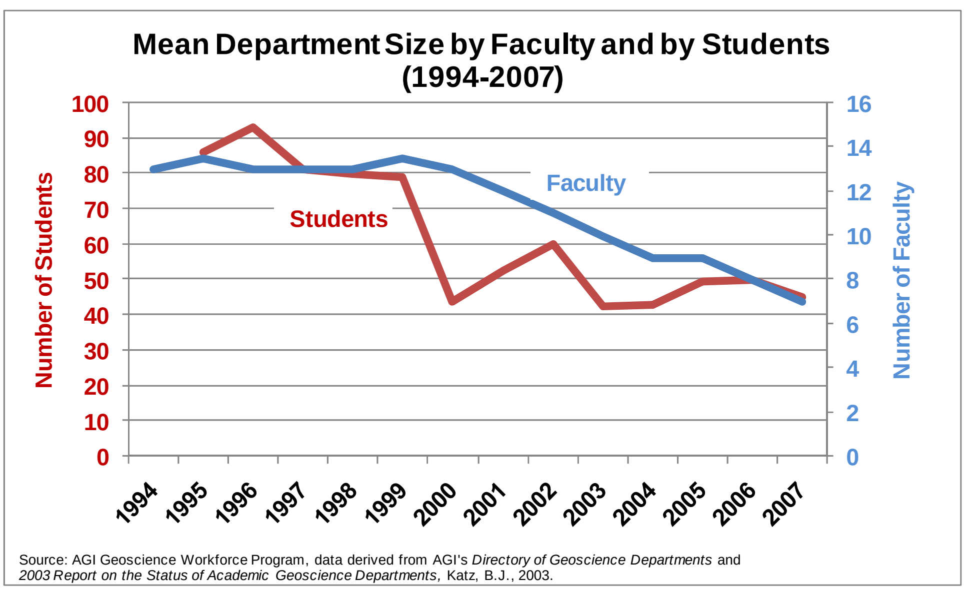


Figure 2.3: Median Size of Geoscience Departments Based on Number of Faculty and Number of Students

State	Percentage of All Undergraduate Geoscience Students
California	7.5
Texas	7.4
New York	7.4
Colorado	5.4
Pennsylvania	5.3

Table 2.2: Percentage of All U.S. Geoscience Undergraduate Students Enrolled in 2006 (Source: AGI Geoscience Workforce Program)

State	Percentage of All Graduate Geoscience Students
Texas	13.6
California	9.3
Florida	7.6
Colorado	5.7
Washington	4.4

Table 2.3: Percentage of All U.S. Geoscience Graduate Students Enrolled in 2006 (Source: AGI Geoscience Workforce Program)

Geoscience Field Camp Experience

Field camp has traditionally served as a central part of undergraduate geoscience curricula, but this tradition appears to be disappearing. The American Geological Institute (AGI) performed a census of geoscience departments in the United States to identify schools that have offered geoscience field camps in the past two years. According to this search, there are currently 90 schools that offer summer field camps at least once every two years. This number marks a 60 percent decrease in the number of departments offering traditional summer field courses. The 1985 Directory of Geoscience Departments (DGD) listed 259 schools as offering summer field camps, and the 1995 DGD listed 257 schools as offering summer field camps. The current number of schools offering summer field camps represents less than 15 percent of the 695 schools listed in the 2006 DGD in the United States. In 1985 and 1995 close to 35 percent of schools offered summer field courses for geoscience students.

There are several reasons for the decline in the number of departments offering traditional summer field camp experiences, including the rising costs of liability insurance and the changing face of geoscience departments in smaller schools that are combining with geography and environmental science programs. Also, summer field camps increase the overall costs for the department.

A number of existing field camp programs are open to outside enrollment, and are designed as upper-level programs for undergraduate geoscience students. The cost for attending these summer courses averages more than $2,000 for tuition, with additional costs for transportation to the camp location and required field equipment. Most of the programs run 4 to 8 weeks and provide 4 to 8 credits that can be transferred to the student's home university. Two multi-institution field consortia were identified that pool resources to provide a more traditional field camp experience – the Wasatch-Uinta Field Camp Group and a group of schools from Virginia and North Carolina. There are several programs that have partnered with another local program to design and teach field camp. This past summer 80 programs offered field camps. The majority of these programs are traditional mapping-based geology field camps, but an increasing number of programs are being offered in environmental science, hydrology, and geophysics.

Despite the decrease in summer field camp options, a majority of the Bachelors of Science degrees in geology/earth science require field experiences as part of the core curriculum. Many departments are allowing for field experiences other than formal field camps to be used to fulfill this requirement. An increasing number of schools are offering semester field courses that combine field experience with written course work, while others allow field-based research projects to serve as field courses. Many departments offer a wide range of field trips and short weekend field experiences to introduce students to field techniques, instead of the summer course.

Despite the decrease in the number of geoscience departments offering summer field camps, total attendance has increased over the past 10 years. Indiana and New Mexico have had the largest decline in total attendance between 1998-2003 and 2004-2008 for all states (169 and 133 students respectively). Texas, South Dakota, and Pennsylvania had the largest increases in total enrollment during the same period (214, 198, and 198 students respectively). At a regional level, the Northeast has experienced the largest percentage increase in attendance (76%) over the same period of time. However, the Midwest consistently has had the largest field camp attendance for the past 10 years.

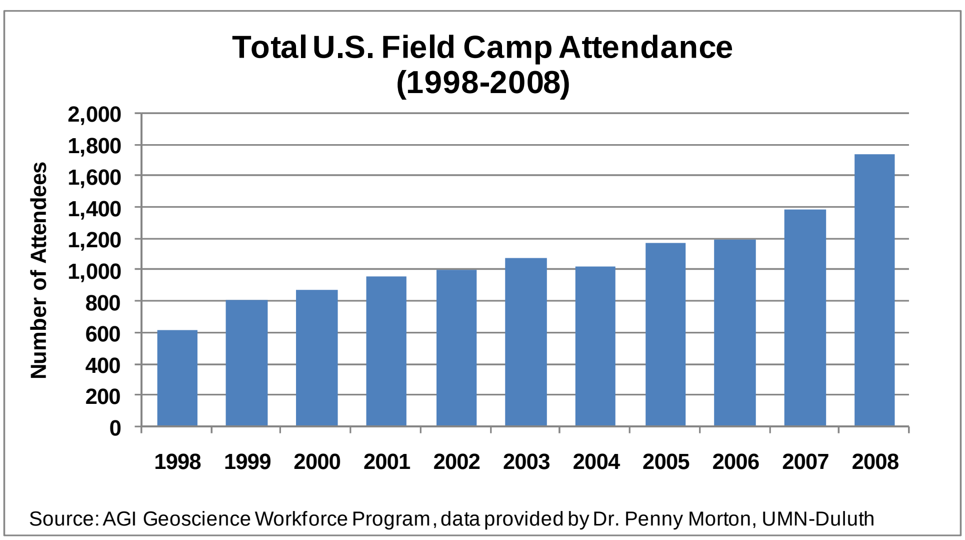


Figure 2.4: Total Field Camp Attendance 1998--2008.

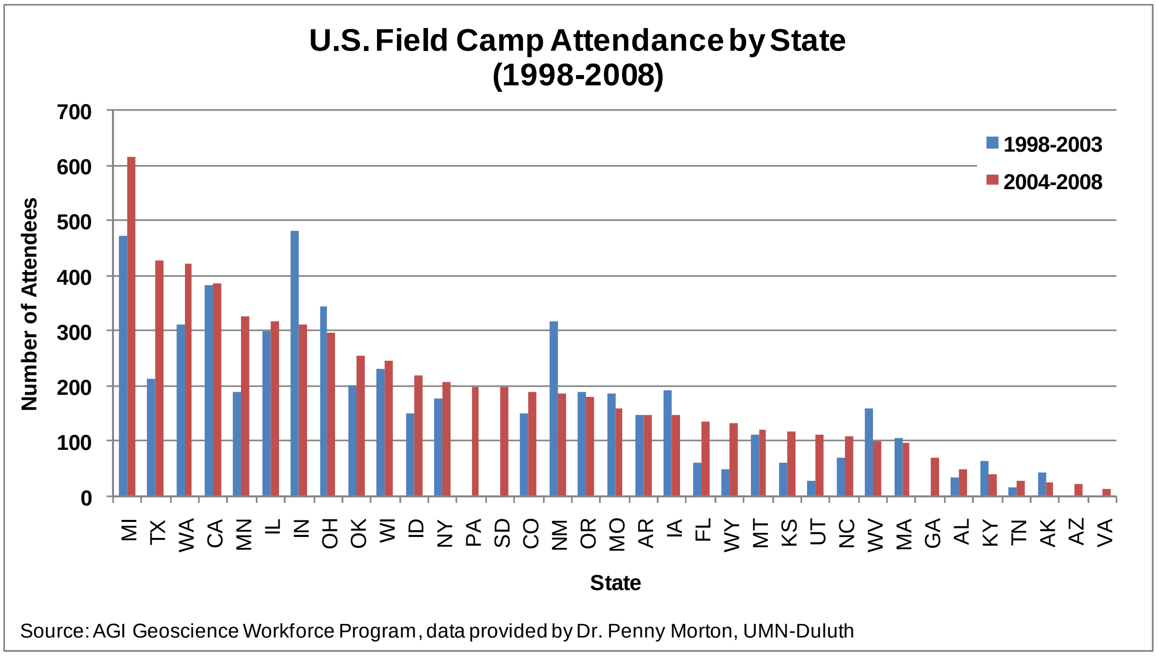


Figure 2.5: Trends in Field Camp Attendance 1998-2003, 2004-2008. (Attendance is based on the location of the host university)

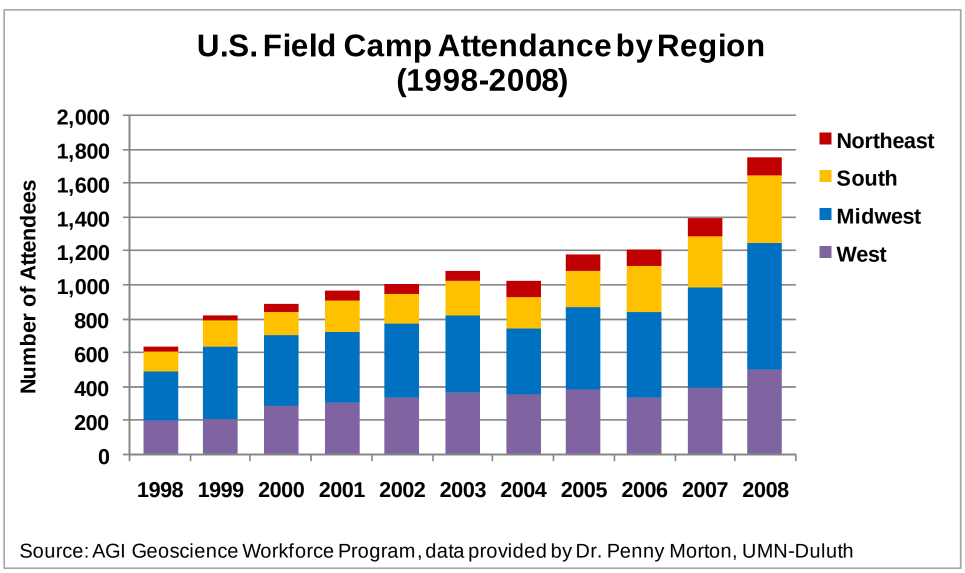


Figure 2.6: Trends in Field Camp Attendance by Region

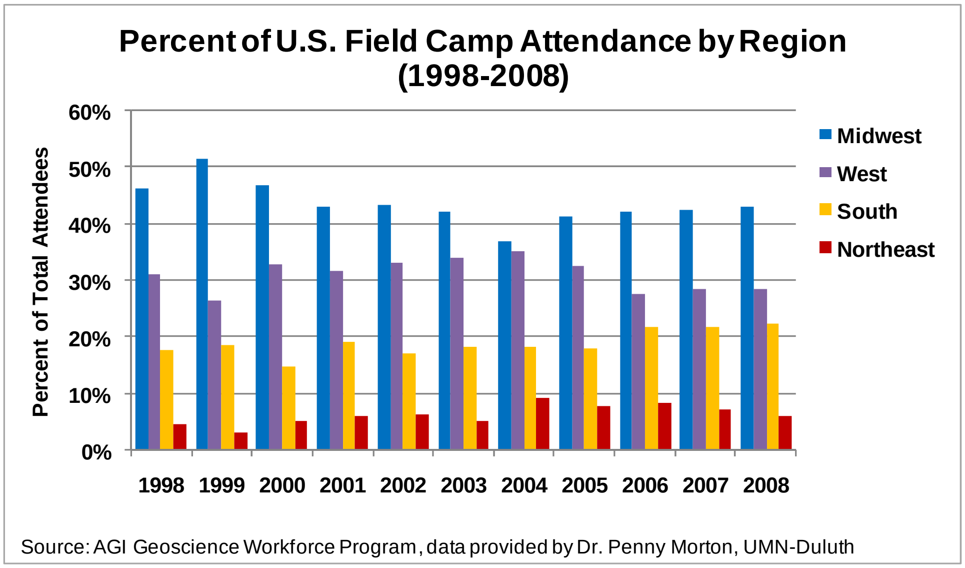


Figure 2.7: Percentage of Field Camp Attendance by Region

Field Camp	State	Field Camp	State
University of Alaska - Fairbanks	AK	University of Missouri - Kansas City	MO
University of Alabama	AL	Montana State University	MT
University of South Alabama	AL	University of Montana	MT
University of Arkansas	AR	University of North Carolina	NC
University of Arizona	AZ	University of North Carolina - Wilmington	NC
California State University - Long Beach	CA	New Mexico Tech	NM
Humboldt State University	CA	University of New Mexico	NM
San Diego State University	CA	Colgate University	NY
San Jose State University	CA	State University of New York - Oswego	NY
University of California - Santa Barbara	CA	State University of New York - Courtland	NY
University of California - Santa Cruz	CA	Bowling Green State University	OH
Colorado School of Mines	CO	Miami University	OH
Colorado State University	CO	Ohio State University	OH
Fort Lewis College	CO	University of Akron	OH
Mesa State College	CO	Wright State University	OH
Florida State	FL	Oklahoma State University	OK
University of Florida	FL	University of Oklahoma	OK
Georgia State University	GA	Oregon State University	OR
University of Georgia	GA	Southern Oregon University	OR
Iowa State University	IA	Lehigh University	PA
University of Iowa	IA	Black Hills Natural Sciences Field Station	SD
Idaho State University	ID	University of Memphis	TN
University of Idaho	ID	Texas A & M University	TX
Illinois State University	IL	University of Houston	TX
Northern Illinois University	IL	University of Texas - Arlington	TX
Southern Illinois University - Carbondale	IL	University of Texas - Austin	TX
University of Illinois - Urbana-Champaign	IL	University of Texas - Dallas	TX
Western Illinois University	IL	University of Texas - El Paso	TX

Field Camp	State	Field Camp	State
Wheaton College	IL	Brigham Young University	UT
Ball State University	IN	Southern Utah University	UT
Indiana University	IN	Utah State University	UT
Fort Hays State University	KS	Weber State University	UT
University of Kansas	KS	George Mason University	VA
Wichita State University	KS	Central Washington University	WA
University of Kentucky	KY	University of Washington	WA
Western Kentucky University	KY	Washington State University	WA
Salem State College	MA	Western Washington University	WA
Albion College	MI	Northland College	WI
Michigan State University	MI	University of Wisconsin	WI
Michigan Technological University	MI	University of Wisconsin - Eau Claire	WI
University of Michigan	MI	University of Wisconsin - Oshkosh	WI
University of Minnesota - Duluth	MN	Concord University	WV
University of Minnesota - Twin Cities	MN	West Virginia University	WV
University of Missouri - Columbia	MO	University of Wyoming	WY

Table 2.4: U.S. Geoscience Field Camps
(Source: Dr. Penny Morton, University of Minnesota-Duluth)

Geoscience Faculty

Geoscience Faculty Demographics

As of January 2008, there were 12,354 geoscience faculty employed in geoscience departments at US colleges and universities, compared to 13,554 in 1999. The numbers of Emeritus and Assistant Professors remained the same over this time, but the number of all other faculty decreased. Currently, 56 percent of all faculty are tenured, while 19 percent are untenured, but in tenure-track positions.

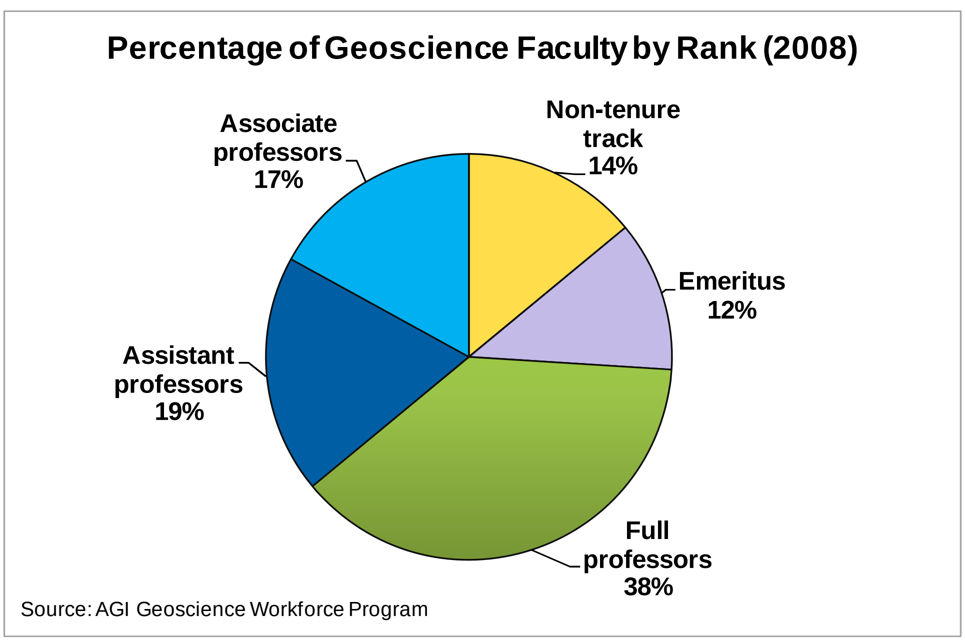


Figure 2.8: Percentage of Geoscience Faculty by Rank

Current tenure-track faculty members received their highest degrees from only 97 different universities, compared to a total of 268 schools that currently grant Ph.D.s in the United States. Of the 97 schools represented, the top ten schools have provided one quarter of all geoscience faculty in the United States.

School	Total number of
Massachusetts Institute of Technology	201
University of California - Berkeley	191
University of Wisconsin	188
University of Washington	184
Columbia University	171
Stanford University	171
California Institute of Technology	148
University of California – Los Angeles	143
Harvard University	139
University of Arizona	137

Table 2.5: Top Ten Degree Granting Institutions of U.S. Geoscience Faculty (Source: AGI Geoscience Workforce Program)

Tenure-track geoscience faculty progress steadily through the academic ranks from assistant professor to full professor by the age of 60. Full professors tend to work later into their career, and there is a cross-over in the population of full professors and emeritus professors in the 71 to 75 age range.

The low numbers of faculty under the age of 40 likely reflects the growing tendency for geoscientists to take post-doctoral fellowships prior taking a faculty position. Lecturers, instructors, and visiting professors comprise less than 5 percent of each age group. Adjunct professors, however, comprise 5 to 10 percent of each age group. This consistent percentage regardless of age, reflects a trend of multiple academic appointments throughout geoscience faculty careers.

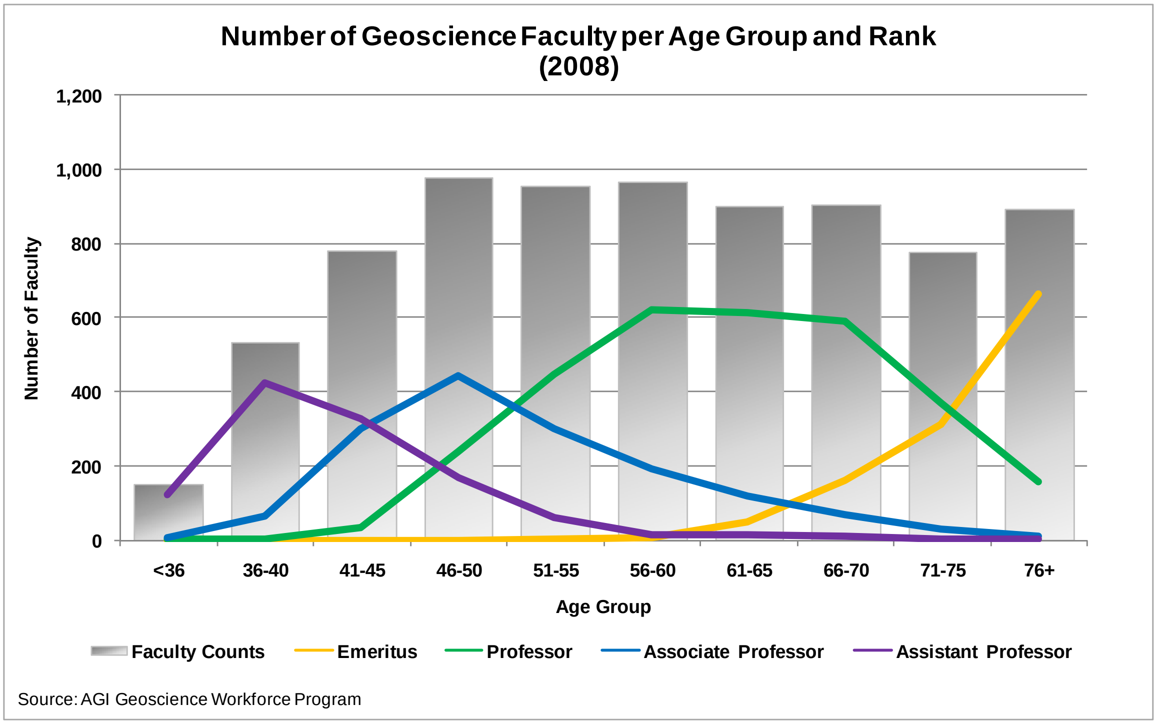


Figure 2.9: Number of Geoscience Faculty per Age Group and Rank

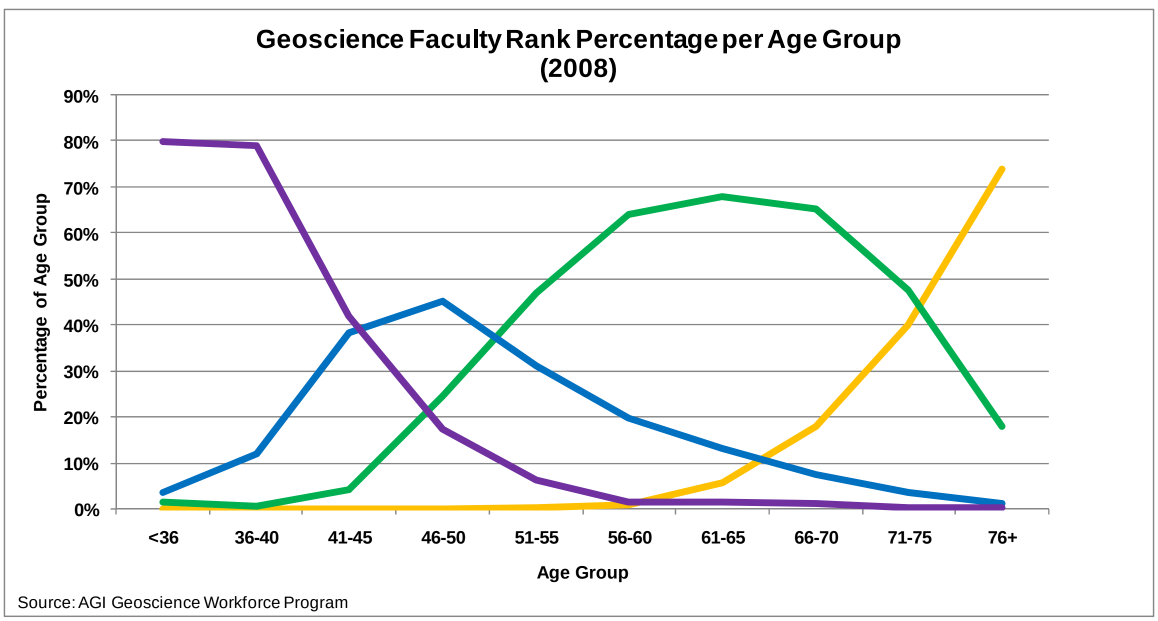


Figure 2.10: Percentage of Geoscience Faculty per Age Group and Rank

Females comprise 14.2 percent of tenure-track faculty in geosciences departments compared to 28 percent in tenure-track positions in all science & engineering fields. In the geosciences, 18.6 percent of non-tenure track positions are held by women. The level of female participation in faculty positions has not changed significantly in recent years.

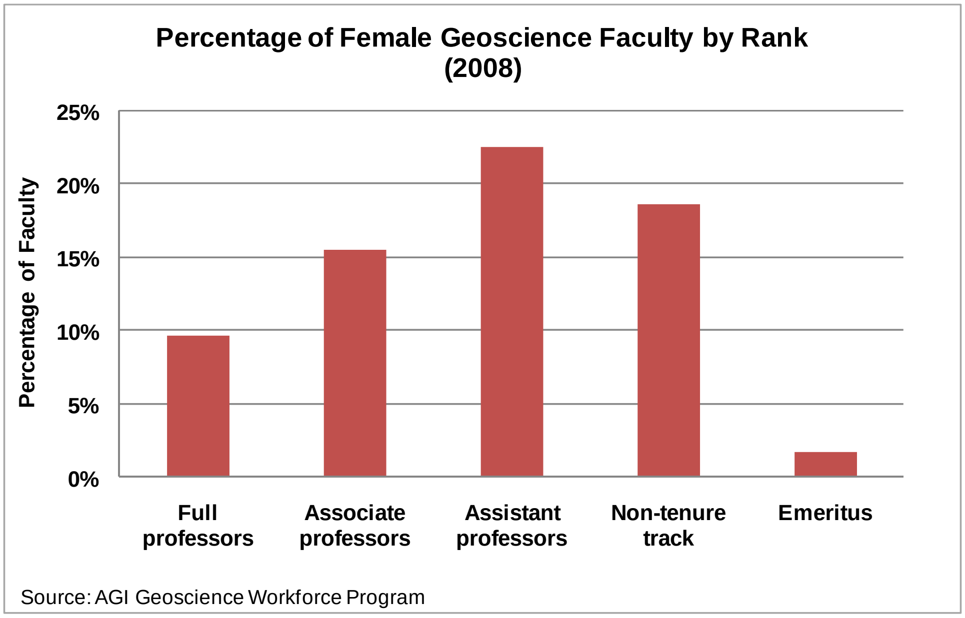


Figure 2.11: Percentage of Female Geoscience Faculty by Rank

Geoscience Faculty Publication Trends and Research Specialties

Although the highest percentage of geoscience journal articles pertain to geology, since the mid-1980's it has steadily declined as interdisciplinary research publications have increased. This trend is concurrent with the increase in funding for interdisciplinary funding that began in the mid-1980's and peaked in 2000, and with the trend in graduate student theses and dissertations pertaining to interdisciplinary research.

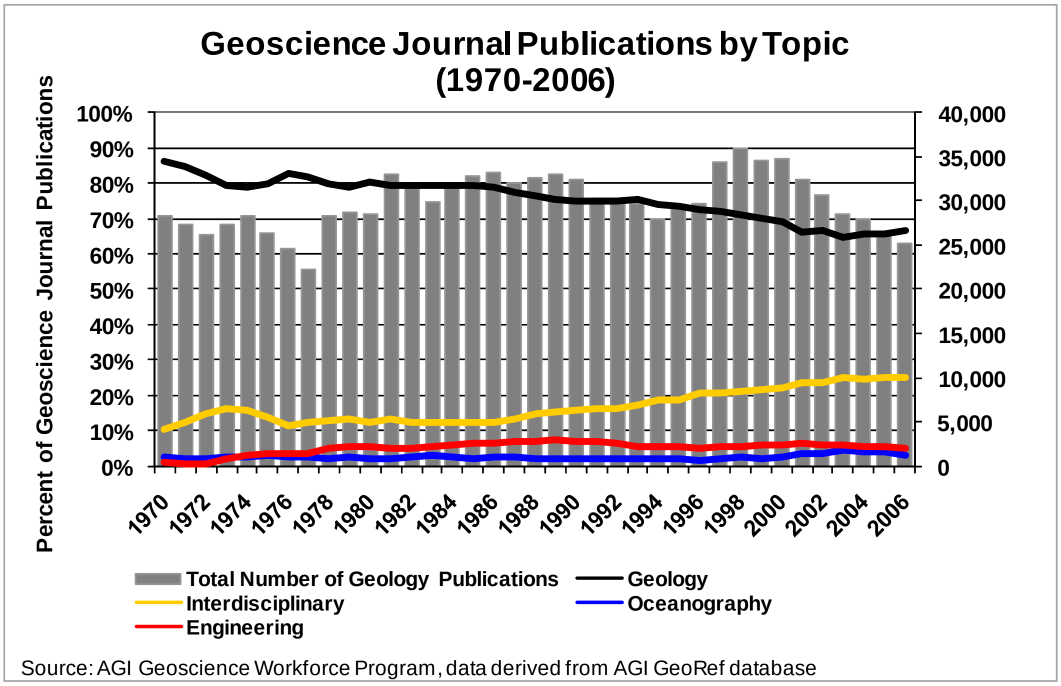


Figure 2.12: Trends in Geoscience Publications

At a national level, the distribution of faculty specialties has remained relatively constant since 1999. However, at a regional level, the Northeast and Midwest have experienced growth in a number of specialties. The largest regional shifts in faculty specialties by region were in Planetology, Economic Geology, and Geochemistry. Additionally, there have been shifts within faculty sub discipline specialties since 1999. Economic Geology has experienced increases in General Economic Geology and Metals (9% and 6% respectively) and a decrease in Oil & Gas, and Coal (5% and 6% respectively). Within Geophysics, Marine Geophysics increased by 8 percent, and in Geochemistry, Marine Geochemistry increased by 4 percent. Within the Paleontology specialty, Paleoecology & Paleoclimatology and Paleobiology have increased each by 4 percent. Soil Science (Other) has increased by 9 percent. In Engineering Geology, General Engineering Geology has decreased by 8 percent. In Planetology, Extraterrestrial Geophysics has increased by 7 percent, and Meteorites & Tektites have decreased by 7 percent. In Other geosciences specialties, Geographic Information Systems has increased by 8 percent.

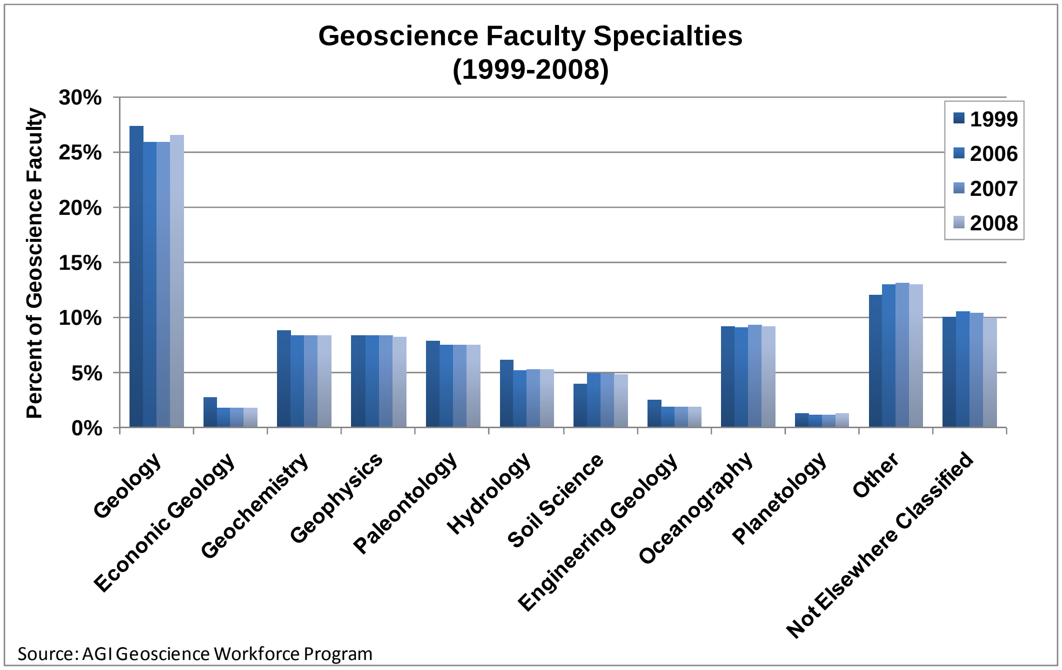


Figure 2.13: Trends in Geoscience Faculty Specialties (1999-2008)

	Percent Change 1999-2008			
	Midwest	**Northeast**	**South**	**West**
Geology	1%	3%	-4%	0%
Economic Geology	8%	4%	-8%	-4%
Geochemistry	0%	7%	-1%	-6%
Geophysics	4%	1%	-2%	-2%
Paleontology	3%	3%	-4%	-2%
Hydrology	0%	4%	1%	-4%
Soil Science	-3%	-2%	-1%	6%
Engineering Geology	0%	4%	2%	-5%
Oceanography	-1%	-3%	-2%	6%
Planetology	-2%	4%	-13%	10%
Other	3%	1%	-1%	-3%
Not Elsewhere Classified	1%	3%	2%	-6%

Table 2.6: Percent Change in Faculty Specialty by Region (1999–2008)
(Source: AGI Geoscience Workforce Program)

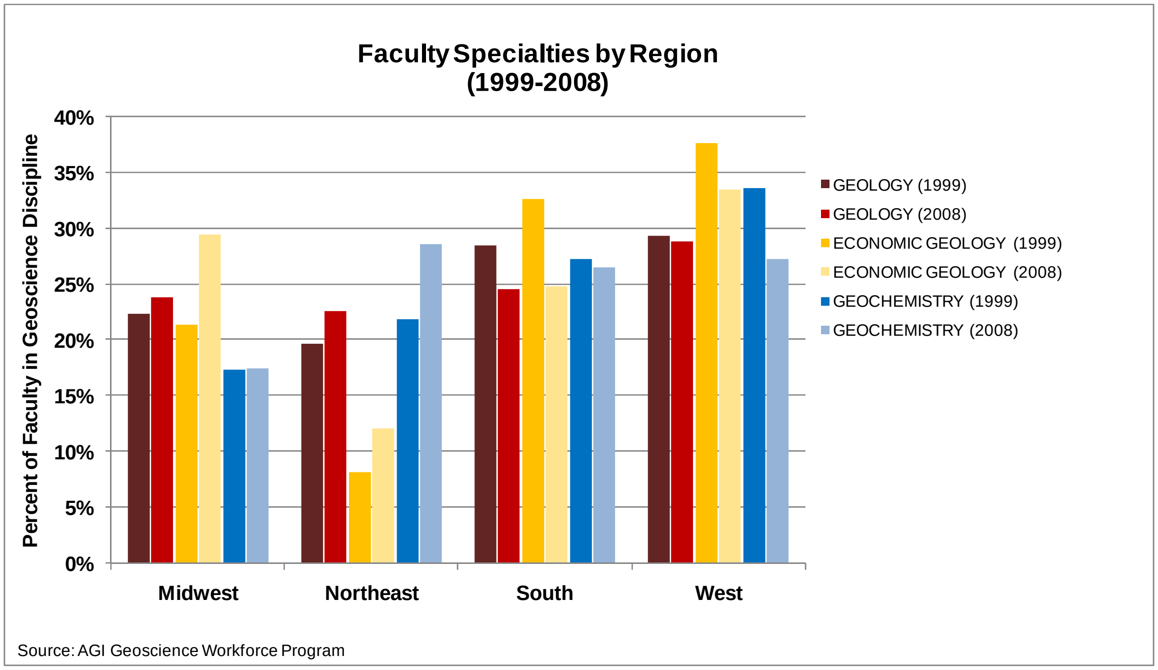


Figure 2.14: Trends in Faculty Specialties by Region (Geology, Economic Geology, Geochemistry)

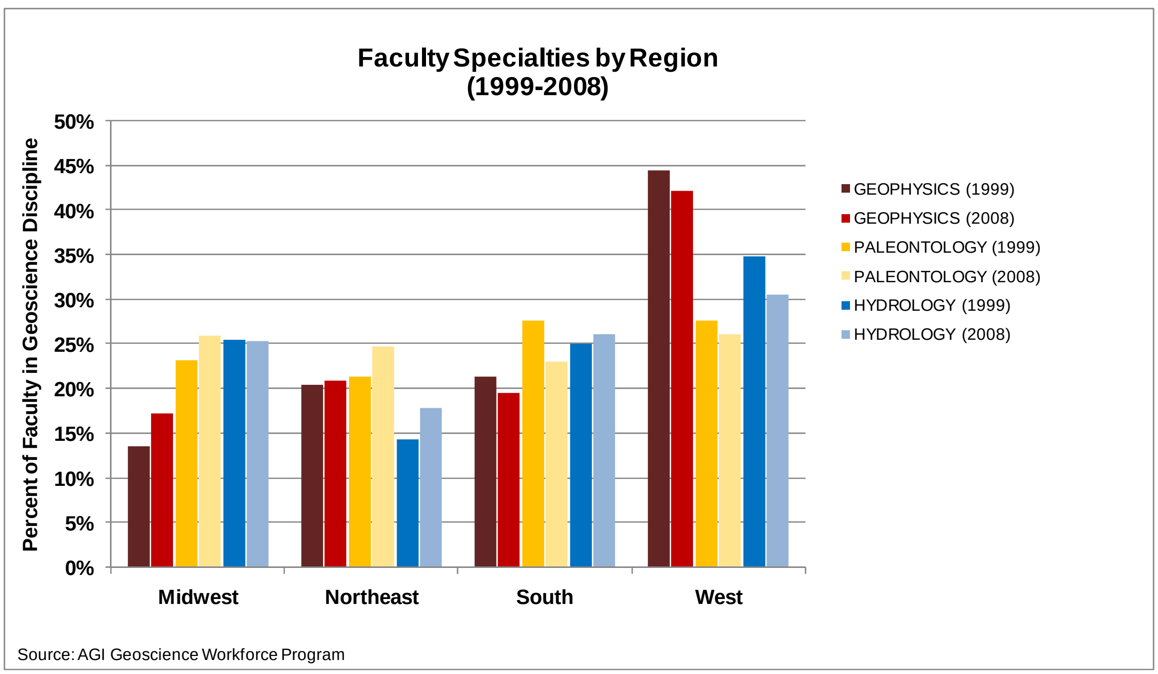


Figure 2.15: Trends in Faculty Specialties by Region (Geophysics, Paleontology, Hydrology)

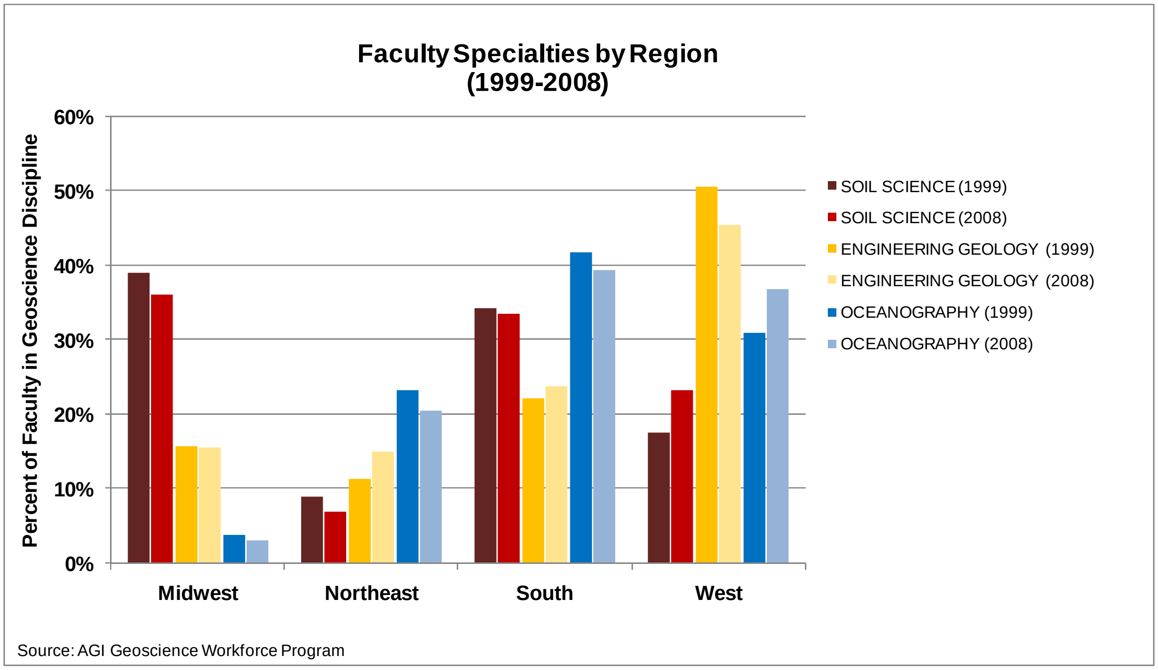


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Figure 2.16: Trends in Faculty Specialties by Region (Soil Science, Engineering Geology, Oceanography)

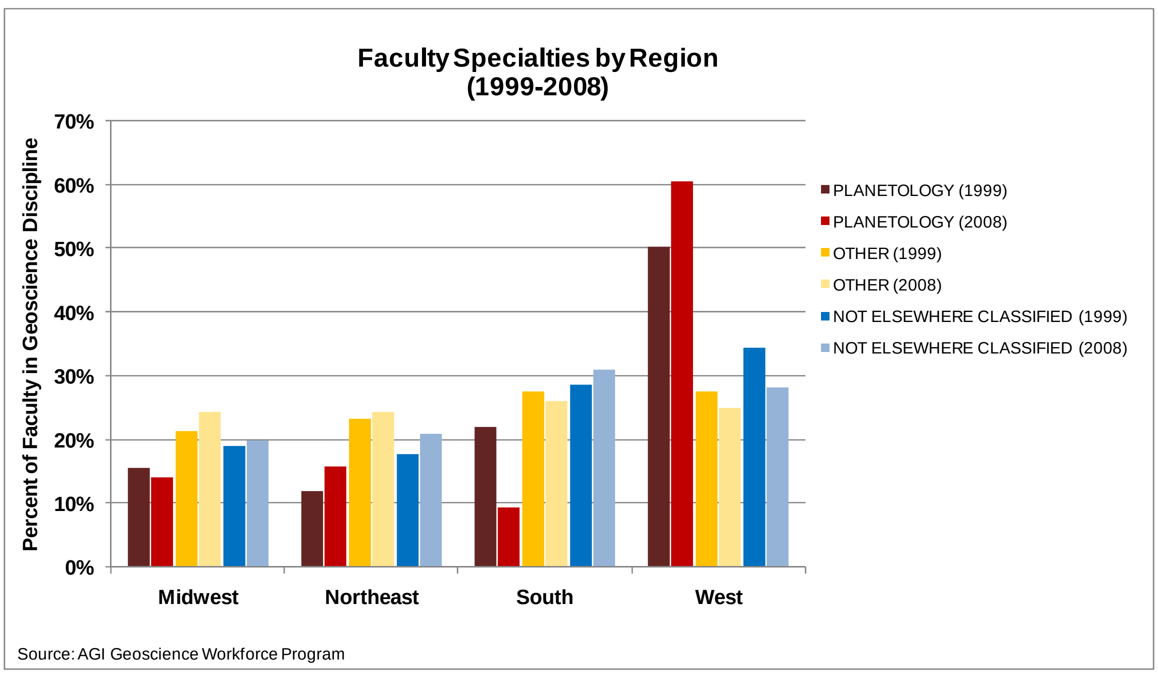


Figure 2.17: Trends in Faculty Specialties by Region (Planetology, Other, Not Elsewhere Classified)

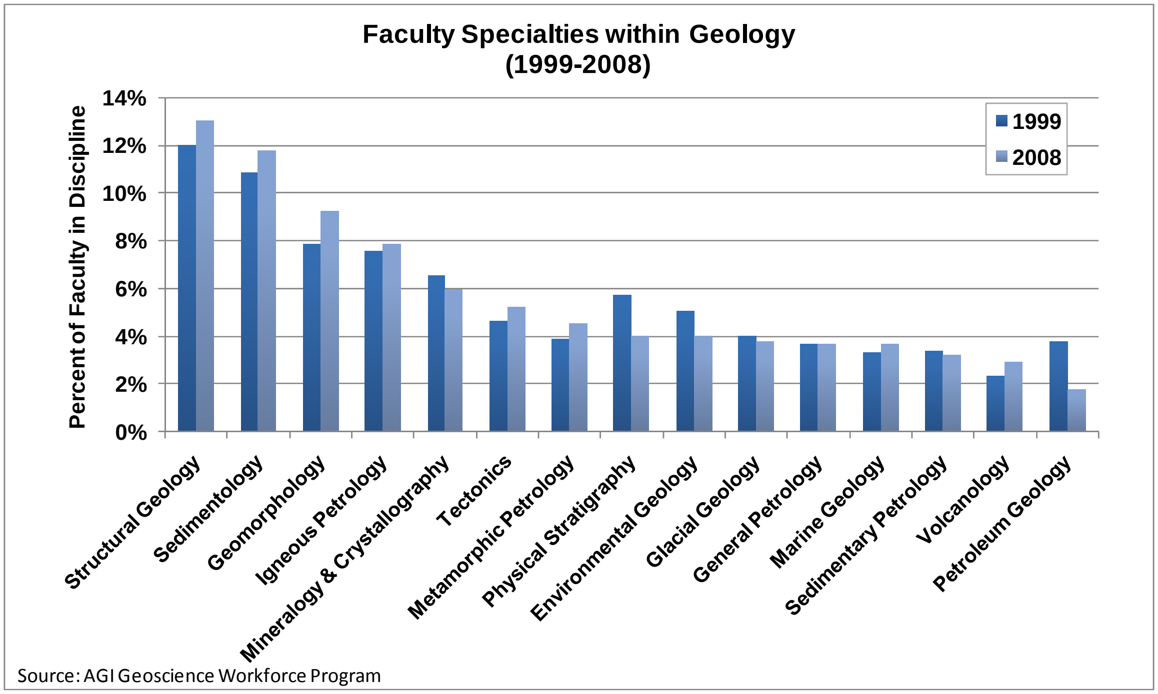


Figure 2.18: Changes in Faculty Specialties within Geology (1998-2008)

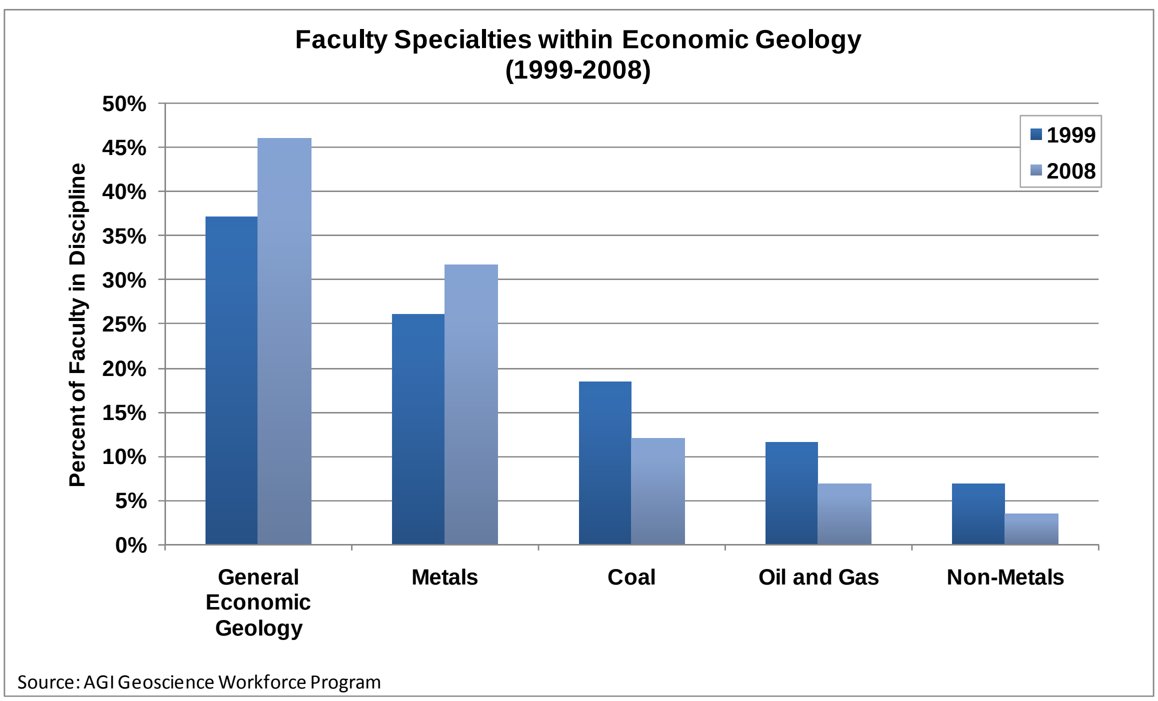


Figure 2.19: Changes in Faculty Specialties within Economic Geology (1998-2008)

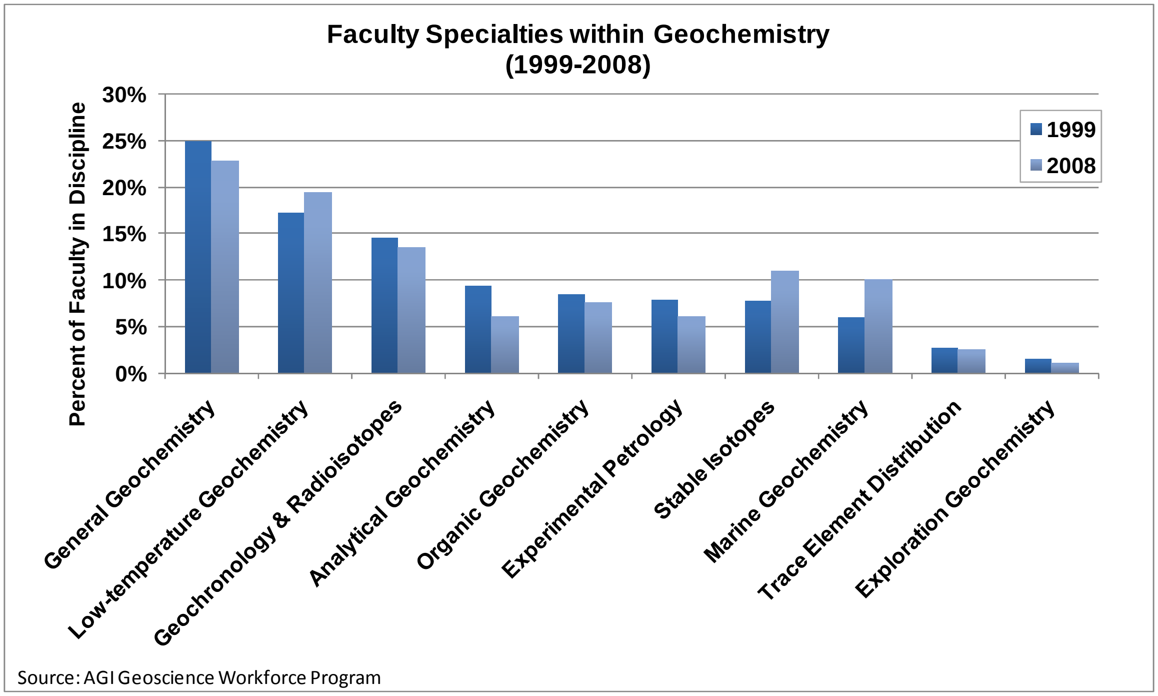


Figure 2.20: Changes in Faculty Specialties within Geochemistry (1998-2008)

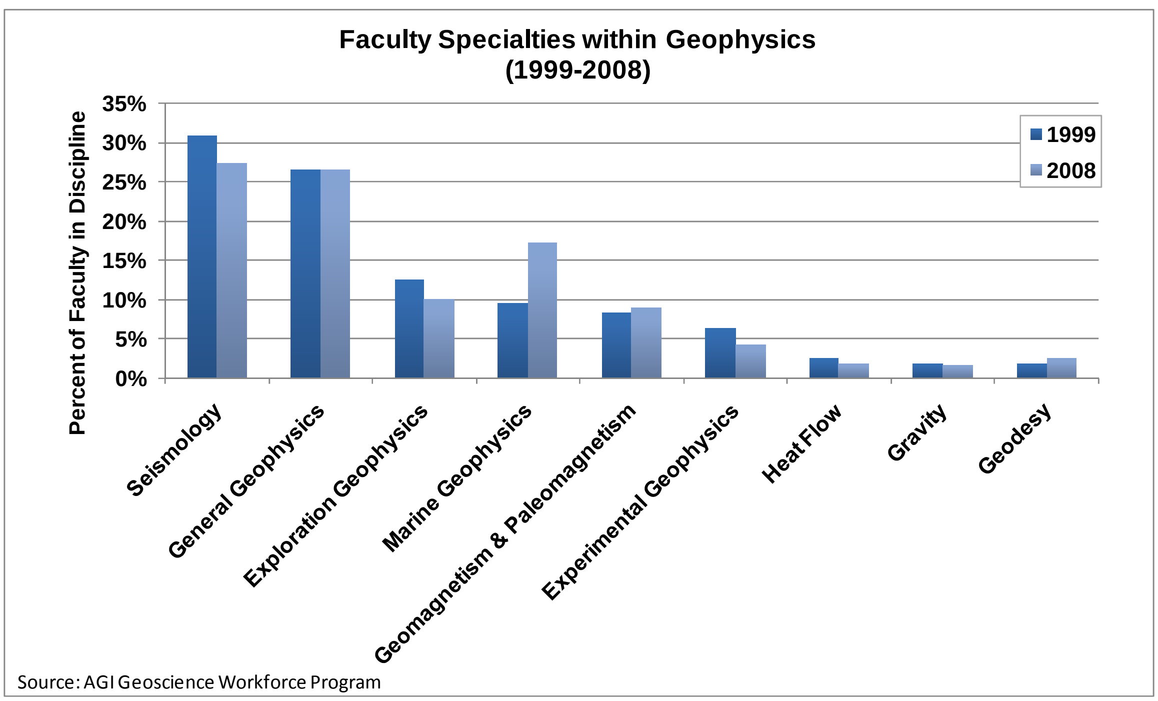


Figure 2.21: Changes in Faculty Specialties within Geophysics (1998-2008)

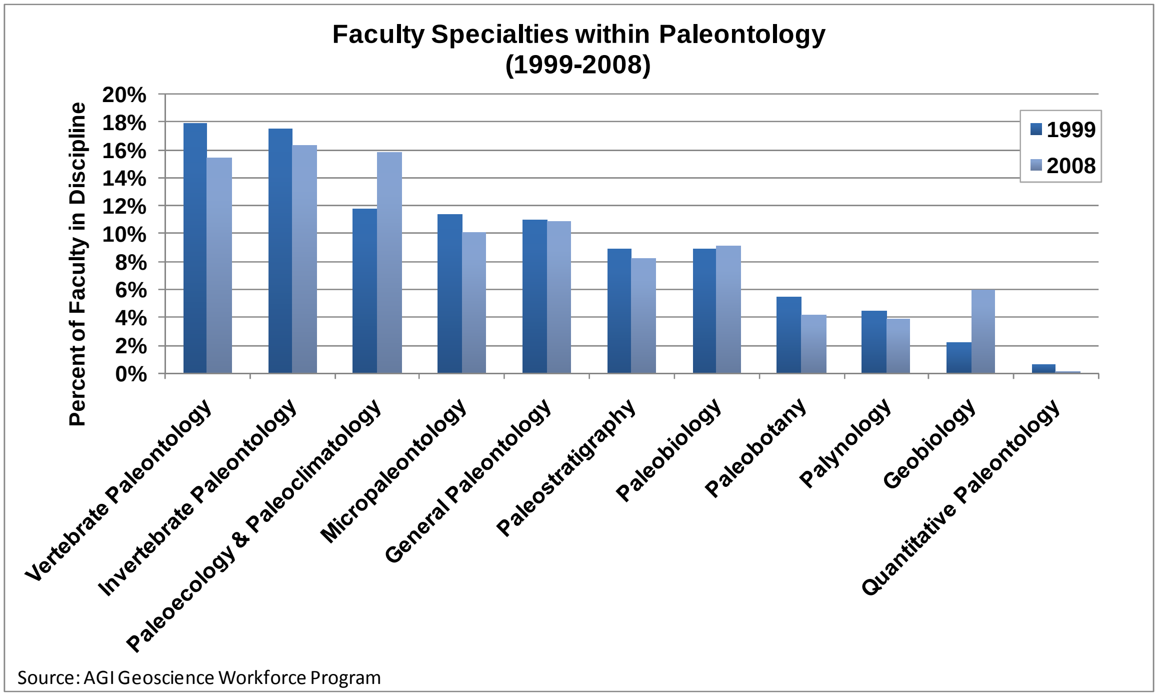


Figure 2.22: Changes in Faculty Specialties within Paleontology (1998-2008)

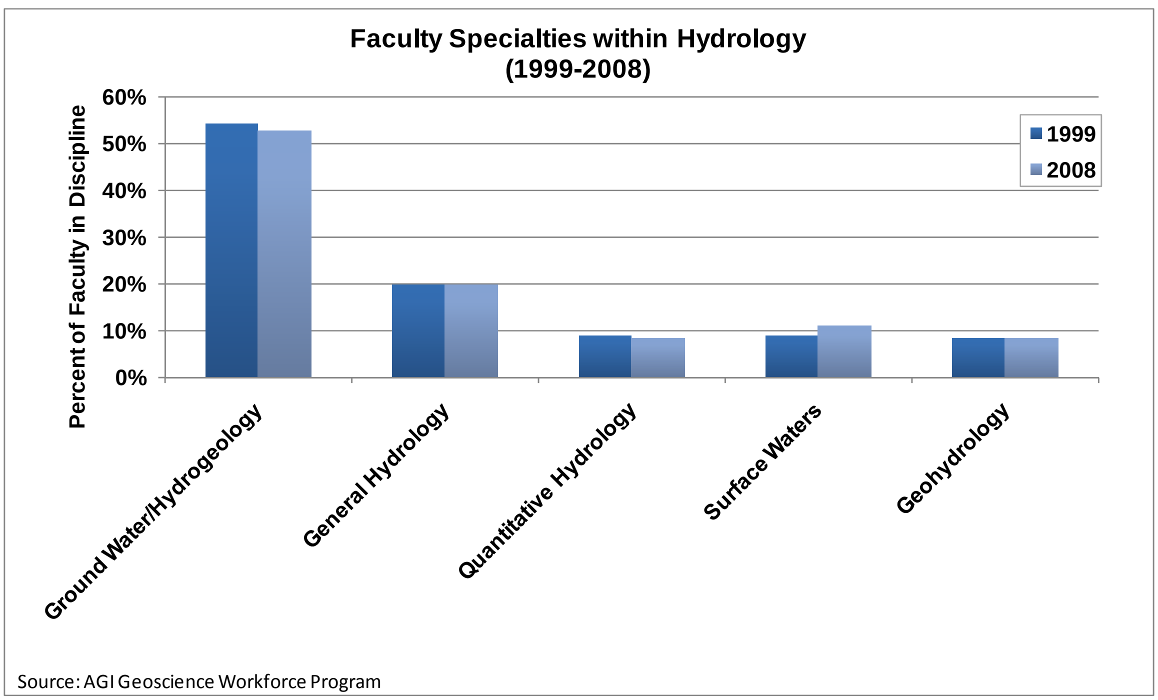


Figure 2.23: Changes in Faculty Specialties within Hydrology (1998-2008)

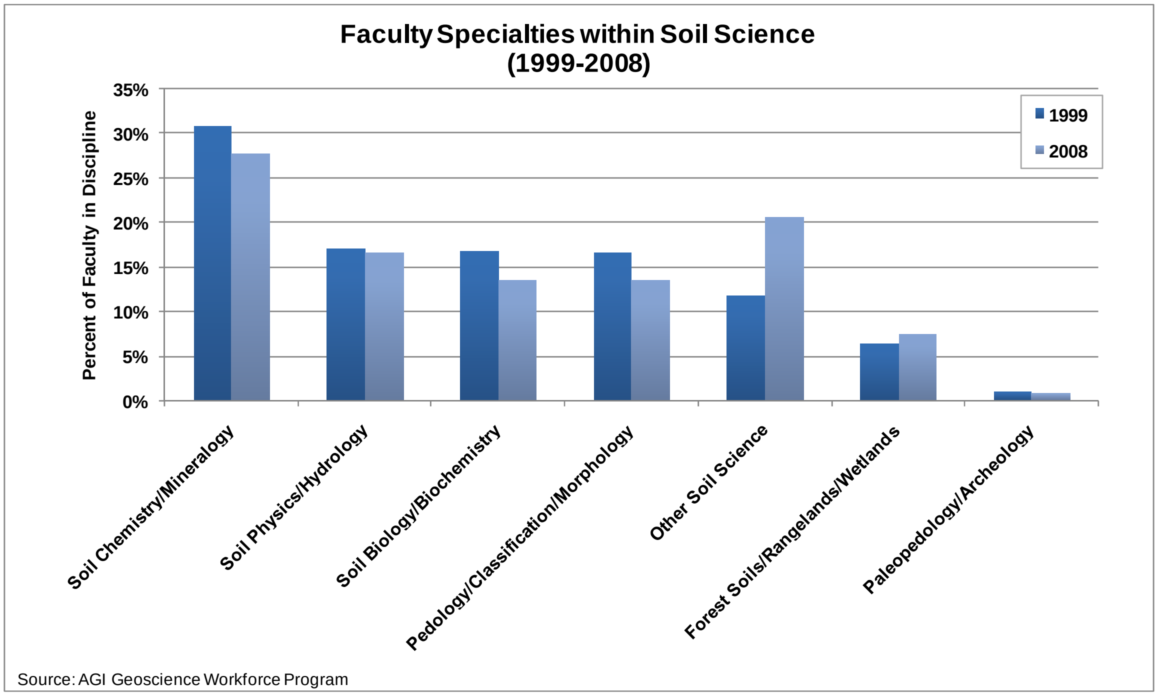


Figure 2.24: Changes in Faculty Specialties within Soil Science (1998-2008)

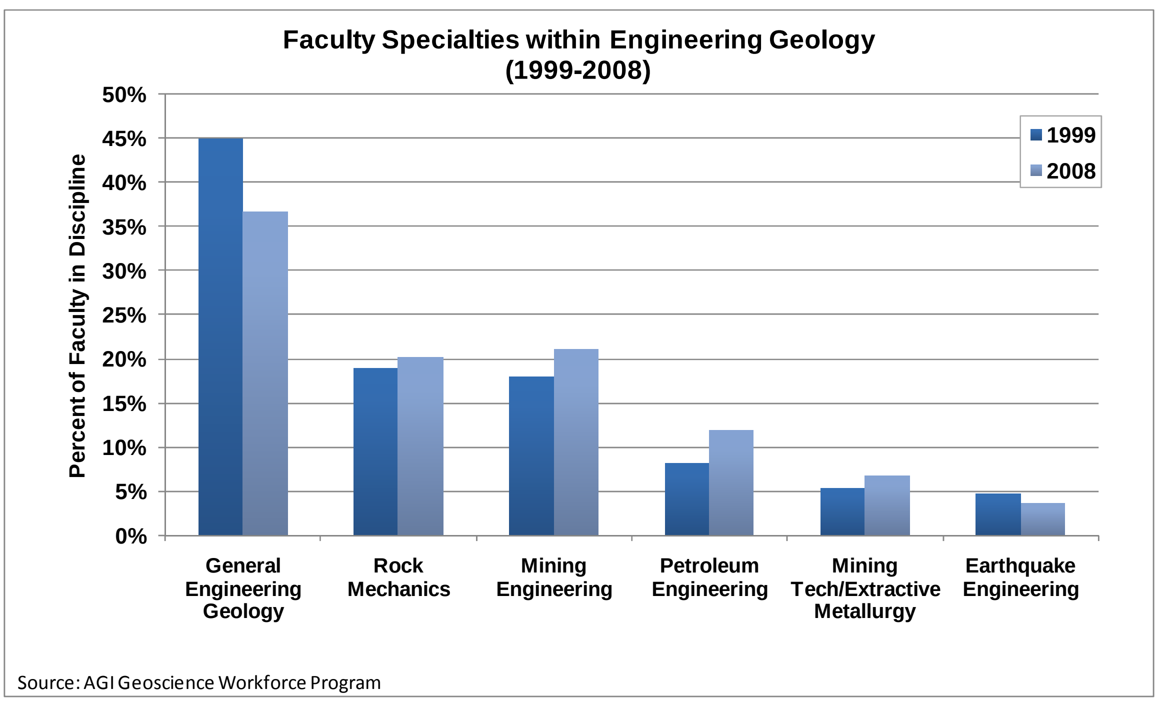


Figure 2.25: Changes in Faculty Specialties within Engineering Geology (1998-2008)

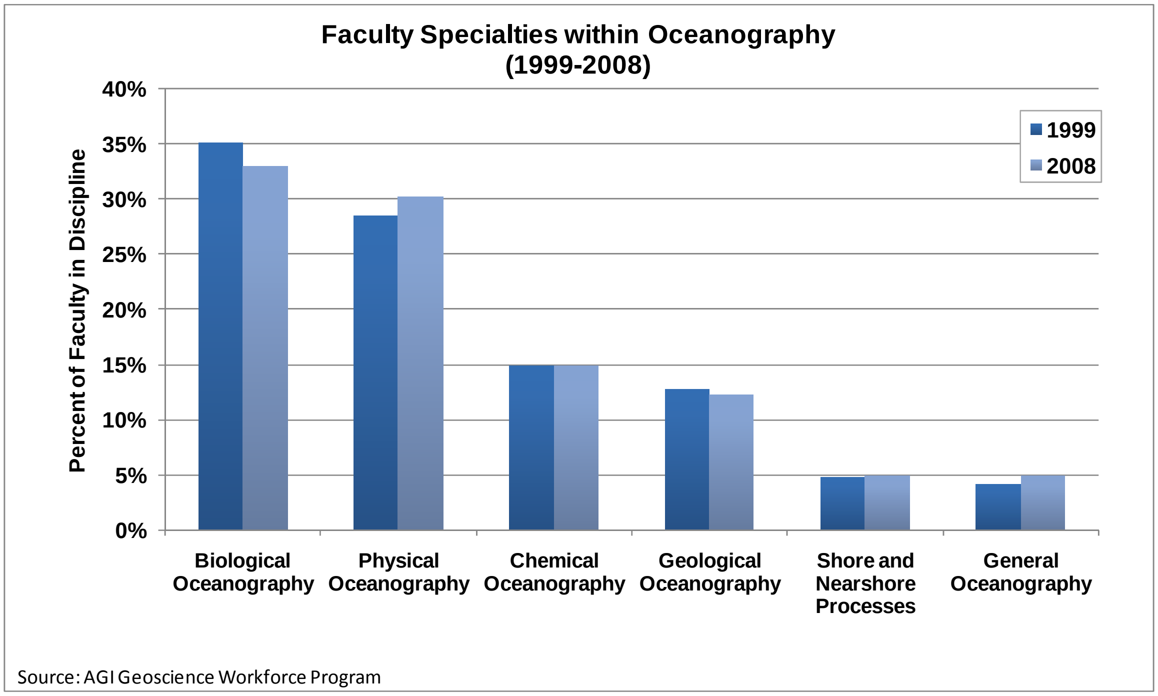


Figure 2.26: Changes in Faculty Specialties within Oceanography (1998-2008)

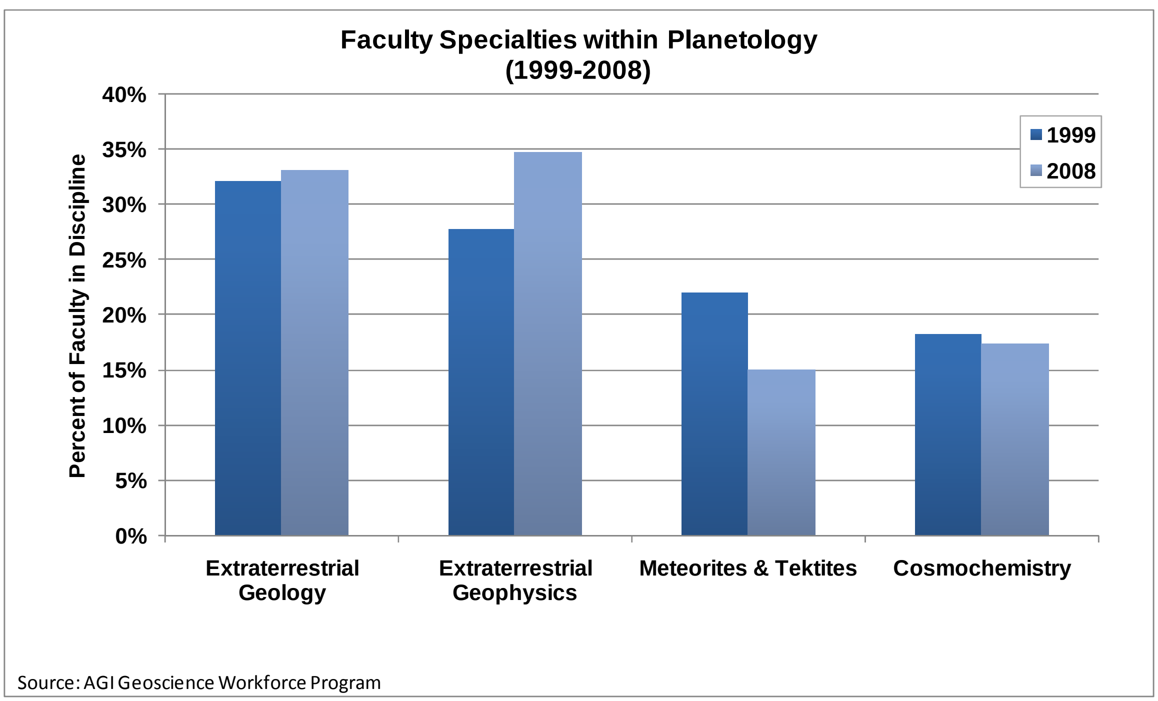


Figure 2.27: Changes in Faculty Specialties within Planetology (1998-2008)

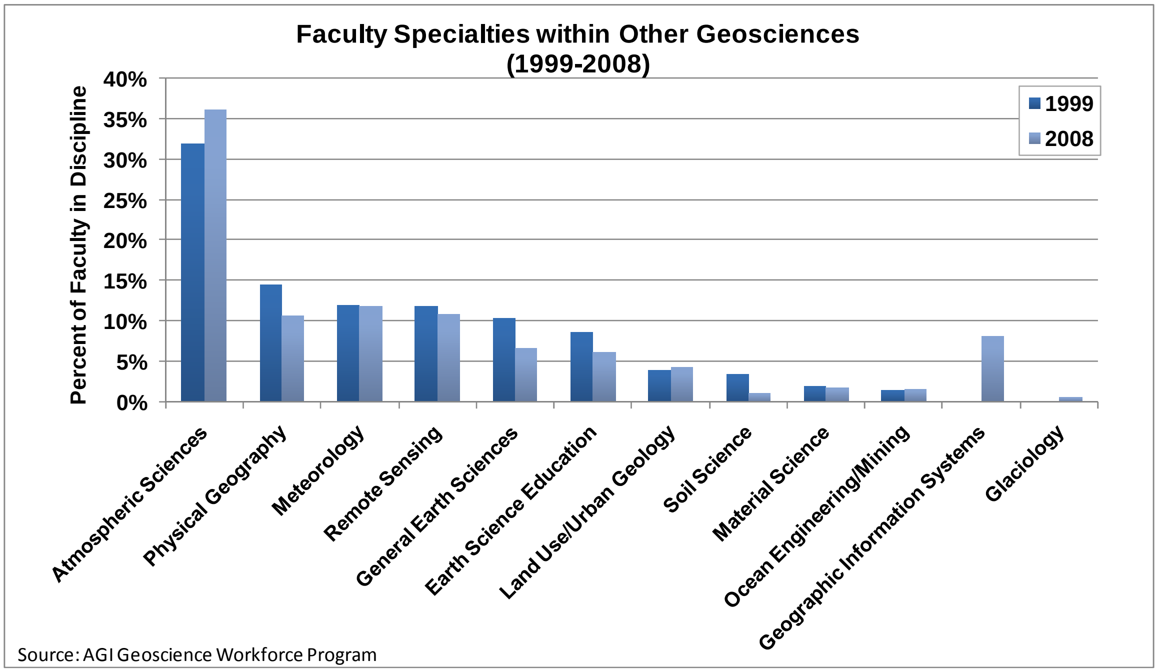


Figure 2.28: Changes in Faculty Specialties within Other Geosciences (1998-2008)

Faculty Specialty	Percent Change (1999-2008)	Faculty Specialty	Percent Change (1999-2008)
GEOLOGY		**HYDROLOGY**	
Geomorphology	1%	Surface Waters	2%
Structural Geology	1%	Quantitative Hydrology	-1%
Sedimentology	1%	Ground Water/Hydrogeology	-2%
Metamorphic Petrology	1%	**SOIL SCIENCE**	
Volcanology	1%	Other Soil Science	9%
Tectonics	1%	Forest	1%
Mineralogy & Crystallography	-1%	Pedology/Classification/Morphol	-3%
Environmental Geology	-1%	Soil Chemistry/Mineralogy	-3%
Physical Stratigraphy	-2%	Soil Biology/Biochemistry	-3%
Petroleum Geology	-2%	**ENGINEERING GEOLOGY**	
General Geology	-4%	Petroleum Engineering	4%
ECONOMIC GEOLOGY		Mining Engineering	3%
General Economic Geology	9%	Mining Tech/Extractive	1%
Metals	6%	Rock Mechanics	1%
Non-Metals	-3%	Earthquake Engineering	-1%
Oil and Gas	-5%	General Engineering Geology	-8%
Coal	-6%	**OCEANOGRAPHY**	
GEOCHEMISTRY		Physical Oceanography	2%
Marine Geochemistry	4%	General Oceanography	1%
Stable Isotopes	3%	Biological Oceanography	-2%
Low-temperature Geochemistry	2%	**PLANETOLOGY**	
Organic Geochemistry	-1%	Extraterrestrial Geophysics	7%
Geochronology & Radioisotopes	-1%	Extraterrestrial Geology	1%
Experimental Petrology	-2%	Cosmochemistry	-1%
General Geochemistry	-2%	Meteorites & Tektites	-7%
Analytical Geochemistry	-3%	**OTHER**	
GEOPHYSICS		Geographic Information Systems	8%
Marine Geophysics	8%	Atmospheric Sciences	4%
Geodesy	1%	Glaciology	1%
Geomagnetism & Paleomagnetism	1%	Remote Sensing	-1%
Heat Flow	-1%	Soil Science	-2%
Experimental Geophysics	-2%	Earth Science Education	-3%
Exploration Geophysics	-3%	General Earth Sciences	-4%
Seismology	-4%	Physical Geography	-4%
PALEONTOLOGY			
Paleoecology & Paleoclimatology	4%		
Geobiology	4%		
Palynology	-1%		
Paleostratigraphy	-1%		
Invertebrate Paleontology	-1%		
Micropaleontology	-1%		
Paleobotany	-1%		
Vertebrate Paleontology	-2%		

Table 2.7: Changes in Faculty Specialty Sub-disciplines (1999-2008)
(Source: AGI Geoscience Workforce Program)

Geoscience University Students

Enrollments and Degrees

The number of students enrolled in the geosciences in U.S. colleges and universities remained relatively steady in 2007 with 19,216 undergraduates and 7,944 graduate students enrolled. The total number of students enrolled in bachelors' degree programs in the United States in 2006 was 20,560. This number has been holding steady in recent years.

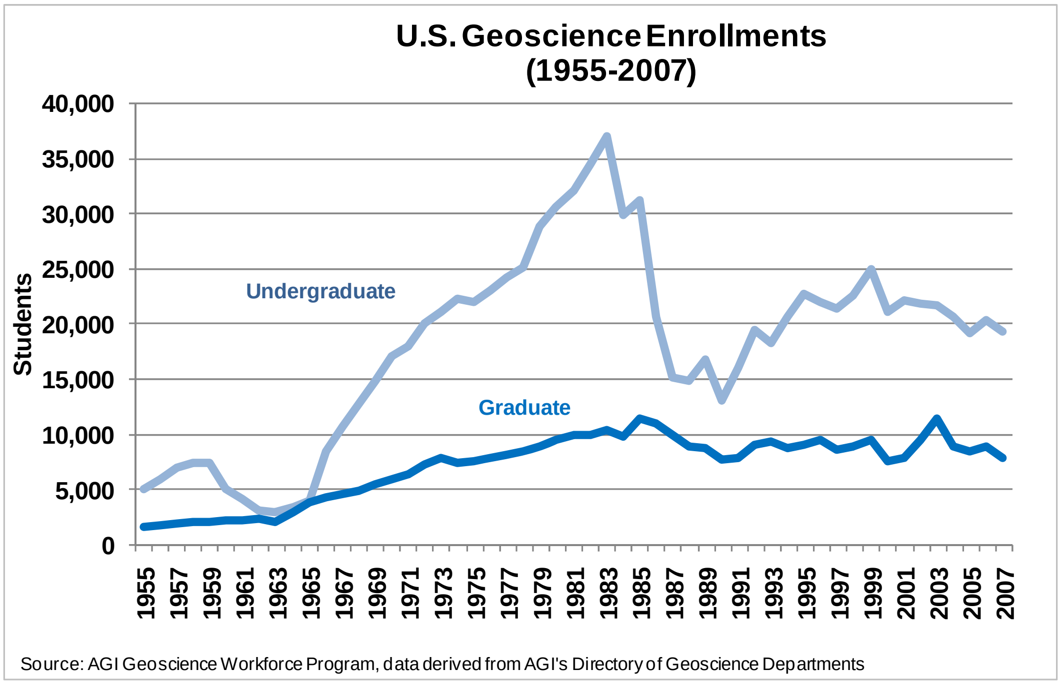


Figure 2.29: Geoscience Enrollments at U.S. Four Year Universities

Degrees granted in 2007 remained steady, except for new doctorates, which increased sharply by over 30 percent. This sharp increase mirrors the influx of entering graduate students in 2003 and 2004 following the burst of the dot-com bubble in 2001. Between 1995 and 2000, the combination of soaring stock prices and available venture capital enabled the quick establishment of many Internet-based companies that favored expansive growth over standard business models. When the dot-com bubble burst in 2001, many of these new companies failed. Many of those who did not survive the bust, returned to their professional field, often enrolling in graduate school. Given the graduate enrollment profile since 2003, this increase in doctorate production will likely be short-lived.

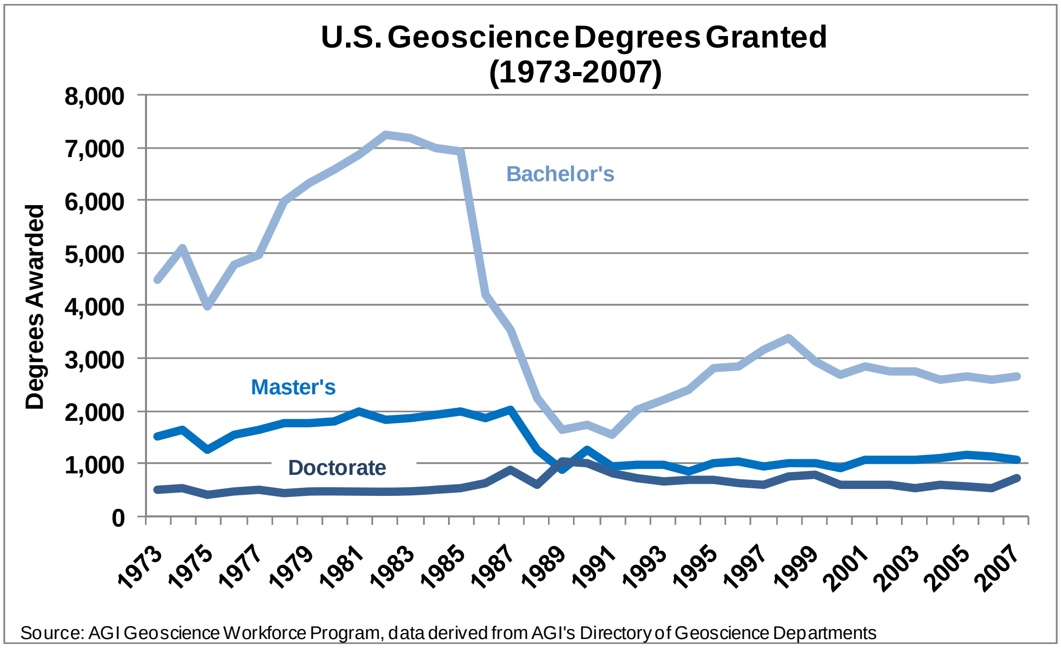


Figure 2.30: Geoscience Degrees Conferred at U.S. Four Year Universities

Diversity in Geoscience Enrollments and Degrees

The composition of degree holders is an important measure of disciplinary health. The ability to attract the maximum level of competency to a profession is dependent upon its ability to recruit across gender, racial, and economic divides. The disparity between whole-population level of specific populations and their representation in the profession can be viewed as a first order proxy of the recruitment and sustainability of a discipline. In the geosciences, the participation of women in the geosciences has steadily increased over the past several decades, and women currently earn 43 percent of all geoscience degrees. The greatest increase in the percentage of women obtaining geoscience degrees since 1990 has been at the Master's level (20%). The smallest increase has been at the Bachelor's level (13%). The percentage of women obtaining geoscience degrees at the Doctoral level has increased 18 percent since 1990.

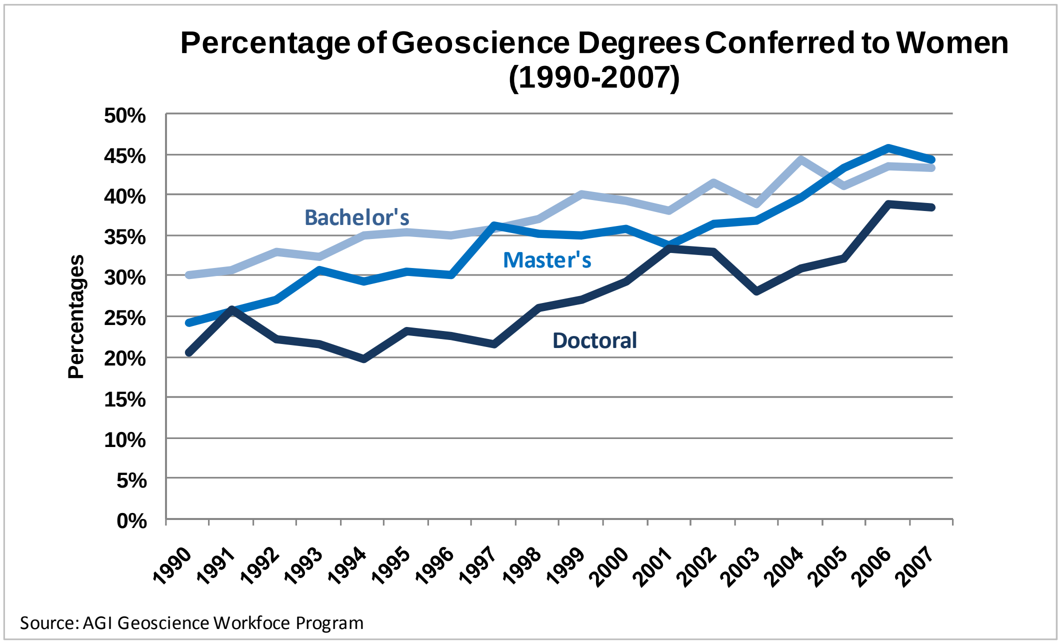
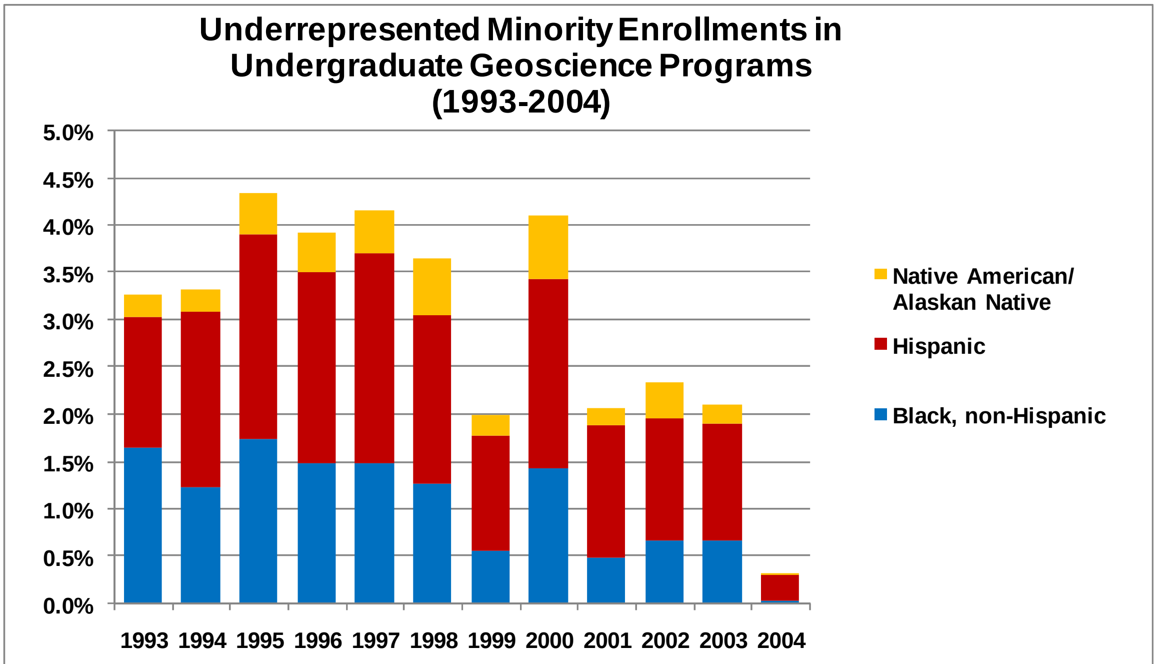


Figure 2.31: Percentage of Geoscience Degrees Conferred to Women

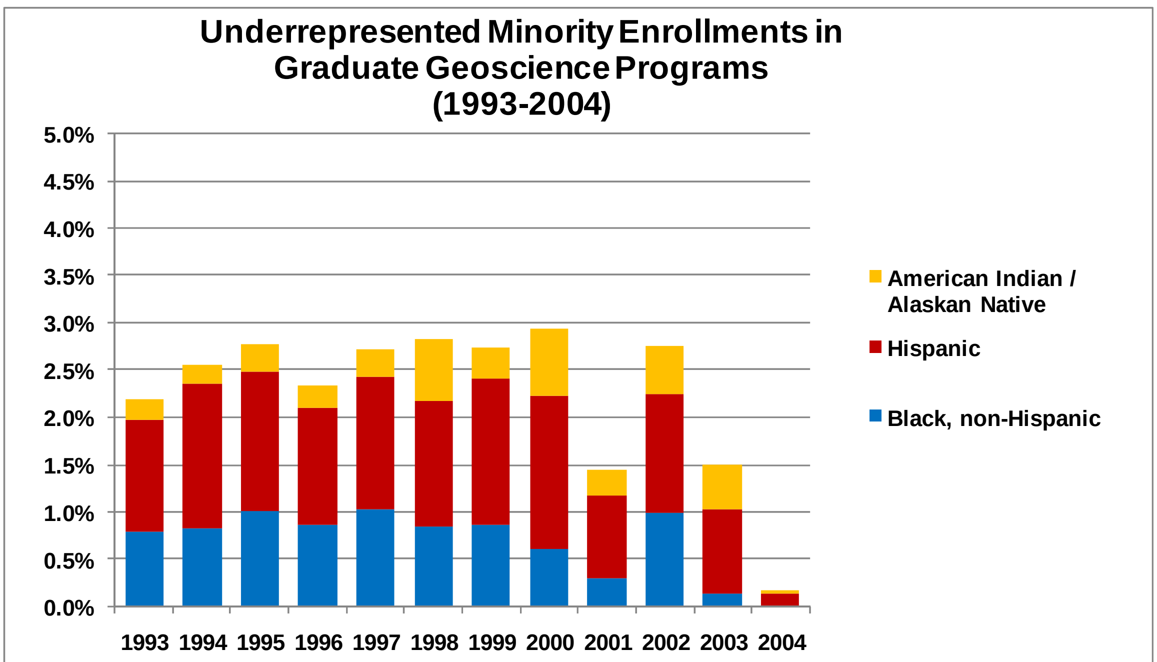
Compared to the success story of female student graduates, the participation of underrepresented minorities in the geosciences is extremely poor. Compared with other science & engineering fields, the geosciences confer the lowest percentage of Bachelor's and Master's degrees to underrepresented minorities. However, at the doctoral level, the geosciences confer a higher percentage of degrees to underrepresented minorities than do mathematics, engineering, physical sciences, and computer science. The percentage of all science & engineering degrees conferred to Hispanics and non-Hispanic African Americans is 8 percent, whereas the percentage of geoscience degrees conferred to these minorities is approximately 2 percent. In comparison, Hispanics and non Hispanic African Americans comprise 29 percent of the U.S. population (14% Hispanic and 15% non-Hispanic African American). The percentage of degrees conferred to Native Americans and Alaskan Natives from all science & engineering programs and from geoscience programs is approximately the same (0.8%). These minorities comprise only 2 percent of the U.S. population.

Overall, Hispanics earn the largest percentage of geoscience degrees conferred to underrepresented minorities. This may be partly due to the geographic distribution of geoscience departments which are located in regions where there are large Hispanic populations. This geographic distribution may also account for the low participation rates of African Americans in geoscience programs. There are few geoscience programs at universities and community colleges in areas where there are large populations of African Americans. Underrepresented minorities currently comprise 31% of the US population. By 2050, they will comprise 48 percent of the U.S. population, with Hispanics comprising 30 percent of the total U.S. population. Considering that the composition of degree holders within a discipline is an important measure of disciplinary health, the geosciences have much to do to increase the participation rate of underrepresented minorities.



Source: AGI Geoscience Workforce Program, data derived from NSF/SRS *S&E Degrees by Race/Ethnicity of Recipients: 1995-2004*

Figure 2.31: Minority Enrollments in Undergraduate Geoscience Programs



Source: AGI Geoscience Workforce Program, data derived from NSF/SRS *S&E Degrees by Race/Ethnicity of Recipients: 1995-2004*

Figure 2.32: Minority Enrollments in Graduate Geoscience Programs

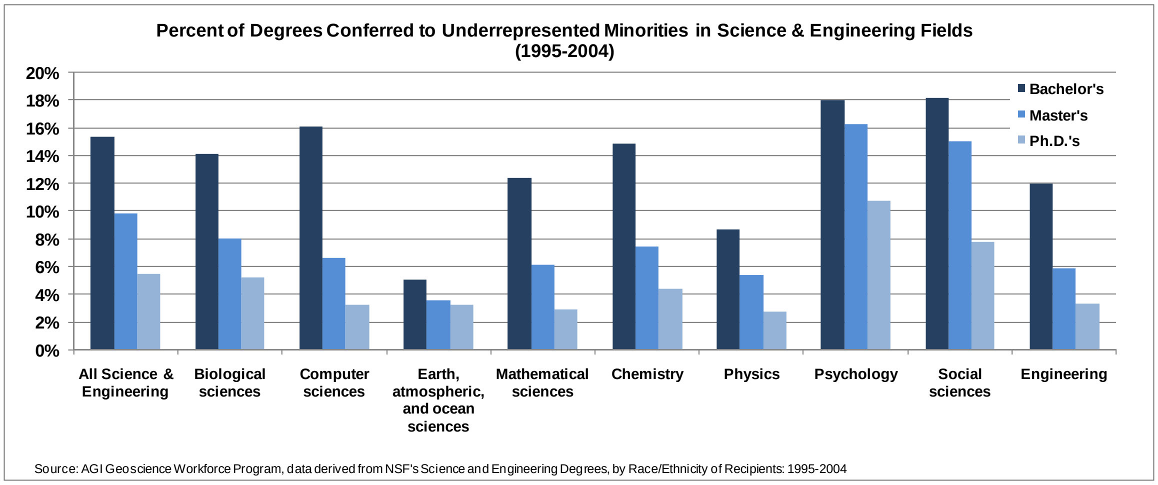


Figure 2.33: Percentage of Degrees Conferred to Underrepresented Minorities by Degree Field

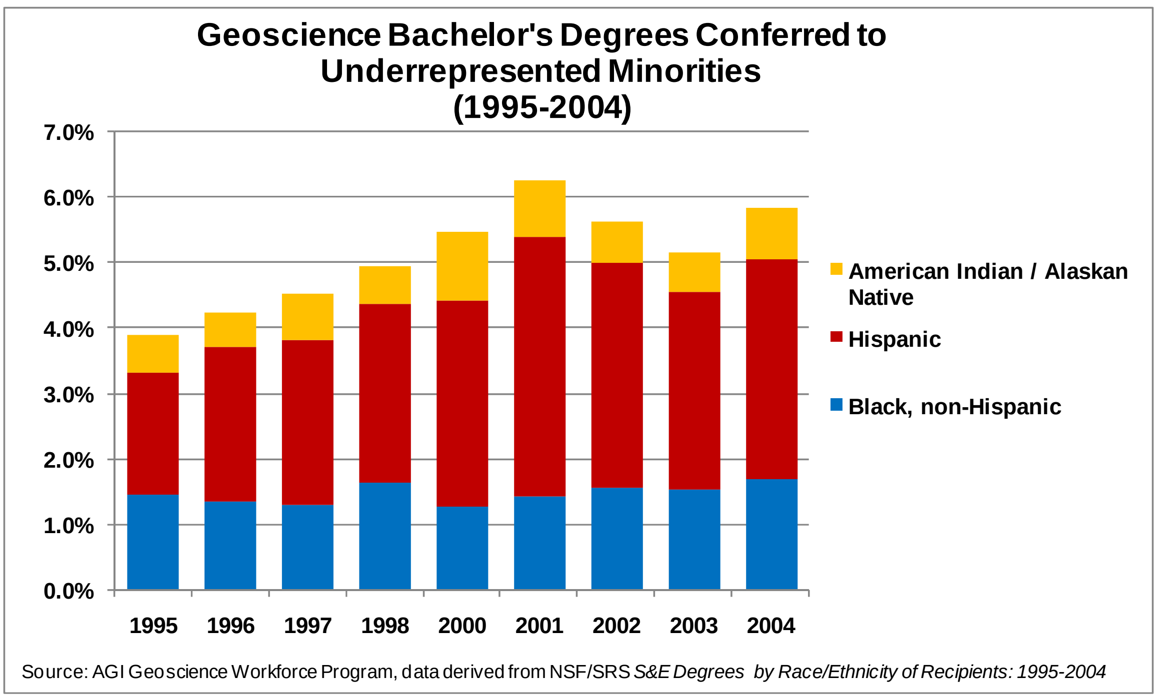


Figure 2.34: Geoscience Bachelor's Degrees Conferred to Minorities

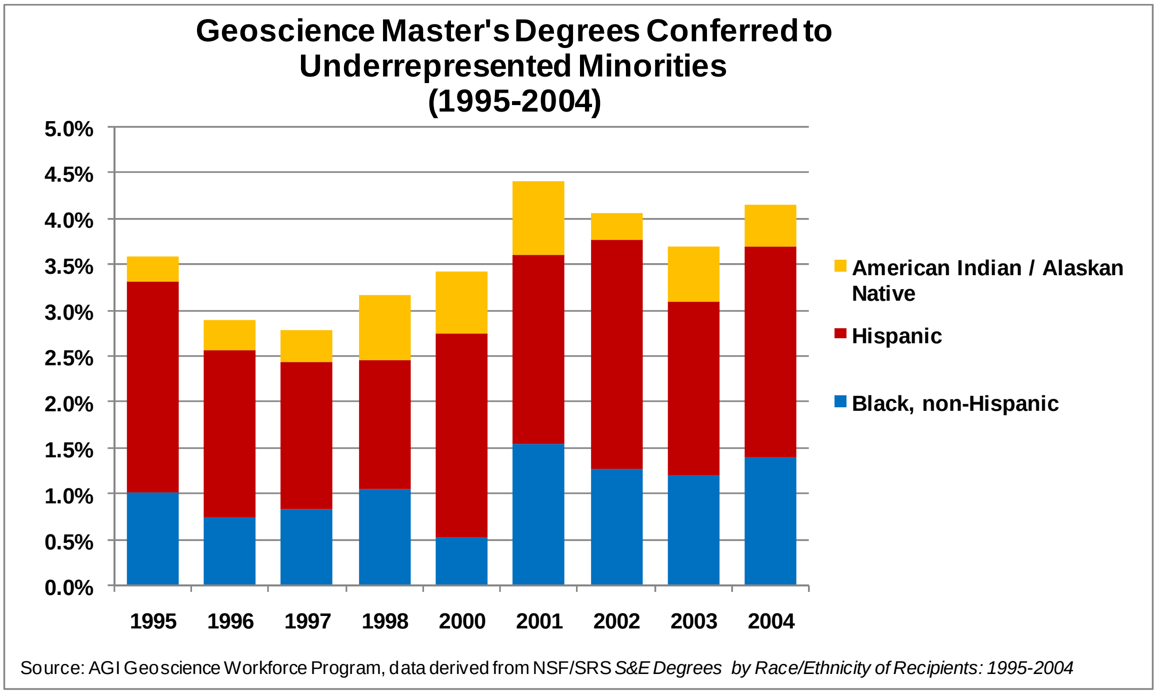


Figure 2.35: Geoscience Master's Degrees Conferred to Minorities

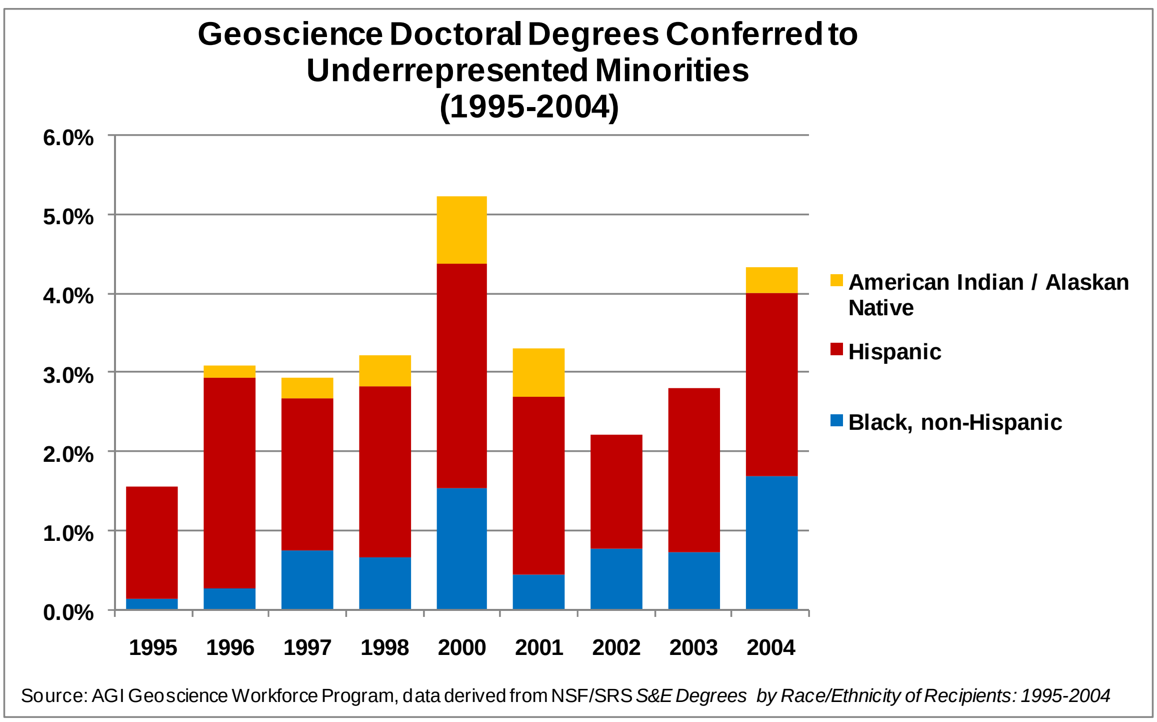


Figure 2.36: Geoscience Doctoral Degrees Conferred to Minorities

Geoscience Degree Completion Rates

A common assertion is that the number of geoscience degrees granted is dependent on the price of oil. However, this metric requires a response lag greater than oil price-change velocity. A more responsive mechanism would likely be the rate of degree completion – that students would be incentivized to complete their geoscience degree by improved economic prospects.

Degree completion rates do show sensitivity to current events. The end of conscription in the U.S. corresponds with a sharp decrease in completion rates, and Bachelor's degree completion rates were sensitive to the stabilizing and eventual decline in oil prices in the 1980's. The more recent rise in oil prices is not reflected in current completion rates, and likely corresponds to a decoupling of aggregate geoscience enrollments and oil price.

Of note is how geoscience completion rates vary from other STEM fields. According to NSF, 59.4 percent of STEM Bachelor's candidates complete their degree, compared to 13 percent of geoscience bachelor's candidates. Yet at the graduate level, STEM Master's candidates complete their degree within 10 years at a rate of 19 percent, and Ph.D.s at 9 percent, compared to the geoscience rates of nearly 20 percent. The geosciences have much lower completion rates than the STEM fields at the undergraduate level, but are equal to superior in completion rates at the graduate level. Understanding the drivers for these differences will require longitudinal analysis of degree recipients.

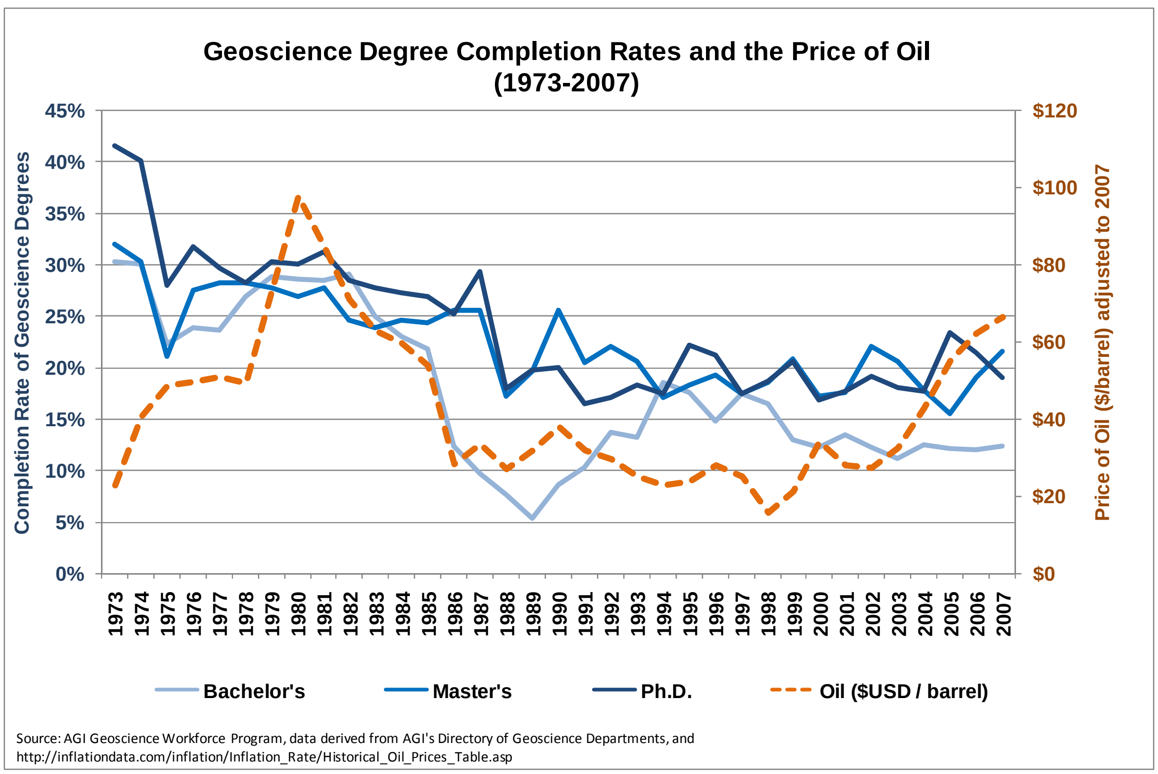


Figure 2.37: Geoscience Degree Completion Rates and Oil Price

Academic Pathways in Geoscience Education

Individuals who hold terminal geosciences Master's or doctoral degrees have similar academic backgrounds. Both groups have comparable percentages of Bachelor degrees in business (~ 1%), engineering (12% to 17%), geosciences (50% to 56%), other science & mathematics (18% to 19%), and other degree fields (12% to 14%). Fourteen percent of individuals with terminal geoscience Master's degree have a second Master's degree, and 79 percent of geoscience doctorate holders have a Master's degree. Additionally, 9 percent of geoscience Master's degree recipients and 4 percent of geoscience doctoral degree recipients have an Associate degree.

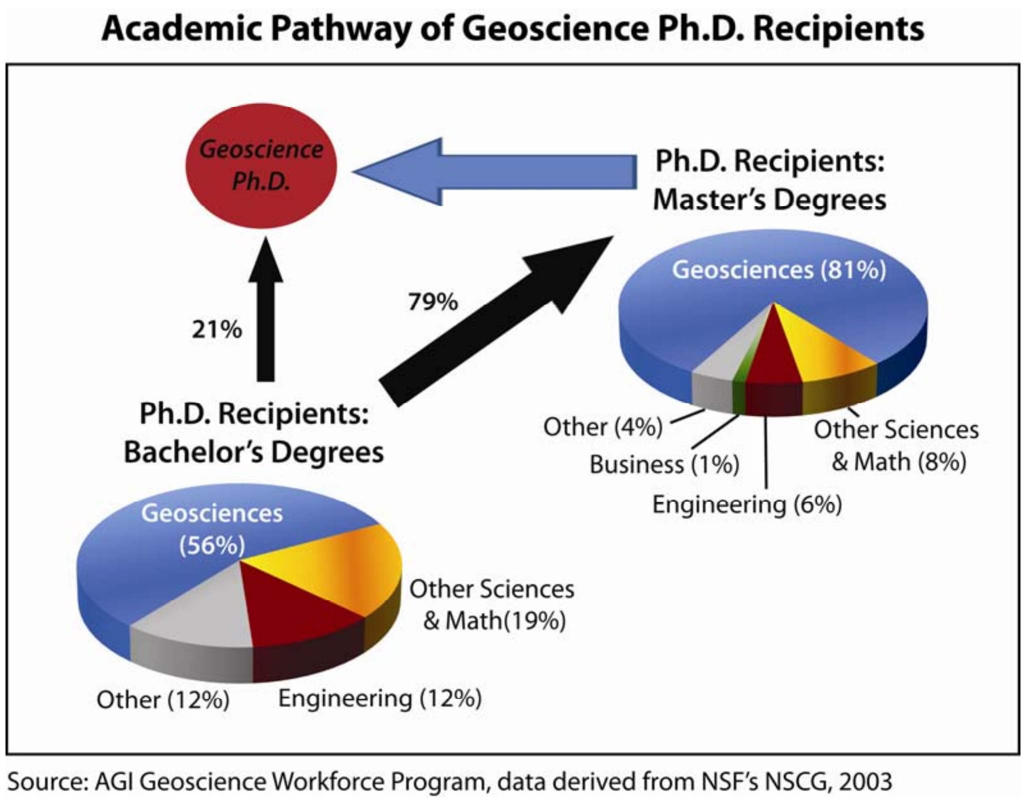


Figure 2.38: Academic Pathway for Geoscience Ph.D. Recipients

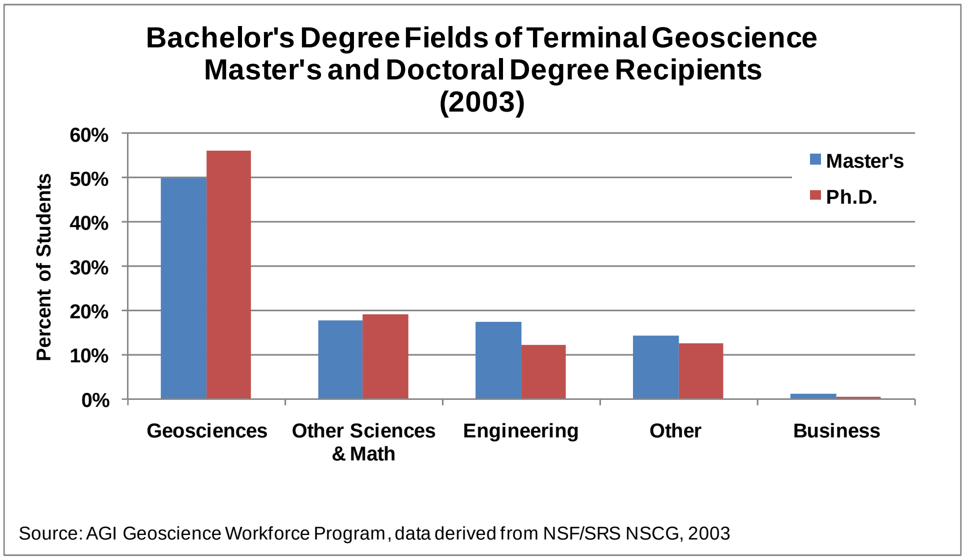


Figure 2.39: Bachelor's Degree Fields of Geoscience Graduates with Master's and Doctoral Degrees

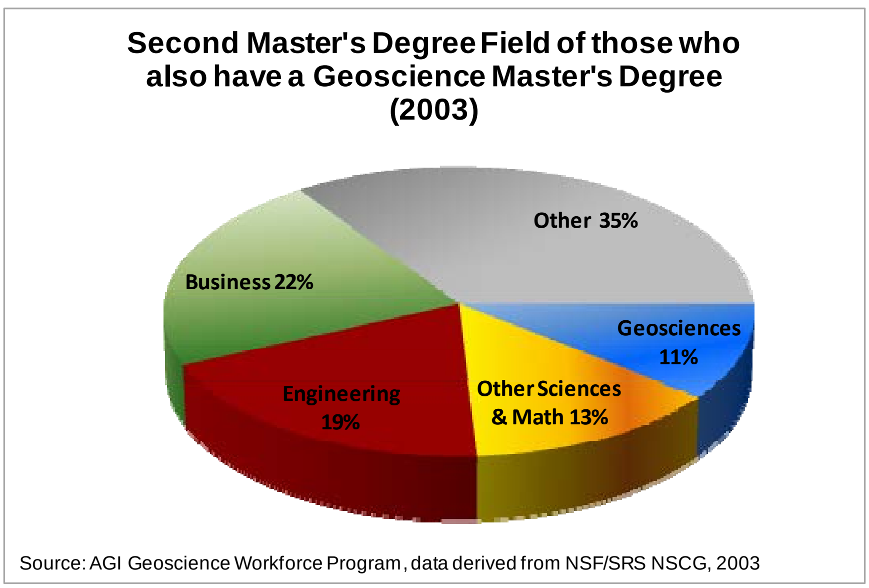


Figure 2.40: Second Master's Degree Fields of those who also hold a Geoscience Master's Degree

Research Topics of Geoscience Graduates

Since 1970, GeoRef indicates that the majority of theses and dissertations pertain to geology topics. Of note is the increase in geoscience theses and dissertations pertaining to interdisciplinary research that began in 1986 and peaked in 2000. This trend is concurrent with an increase in the percentage of geoscience federal funding applied to interdisciplinary research at the university level during the same period.

Master's theses pertaining to geology topics have consistently comprised the largest percent of all geoscience theses recorded by GeoRef. The brief peak in theses pertaining to interdisciplinary research occurred between 1994 and 1996, after which time the percentage of theses pertaining to interdisciplinary research declined while those pertaining to geology research increased.

Geoscience doctoral dissertation topics show a similar trend to master's these topics with an increase in interdisciplinary geoscience research and gradual decline in geology research beginning in the mid 1980's. The peak in dissertations pertaining to interdisciplinary research occurs in 2000, later than for master's theses. This later peak most likely represents those master's students continuing on in geoscience Ph.D. programs. One other unique trend in geoscience doctoral dissertations is that engineering research comprises a larger percentage of dissertations than it does geoscience master's theses. (Note that the decrease in the number of theses and dissertations from 2004 to 2006 reflects a lag in the number of theses and dissertations being indexed in GeoRef).

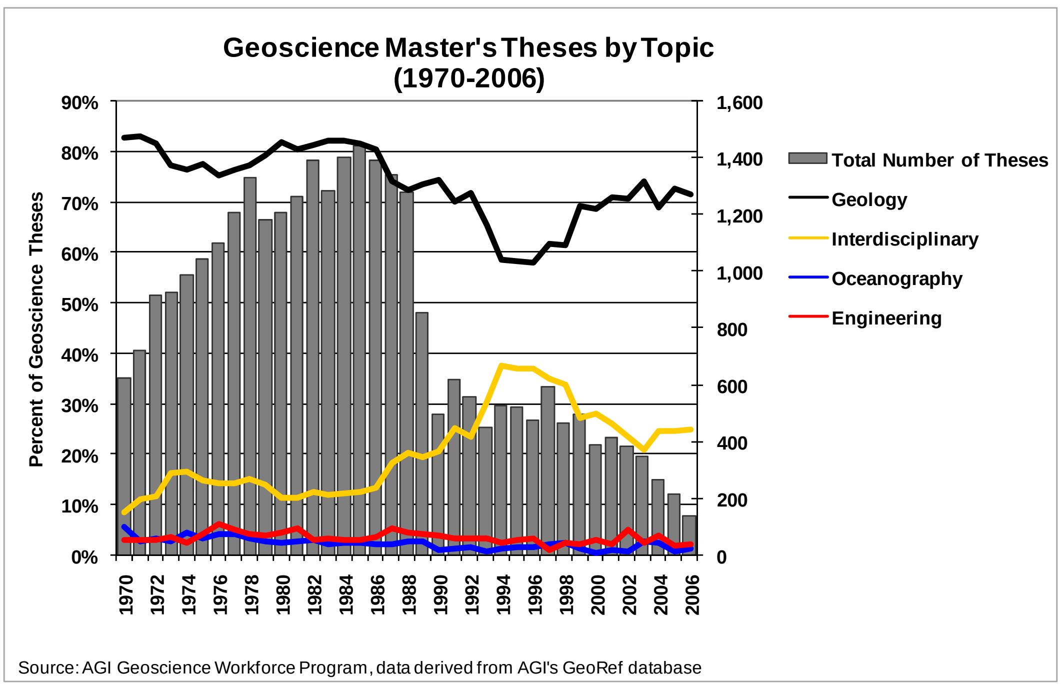


Figure 2.41: Trends in Geoscience Master's Theses Topics

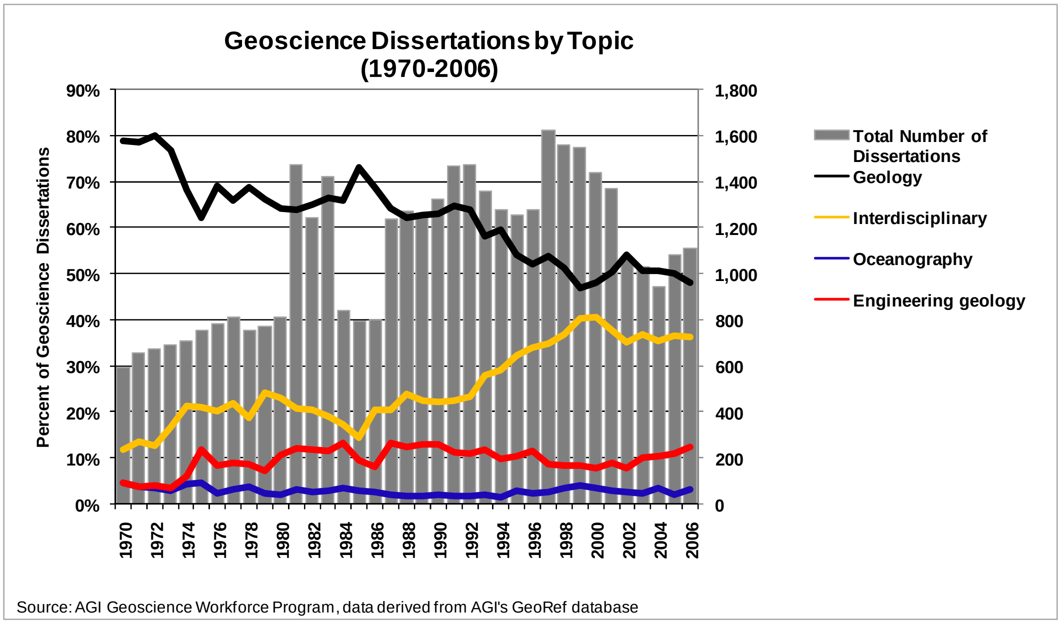


Figure 2.42: Trends in Geoscience Doctoral Dissertation Topics

Funding of the Geosciences at the University Level

Although there was a brief increase in funding between 1990 and 1998, since 1980 there has been a steady decline in the percent of federal research funds applied to the geosciences. However, the absolute amount of research funds applied to geoscience research at universities has increased. Interdisciplinary research has received the largest portion of these funds since 2000 while funding for geological science and atmospheric science research has decreased since 1995.

Each federal agency that supports geoscience research at the university level distributes their funding differently to the geoscience sub-disciplines. The Department of Agriculture has primarily funded atmospheric science research since 1973, and in 2005 90 percent of its geoscience funding went to support atmospheric science research. Geological research funding from the Department of Agriculture peaked during the late 1980's after which time it steadily declined. The Department of Defense has primarily funded oceanographic research since 1973, however geological science research received 30 to 40 percent of geoscience funding from 1985 to 1994. In 2005, 70 percent of the Department of Defense's geoscience funding went to oceanographic research. The Department of Energy has focused its geoscience funding on different sub-disciplines through time. In the early 1970's, the majority of its funding went toward oceanographic research, and later in the 1980's towards geological science research. From 1997 to 2005, over 90 percent of its geoscience funds have been applied to geological science, atmospheric science, and interdisciplinary science. NASA has funded primarily atmospheric science research; however, since 1985 it has directed an increasing amount of funding towards interdisciplinary research and less to geological science research. This trend, however, abruptly reversed in 2003, when atmospheric science and geological science funding increased and interdisciplinary research funding decreased from 50 percent to less than 10 percent. The National Science Foundation has directed the largest proportion of its geoscience research funding towards oceanographic research since 1973 and funding trends within the sub-disciplines have been relatively stratified since 1975, with the exception of the period between 1991 and 1996 where the percent of funding applied to interdisciplinary research and geological science research peaked at the expense of oceanographic research.

Since 1999, the proportion of geoscience NSF funds applied to geological science research (earth science proposals and awards) has increased to just below 30 percent, while the majority of funding under the NSF geoscience directorate has been applied to both oceanographic and atmospheric science research. However, the funding rate for earth science proposals submitted to NSF has decreased steadily because the number of proposals has increased by 36 percent while the total number of earth science awards has only increased by 11 percent since 1999. Additionally, the median annual award has increased by 92 percent since 1999. Ten of the fifteen subject areas had an increase in the number of proposals submitted from 1999 to 2007 and only seven areas had an increase in the number of awards. Overall funding rates of proposals have decreased in most of the subject areas, with the exception of two: Continental Dynamics Program and Global Change.

From 1999 to 2007, California has led the nation in median annual funding for earth science awards from the National Science Foundation. Universities that have topped the list of those receiving the largest amount of money for NSF earth science awards for the past 10 years have come from Arizona, California, Colorado, Hawaii, Illinois, Massachusetts, Michigan, Minnesota, Montana, New Jersey, New York, Oregon, Pennsylvania, Texas, and Wisconsin. Of these states, California, New York, Massachusetts and Texas have produced the most earth science proposals.

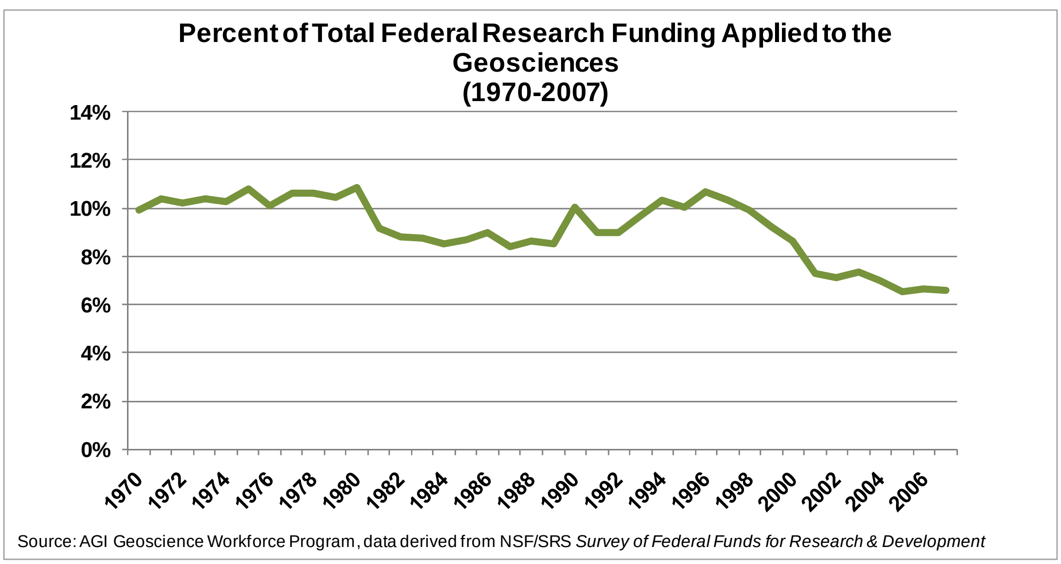


Figure 2.43: Percent of Total Federal Research Funding applied to the Geosciences

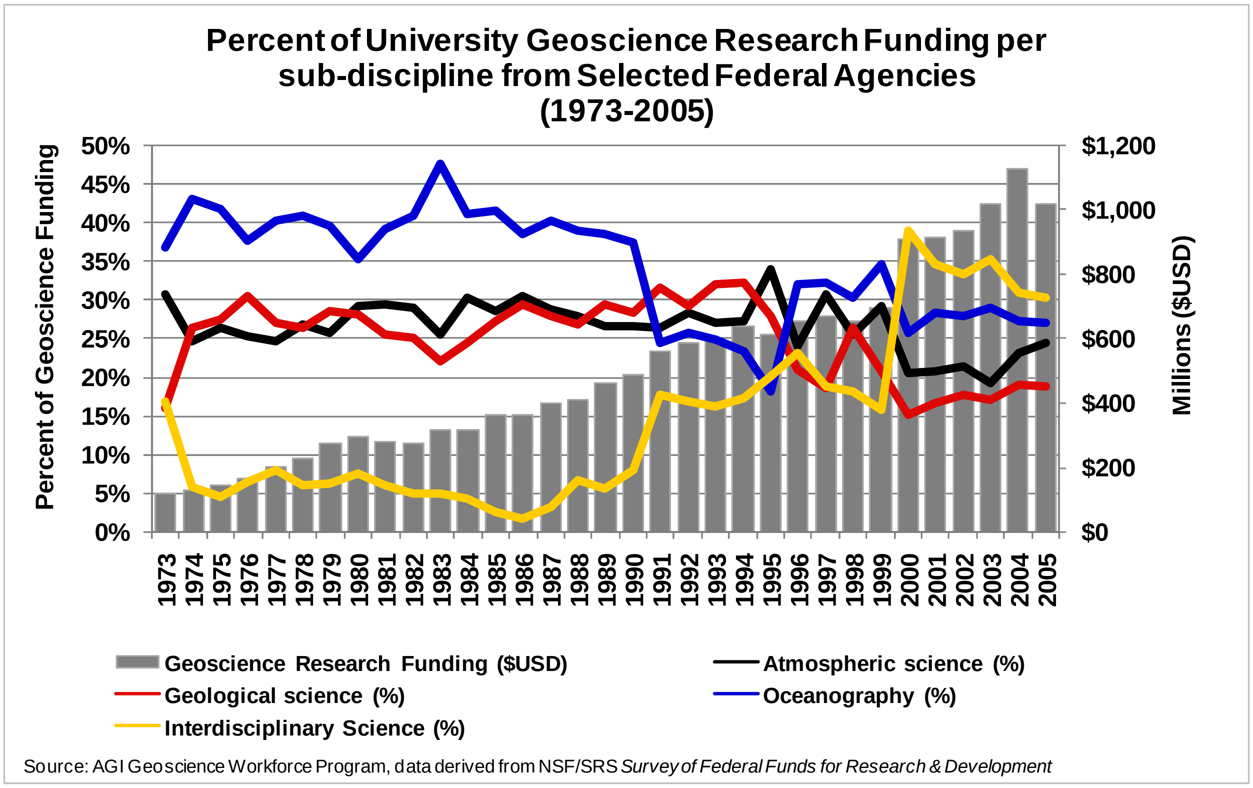


Figure 2.44: Percent of University Geoscience Research Funding per sub-discipline from Selected Federal Agencies

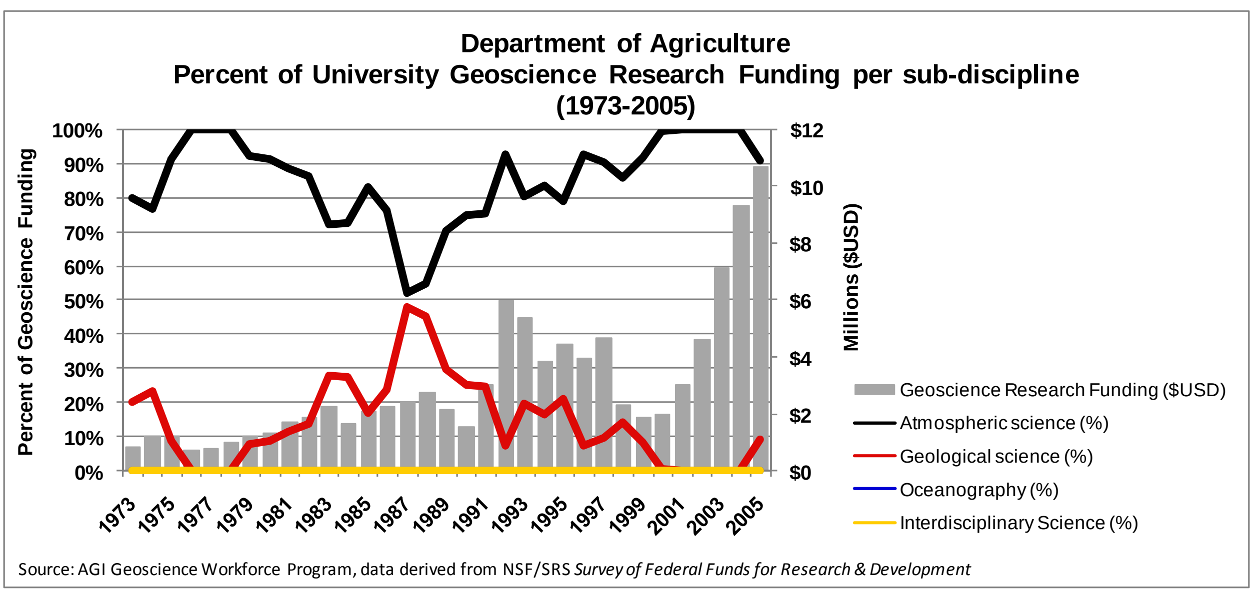


Figure 2.45: Percent of University Geoscience Research Funding per sub-discipline (Department of Agriculture)

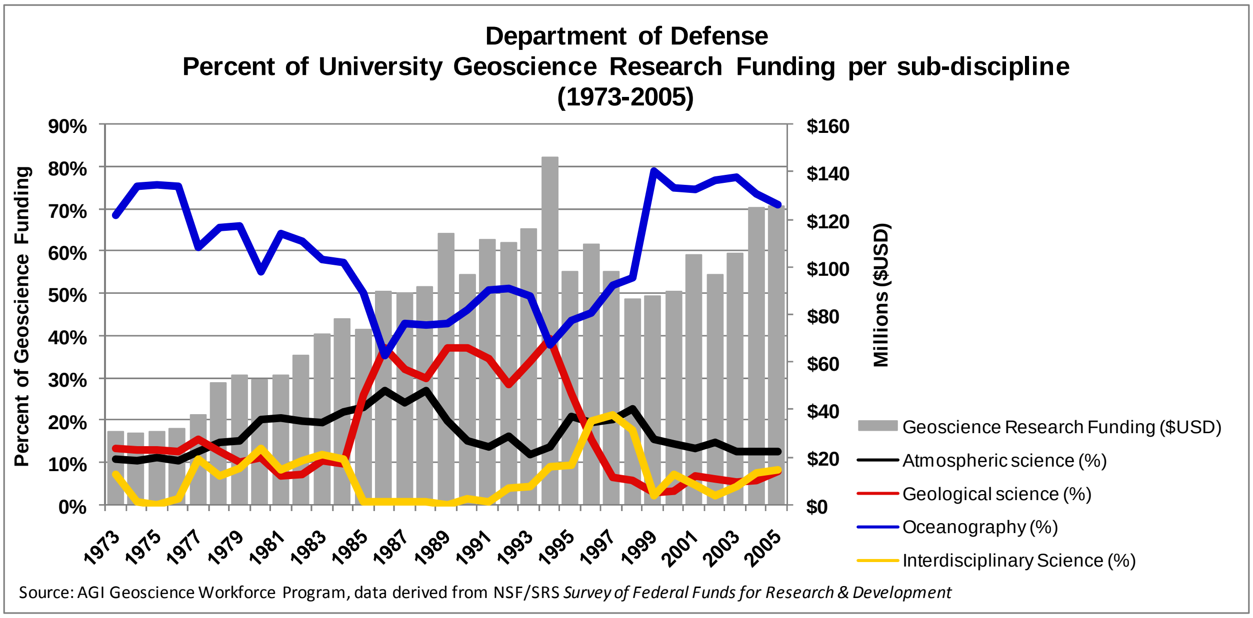


Figure 2.46: Percent of University Geoscience Research Funding per sub-discipline (Department of Defense)

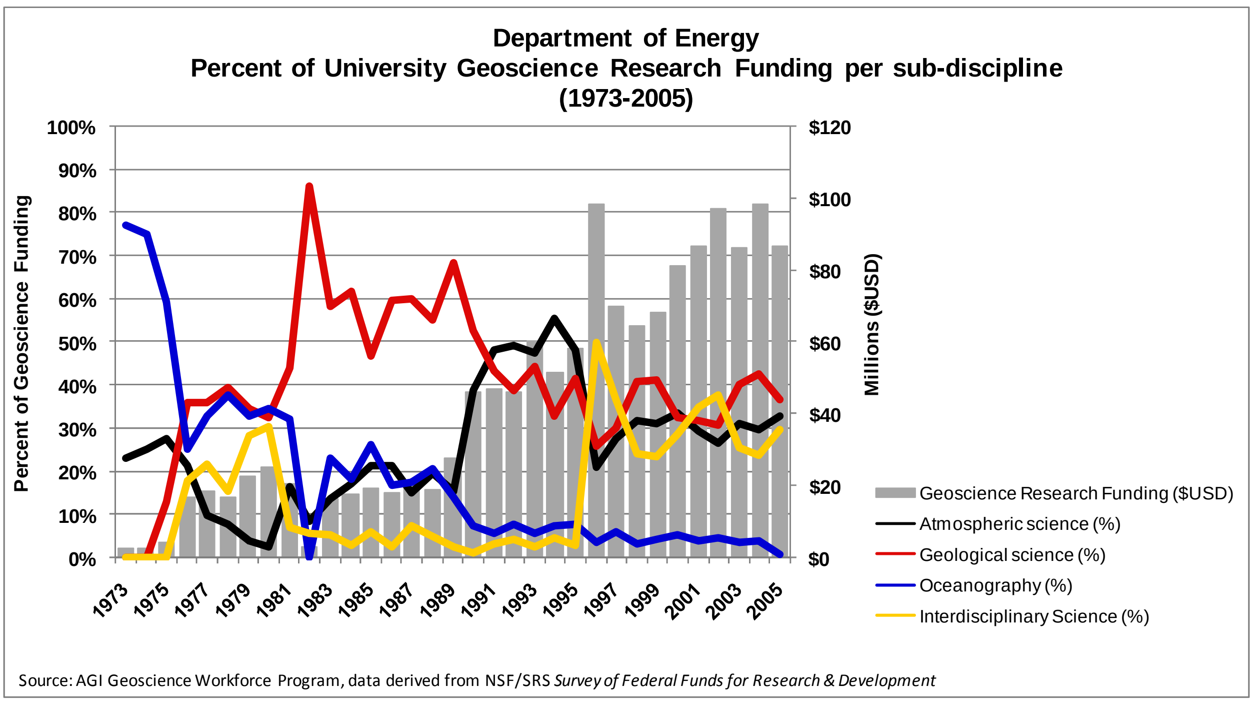


Figure 2.47: Percent of University Geoscience Research Funding per sub-discipline (Department of Energy)

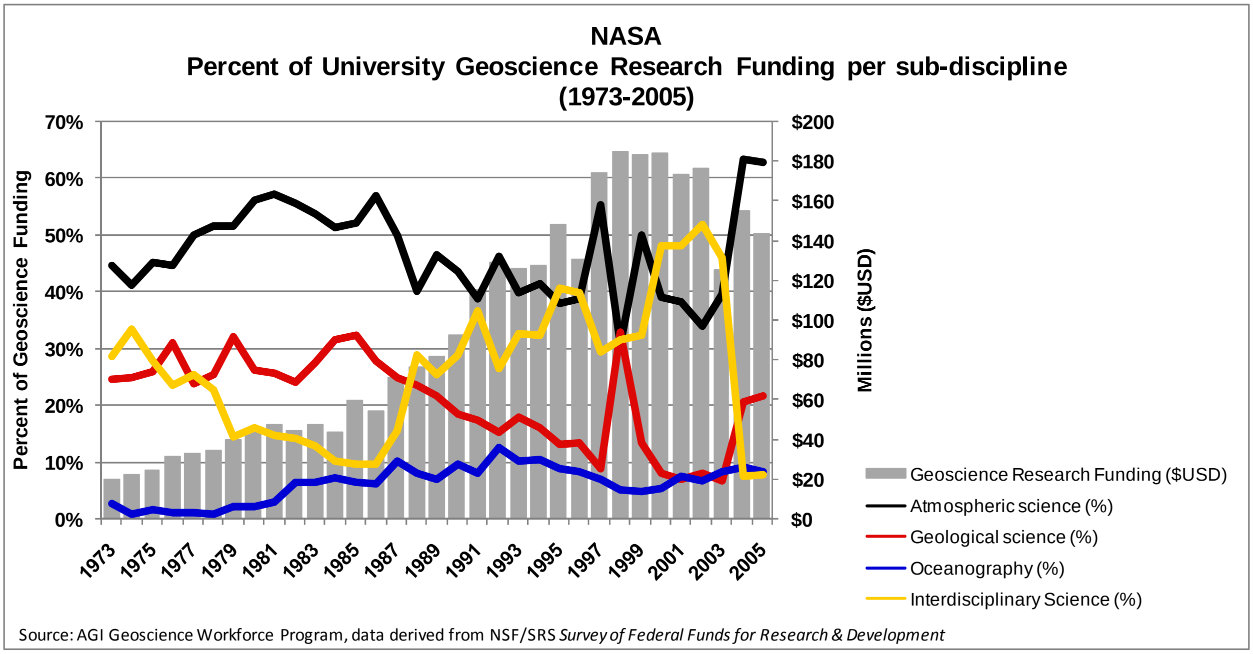


Figure 2.48: Percent of University Geoscience Research Funding per sub-discipline (NASA)

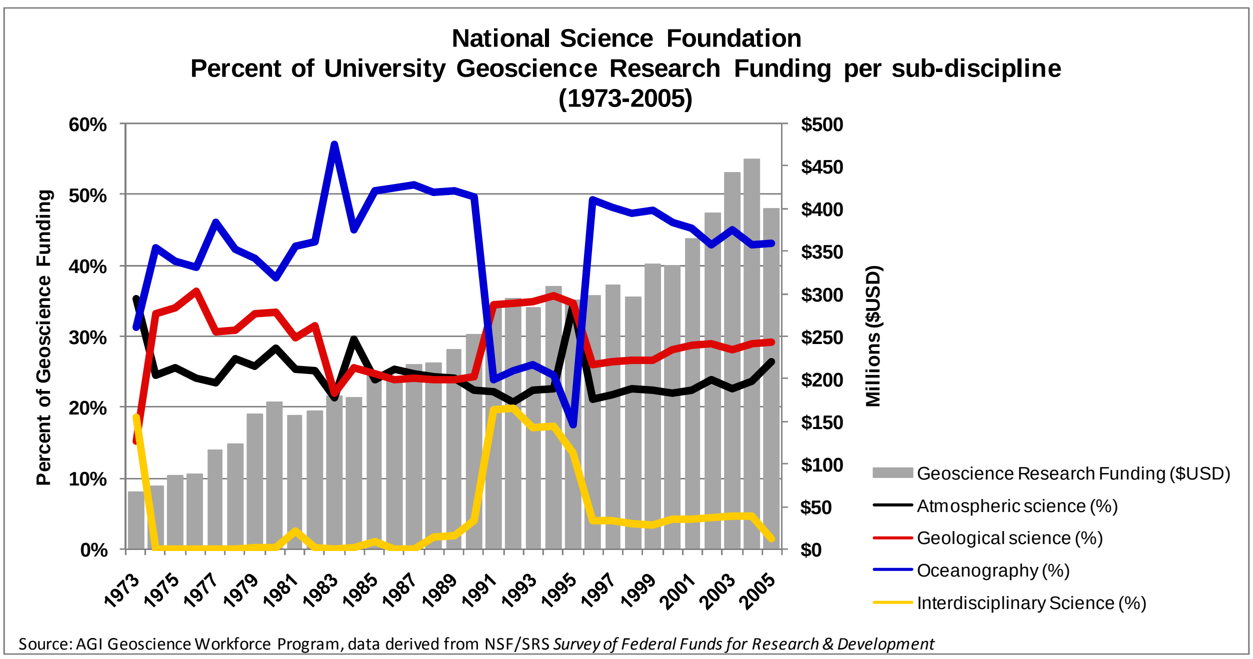


Figure 2.49: Percent of University Geoscience Research Funding per sub-discipline (NSF)

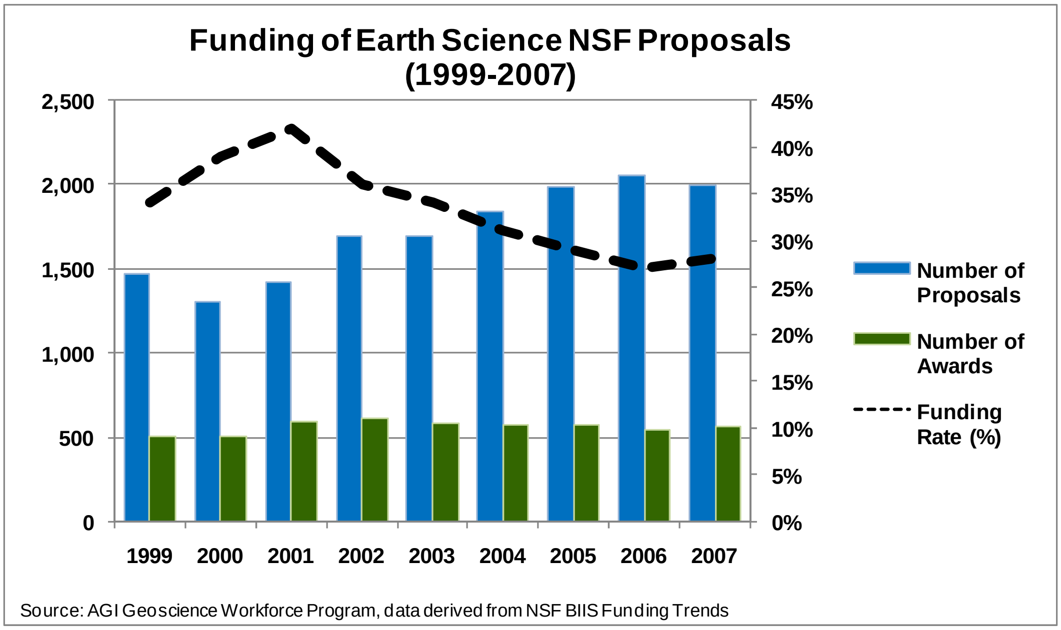


Figure 2.50: Funding of Earth Science NSF Proposals

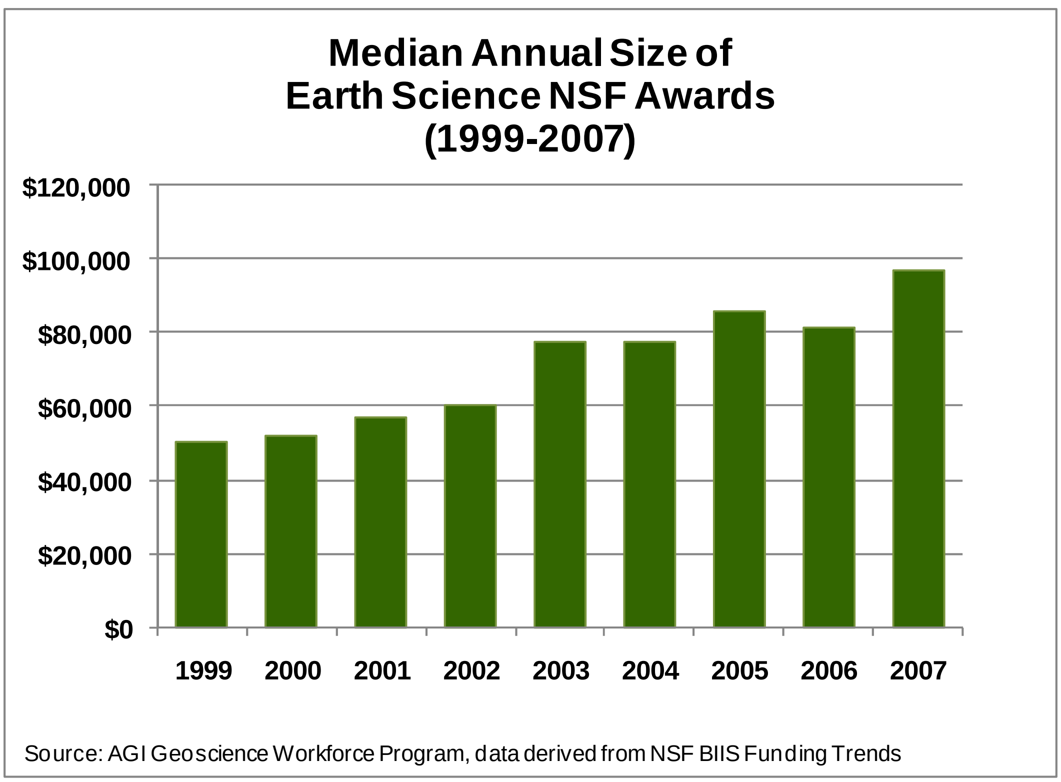


Figure 2.51: Funding of Earth Science NSF Proposals

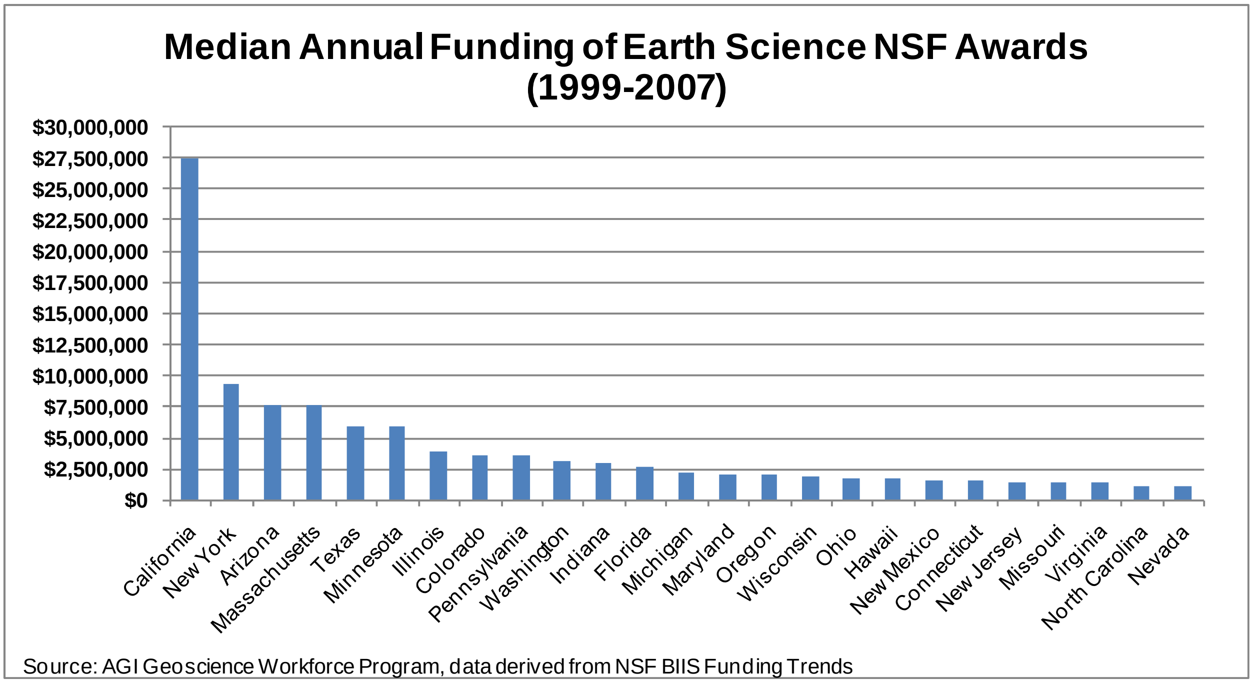


Figure 2.52: Median Annual Funding of Earth Science NSF Proposals by State

		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
University of Southern California	CA	$4.1	$5.0	$4.8	$5.9	$5.5	$5.5	$6.3	$6.1	$4.6	$4.8
State University of New York - Stony Brook	NY	$3.9	$3.5	$3.9	$3.7	$3.2	$4.8	$3.2	$3.7	$3.5	$3.4
University of Arizona	AZ	$3.5	$3.4	$5.6	$5.8	$6.8	$6.5	$5.3	$6.2	$6.7	$6.4
Massachusetts Institute of Technology	MA	$2.7	$4.6	$3.2	$3.3	$2.3	$2.5	$4.0	$6.9	$3.2	$3.1
California Institute of Technology	CA	$3.1	$2.9	$2.0	$2.5	$4.3		$3.3	$4.8	$4.6	$4.2
University of Minnesota - Twin Cities	MN	$1.9	$2.3			$6.4	$7.4	$5.0	$5.5	$5.5	$8.2
University of California - Berkeley	CA		$2.0	$2.3	$4.4	$4.0	$2.6		$2.8		
University of Chicago	IL	$1.8	$2.0	$2.3			$2.6	$3.3			
University of Colorado - Boulder	CO	$1.5					$4.1	$4.3		$2.8	$4.1
Stanford University	CA						$8.8	$11.3	$2.9	$6.4	$6.5
University of California - Los Angeles	CA	$1.5	$2.2			$2.4		$3.5			
Pennsylvania State University	PA			$2.7			$2.5		$2.7		
Woods Hole Oceanographic Institute	MA			$2.0	$3.8	$2.2					
University of Hawaii	HI				$2.4	$2.6				$2.5	
University of Wisconsin-Madison	WI								$3.0		
Oregon State University	OR										$5.0
University of Texas - Austin	TX										$2.9
Columbia University	NY	$1.5								$2.7	
Princeton University	NJ		$2.5								
University of California - Santa Cruz	CA				$4.0						
University of Montana	MT				$2.8						
University of Michigan	MI			$2.1							

Table 2.8: Top 10 Universities Receiving NSF Earth Science Awards (Millions of $USD)
(Source: AGI Geoscience Workforce Program, data derived from NSF BIIS Funding Trends)

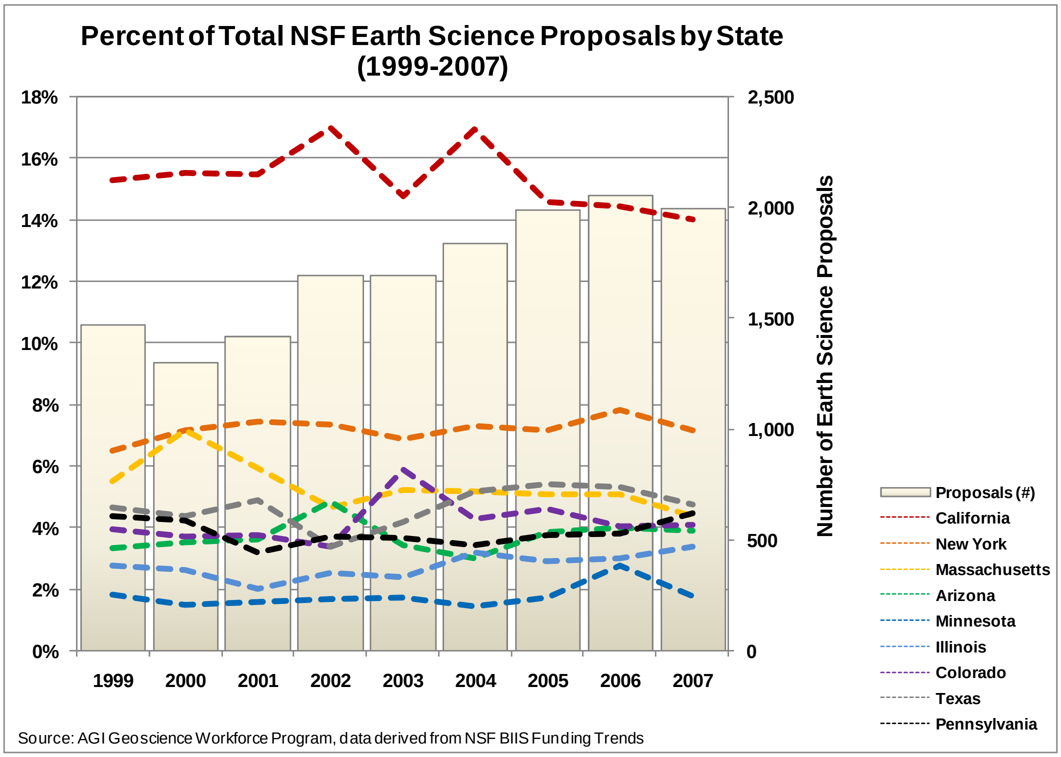


Figure 2.53: Percent of Total NSF Earth Science Proposals by State

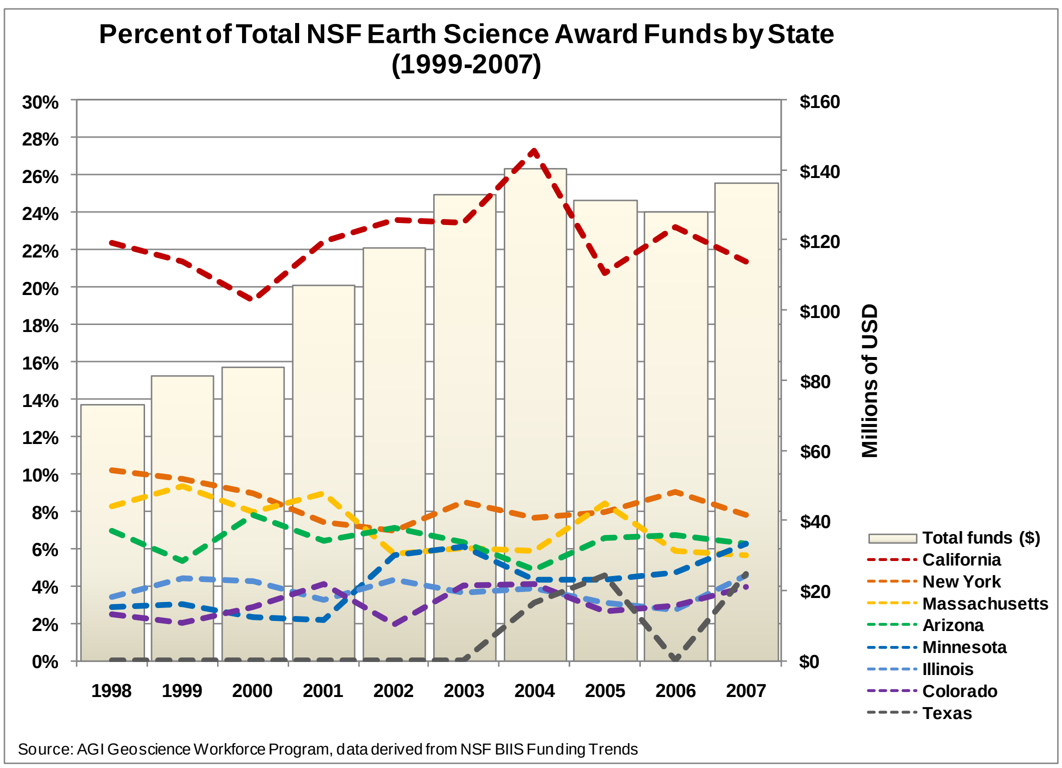


Figure 2.54: Percent of Total NSF Earth Science Award Funds by State

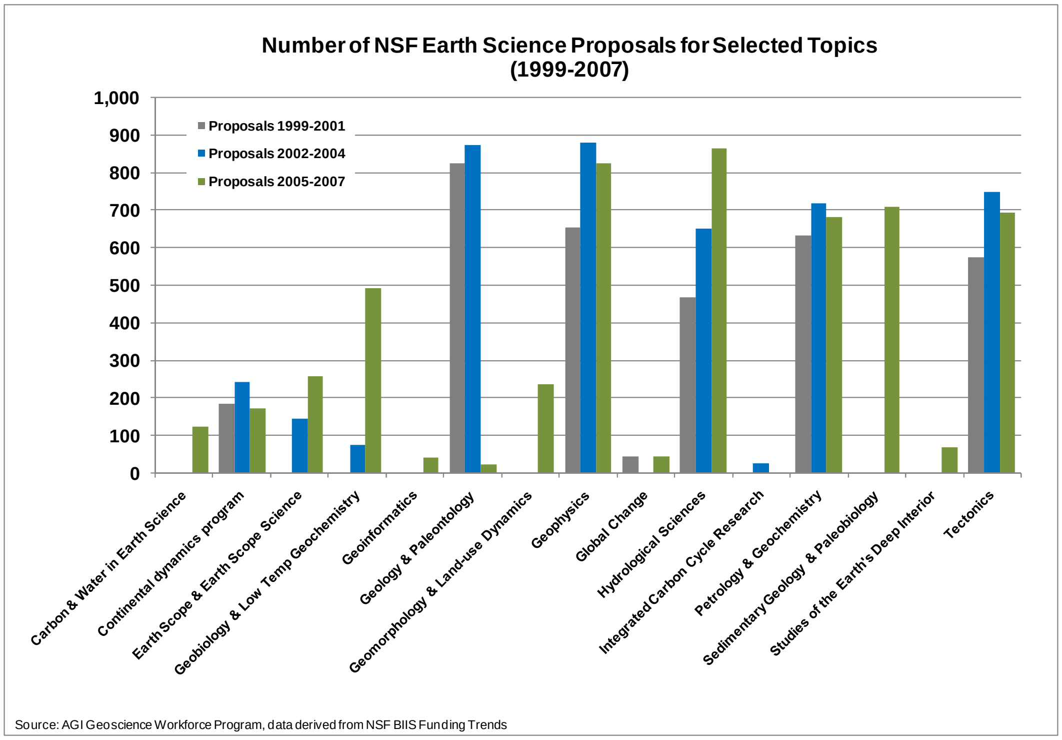


Figure 2.55: Trends in NSF Earth Science Proposals by Subject

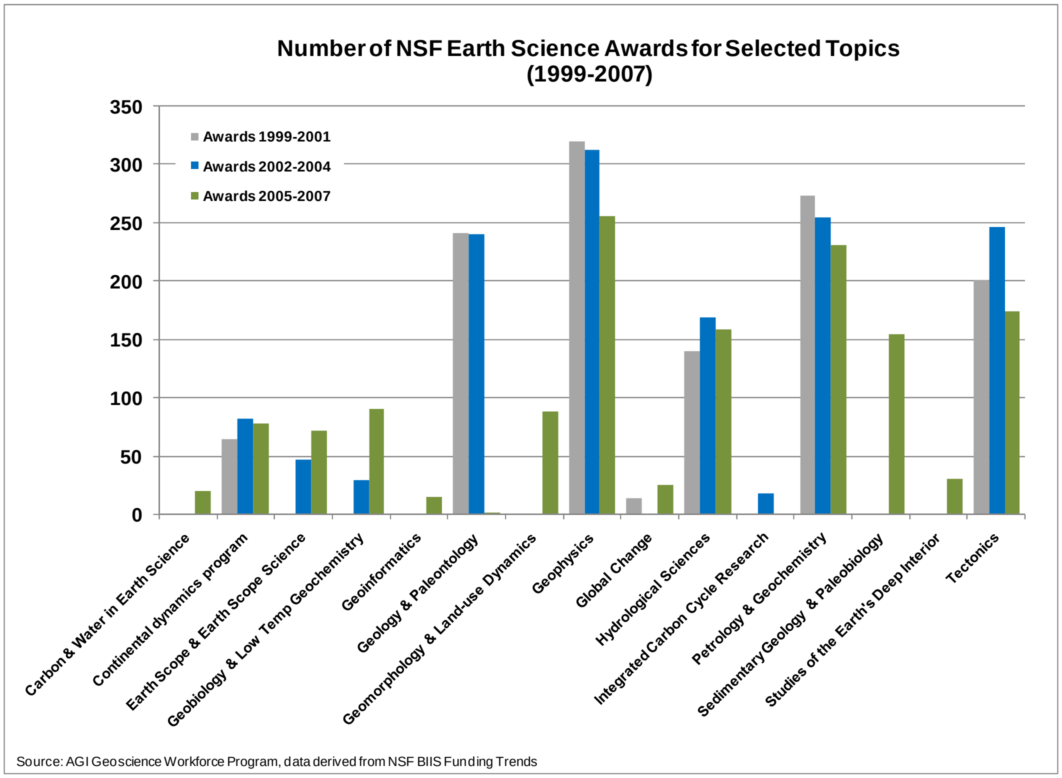


Figure 2.56: Trends in NSF Earth Science Awards by Subject

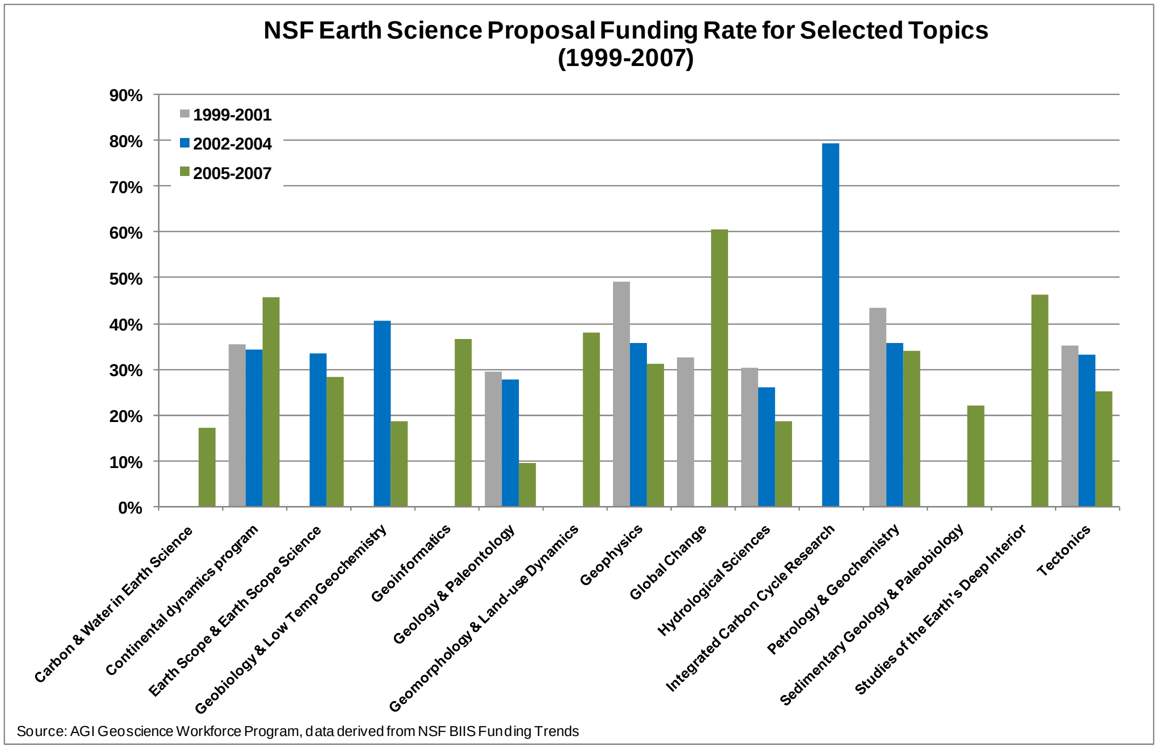


Figure 2.57: Trends in NSF Earth Science Funding Rates by Subject

Funding of Geoscience Students

Direct support for geoscience students has increased for the last two years. The trend looks to continue in 2008-2009 with a projected 6 percent increase in available funds. These opportunities for student support include funds from government agencies (60%) and non-profit organizations (40%, which includes support from private foundations and companies).

Graduate student support comprises 91 percent of all awards in the 2007-2008 academic year: over $2.4 million distributed among 570 individual awards. The largest student support program is the NSF Graduate Student Fellowship program. This program provided more than $1.13 million (from a total program budget of $40.5 million) in support to geoscience graduate students during 2007.

Several programs have significantly grown in recent years, including the Society of Exploration Geophysicists scholarship program's 65 percent increase in awarded support since 2006-2007. Funding for student travel grants has increased by more than $32,000 since that time, though field camp scholarships have remained steady.

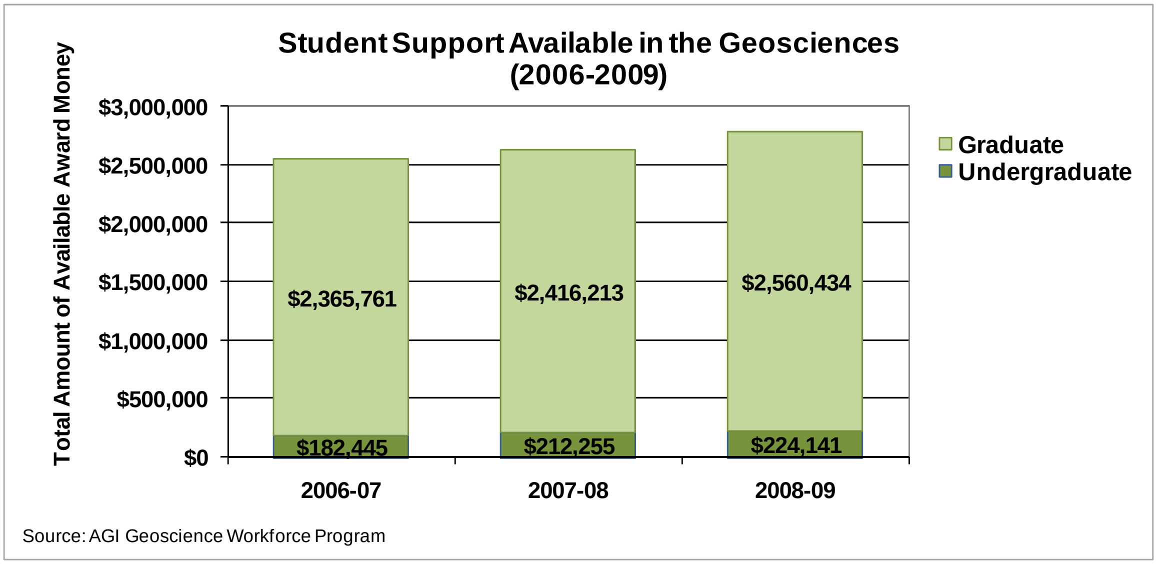


Figure 2.58: Total U.S. Geoscience Student Aid by Degree Level

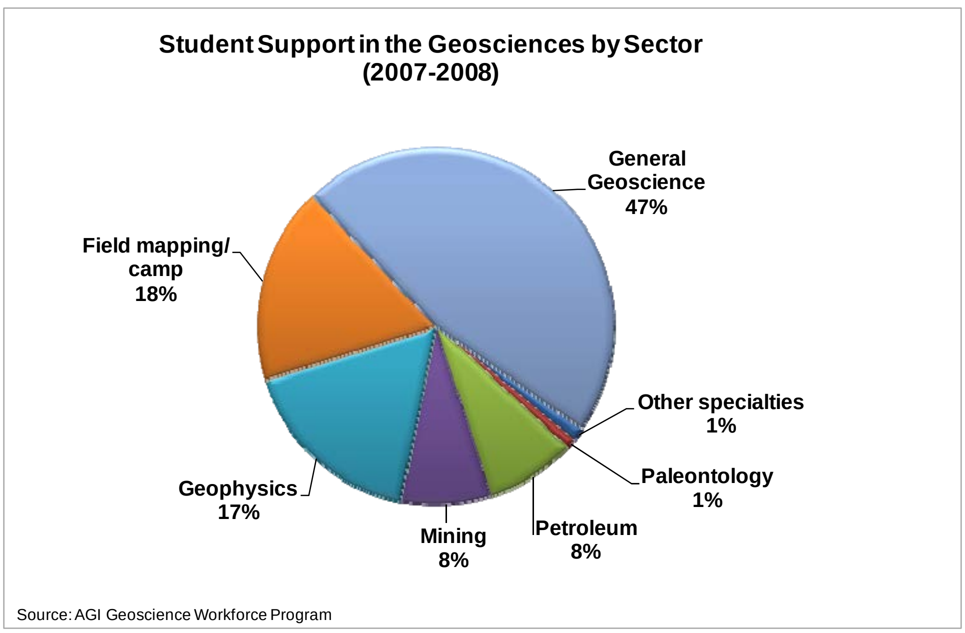


Figure 2.59: 2007-2008 Geoscience Student Aid by Discipline

The number of NSF Graduate Fellowships awarded to geoscience students decreased by 22 percent between 2005 and 2007 while the total budget has remained stable at $40.5 million. However, geoscience students continue to earn over 3 percent of the total awards, which is higher than the 2.5 percent of all Ph.D. students studying geoscience. The rate of decline of the number of geoscience fellowships is slightly higher than the total reduction in the number of awards given during the same 3-year period, which was 10 percent. NSF Graduate Fellowships have been well-distributed across the sub-specialties within in the geoscience community.

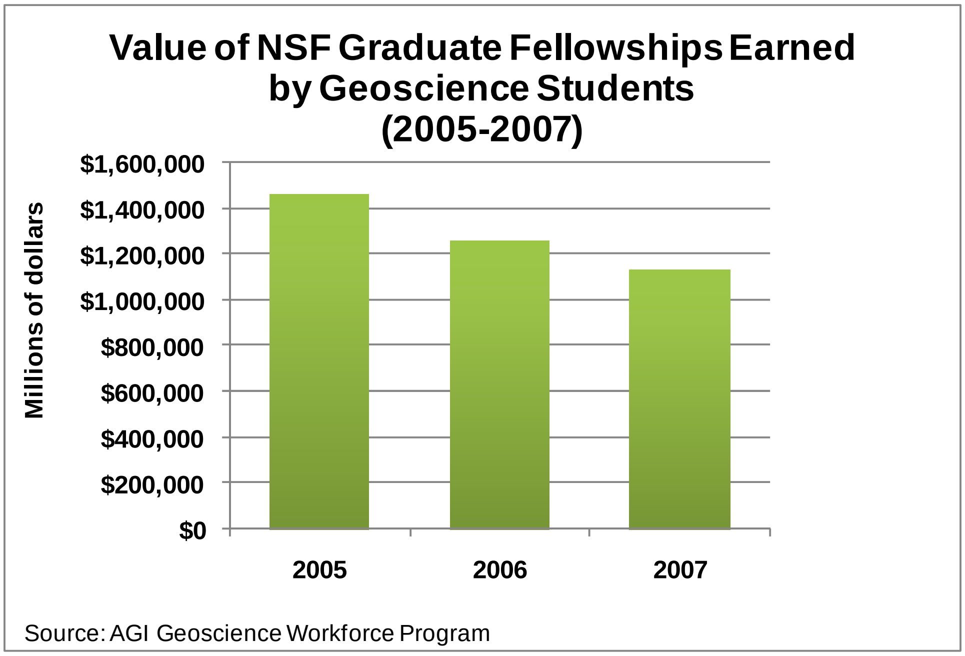


Figure 2.59: Total Funding of Geoscience NSF Fellowships

Geoscience NSF Graduate Fellows attended 38 individual institutions between 2005 and 2007, including two international programs. The Massachusetts Institute of Technology tops the list with 10 fellowship awardees since 2005, and the top 11 schools listed account for 64 percent of the awardees.

University	Total NSF Fellowships 2005-2007
Massachusetts Institute of Technology	10
California Institute of Technology	7
University of Washington	7
Harvard University	6
University of California - Berkeley	6
Columbia University	6
Penn State University	5
Stanford University	4
Boston University	3
University of Colorado - Boulder	3
Brown University	3

Table 2.9: Universities with the most geoscience NSF fellows (Source: AGI Geoscience Workforce Program)

The "Status of the Geoscience Workforce" Report

The "Status of the Geoscience Workforce" report provides a comprehensive benchmark of the geoscience profession. The report is based on original data collected by the American Geological Institute as well as from existing data from federal data sources, professional membership organizations, and industry data sources. The report synthesizes all available data for the geosciences, from the supply and training of new students, to workforce demographics and employment projections, to trends in geoscience research funding and economic indicators. The report is available as a complete document, as well as on a per chapter basis. It will be available for download from AGI's website: http://www.agiweb.org/.

Report Summary

This 32 page summary provides an in-depth summary of each chapter of the report.

Chapter 1: Trends in Geoscience Education from K-12 through Community College

This chapter examines the student participation in geoscience education at the K-12 level and includes data on state requirements for earth science education in middle and high school, and data pertaining to the number of earth science high school teachers. The chapter also examines trends in college bound students including SAT scores, aspirations for higher education, and choice of college major. Additionally, this chapter examines the availability of geoscience education at community colleges and examines the trends in Associate degrees conferred from geoscience programs at these institutions.

Chapter 2: Trends in Geoscience Education at Four-Year Institutions

This chapter summarizes all available data pertaining to geoscience enrollments, degrees conferred, field camp attendance, and funding of geoscience undergraduate and graduate students. The chapter also explores trends in department size, faculty numbers and research specialties, and funding of geoscience research at the university level.

Chapter 3: Geoscience Employment Sectors

This chapter explores the transition of geoscience graduates into the workforce, age demographics of the industries where geoscientists work, and projected workforce demand. Data pertaining to the current number of jobs and projected number of jobs in 2016 is also provided, as is current salary information for each profession.

Chapter 4: Economic Metrics and Drivers of the Geoscience Pipeline

This chapter provides data on productive activity (number of oil rigs, mines, etc.), commodity pricing and output, gross domestic product, and market capitalization of the industries where geoscientists work.

Appendix A: Defining the Geosciences

This appendix outlines how geoscience occupations and industries are defined in federal data sources. Additionally, the appendix details the working definition proposed by AGI for tracking the geoscience occupation.

Acknowledgements

The AGI Geoscience Workforce program would like to thank the AGI Foundation for funding of the program and this report. The AGI Geoscience Workforce Program would also like to thank the following people, organizations, companies, and industries that provided data for this report, including:

Dr. Penny Morton, University of Minnesota-Duluth, who provided all field camp attendance data; Barry Jay Katz, ChevronTexaco for the "*2003 Report on the Status of Academic Geoscience Departments*"; American Association of Petroleum Geologists (AAPG); American Geophysical Union; Baker Hughes; College Board; Council of Chief State School Officers (CCSSO); Econostats.com; Energy Information Administration; Google Finance; Indexmundi.com; InflationData.com; Industry and corporate data collaborators; Integrated Postsecondary Education Data System (IPEDS); Kitco.com; National Center for Education Statistics (NCES); National Ground Water Association (NGWA); National Mining Association; National Science Foundation Division of Science Resources Statistics; National Science Foundation Award Database; OANDA.com; Office of Personnel Management; Society of Economic Geologists (SEG); Society of Exploration Geophysicists (SEG); U.S. Bureau of Economic Analysis; U.S. Bureau of Labor Statistics; U.S. Department of Education; U.S. Geological Survey.

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Questions and More Information

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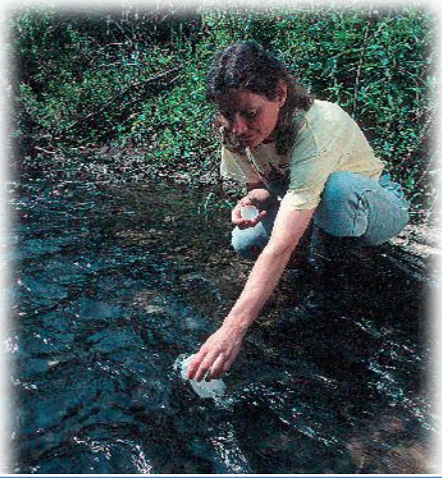
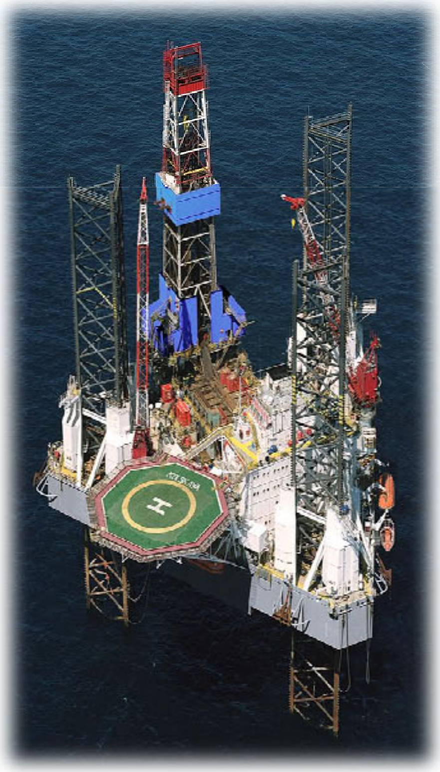


2009

Status of the Geoscience Workforce

Chapter 3: Geoscience Employment Sectors



American Geological Institute

February 2009

Table of Contents

Geoscience Employment Sectors:

Trends in Student Transitions and Workforce Dynamics

Perceptions of career pathways can influence students' career choice, and the trends in job search activity and geoscience graduate student perceptions of employment sectors are similar. In an AGI/AGU survey of new graduate students, 81 percent of geoscience doctorates reported that they searched for jobs in academia, 45 percent in the government, and 31 percent in the private sector. Sixty-seven percent of recent geoscience graduates found jobs in academia, 18 percent in government, and 10 percent in private industry. Geoscience Master's graduates were less picky in their job search efforts: 58 percent searched for jobs in academia, 55 percent in the government, and 35 percent in the private sector. However, only 24 percent of geoscience Master's graduates found work in academia, 22 percent in the government, and 50 percent in private industry (21% oil & gas industry, 20% environmental industry, 9% other industry).

With approximately 1,500 geoscience graduate students transitioning into the professional workplace each year, the supply of newly trained geoscientists falls short of geoscience workforce demand and replacement needs. The majority of geoscientists in the workforce are within 15 years of retirement age. Data from federal sources, professional societies, and industry indicate this imbalance of the age of geoscientists in the profession. The percentage of geoscientists between 31 and 35 years of age is less than half of geoscientists between 51 and 55 years old. All geoscientist occupations in the government, with the exception of meteorologists and oceanographers, have experienced an age shift towards the 50 to 54 year old age group between 2003 and 2007. This shift is most pronounced in the age demographics of mining engineers and petroleum engineers.

Even in oil & gas companies, which typically offer the highest salaries of all geoscience employing industries, the supply of new geoscientists is short of replacement needs. The number of younger geoscientists in their early 30's is approximately half the number of those nearing retirement age. This number is greater than the data reported from federal agencies and professional societies. Additionally, the supply of geoscientists is not expected to meet the demand for geoscientists over the next 20 years. By 2030, the unmet demand for geoscientists in the petroleum industry will be approximately 30,000 workers.

Support activities for mining and oil & gas is the only geoscience employing industry where the demographics provide for the replacement of the older generation of

Did you know?

- Academic advisors tend to have more positive attitudes than students about career paths for students in the environmental industry, petroleum industry, academia, and K-12 education.
- 21 percent of new geoscience Master's students find jobs in the petroleum industry and 20 percent find jobs in the environmental industry.
- The percentage of women in geoscience and environmental science occupations has hovered around 30 percent since 2003.
- The majority of geoscientists in the workforce are within 15 years of retirement and the number of geoscientists needed to replace this older generation currently does not exist.

geoscientists who will retire within the next 15 years.

In academia, like other geoscience industries, those with full professorships are older (late 50's to mid 70's), and there are 30 percent fewer assistant and associate faculty than full professors. Over the next 10 to 15 years, the number of full professor faculty is expected to decline as more full professors retire.

The Transition from Student to Professional

Faculty and Student Attitudes about Career Pathways

Student perceptions of career paths influence how and where they conduct their job searches. Peers, parents, and mentors, including academic advisors shape students' perceptions of career pathways. Ultimately, these perceptions and the actions based upon them are reflected in the geoscience workforce.

The American Geological Institute conducted a survey from March to April 2006 of 1,358 students and 558 advisors from 262 schools with geoscience departments in order to document the attitudes of students and academic advisors of the professional pathways for geoscientists. Academic advisors tended to have more positive attitudes than graduate and undergraduate students about all career pathways (with the exception of "Other"), especially the environmental industry, petroleum industry, academia, and K-12 education. However, when the data is analyzed by degree and career experience, it is apparent that Ph.D. students and graduates had a more positive opinion about academia than their advisors.

Sector	Undergraduate Students	Graduate Students	All Students	All Advisors
State / Local Government	66%	59%	63%	72%
Federal Government	64%	64%	64%	67%
Environmental Industry	69%	51%	61%	89%
Mining Industry	29%	17%	24%	38%
Petroleum Industry	34%	35%	34%	67%
Academia	37%	61%	48%	68%
K-12 Education	29%	23%	26%	67%
High-Tech Industry	9%	9%	9%	18%
General Business	14%	8%	11%	15%
Continue Education / Post-doc	43%	43%	43%	60%
Other	15%	11%	13%	8%
Look Outside of Geoscience	16%	14%	15%	16%

Table 3.1: Percentage of Students and Faculty with Positive Attitudes Pertaining to Students Pursuing Careers in Different Employment Sectors (2006)
(Source AGI Geoscience Workforce Program)

Sector	BA/BS	MA/MS	Ph.D.
State/Local Government	66%	67%	49%
Federal Government	64%	67%	60%
Environmental Industry	69%	61%	39%
Mining Industry	29%	21%	12%
Petroleum Industry	34%	42%	27%
Academia	37%	45%	81%
K-12 Education	29%	24%	22%
High-Tech Industry	9%	9%	9%
Finance	3%	1%	3%
General Business	11%	7%	5%
Continue Education/PostDoc	43%	34%	53%
Other	15%	11%	10%
Look Outside of geosciences	16%	16%	13%

Table 3.2: Percentage of Students with Positive Attitudes Pertaining to Careers in Different Employment Sectors (2006)
(Source AGI Geoscience Workforce Program)

Sector	BA/BS		MA/MS		Ph.D.	
	1 yr	> 1 yr	1 yr	> 1 yr	1 yr	> 1 yr
State/Local Government	69%	61%	66%	70%	42%	56%
Federal Government	65%	60%	66%	77%	55%	64%
Environmental Industry	69%	70%	61%	66%	35%	42%
Mining Industry	30%	27%	20%	26%	11%	13%
Petroleum Industry	35%	32%	43%	34%	28%	26%
Academia	38%	36%	45%	47%	80%	83%
K-12 Education	28%	30%	23%	26%	20%	23%
High-Tech Industry	9%	8%	9%	6%	8%	11%
Finance	3%	1%	0%	2%	5%	1%
General Business	11%	10%	7%	11%	7%	3%
Continue Education/PostDoc	44%	39%	33%	43%	43%	61%
Other	16%	11%	9%	23%	8%	12%
Look Outside of geosciences	17%	12%	17%	11%	14%	12%

Table 3.3: Percentage of Graduates with Positive Attitudes Pertaining to Careers in Different Employment Sectors at 1-year Post-graduation and Beyond (2006)
(Source AGI Geoscience Workforce Program)

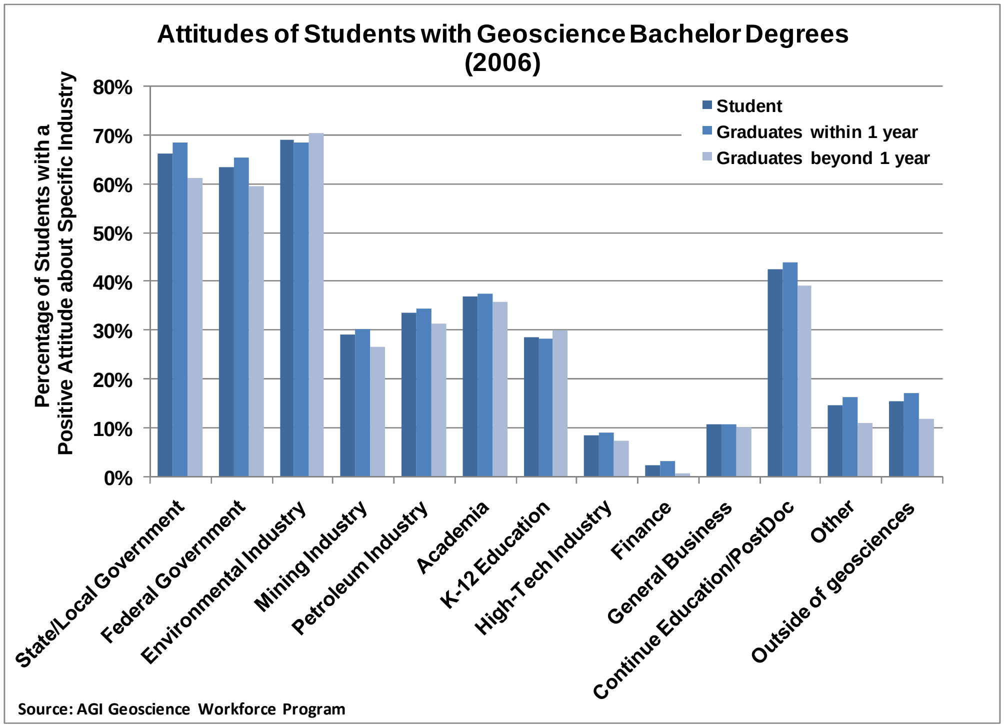


Figure 3.1: Percentage of Geoscience Bachelor Degree Recipients with Positive Attitudes Pertaining to Careers in Different Employment Sectors

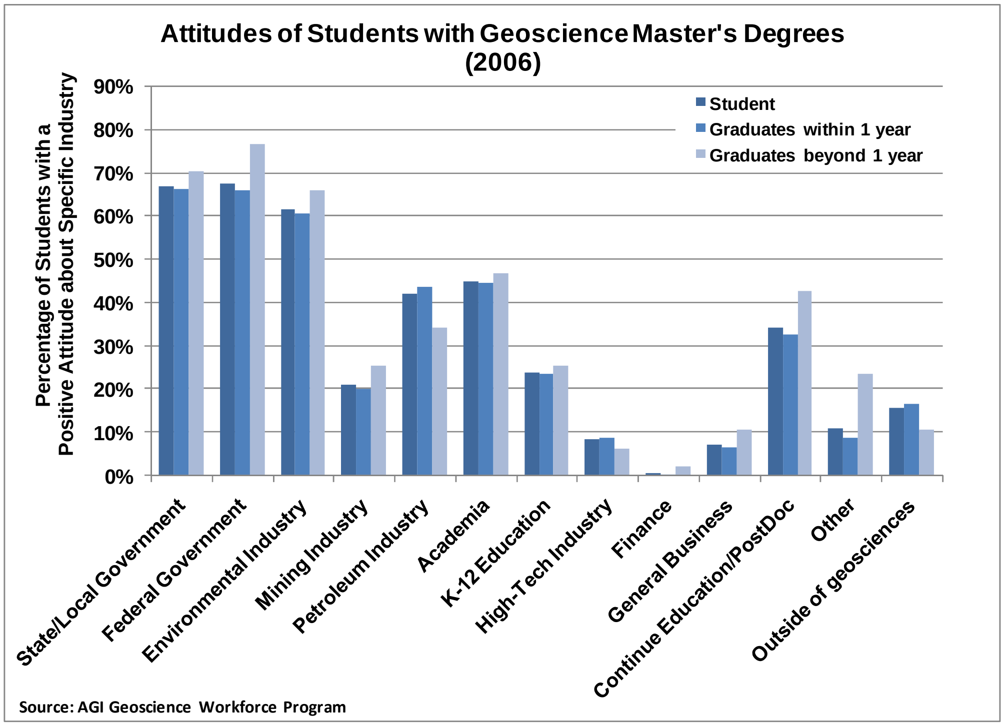


Figure 3.2: Percentage of Geoscience Master's Degree Recipients with Positive Attitudes Pertaining to Careers in Different Employment Sectors

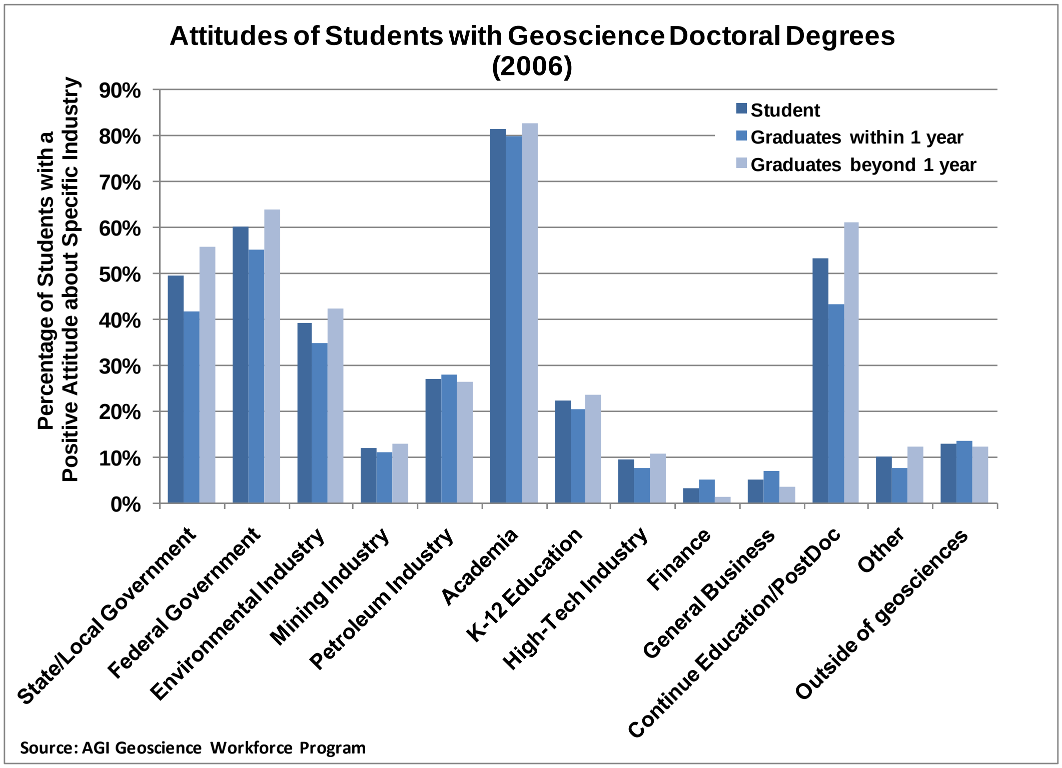


Figure 3.3: Percentage of Geoscience Doctoral Degree Recipients with Positive Attitudes Pertaining to Careers in Different Employment Sectors

Career Pathways of Geoscience Graduates

Perceptions of career pathways can influence where students look to establish their careers. In a AGI/AGU survey of new Ph.D.'s and Master's degree recipients, 81 percent of geoscience doctoral students searched for jobs in academia, 45 percent in the government, and 31 percent in the private sector. This trend of preference for academia, government, and then private sector is also evident in the attitudes of Ph.D. students towards these industries and in the employment sectors of recent graduates.

Geoscience Master's students however had less preference in the places they searched for jobs: 58 percent searched for jobs in academia, 55 percent in the government, and 35 percent in the private sector. As with geoscience doctoral students, the sectors in which geoscience Master's students searched for jobs were similar to their perceptions of different employment sectors. However, half of geoscience Master's graduates found initial employment in the private sector (21% oil & gas industry, 20% environmental industry, and 9% in other private sector industries). This may be driven by the high percentage of geoscience Master's student with a positive perception of employment in the environmental industry (61%) and in the petroleum industry (42%).

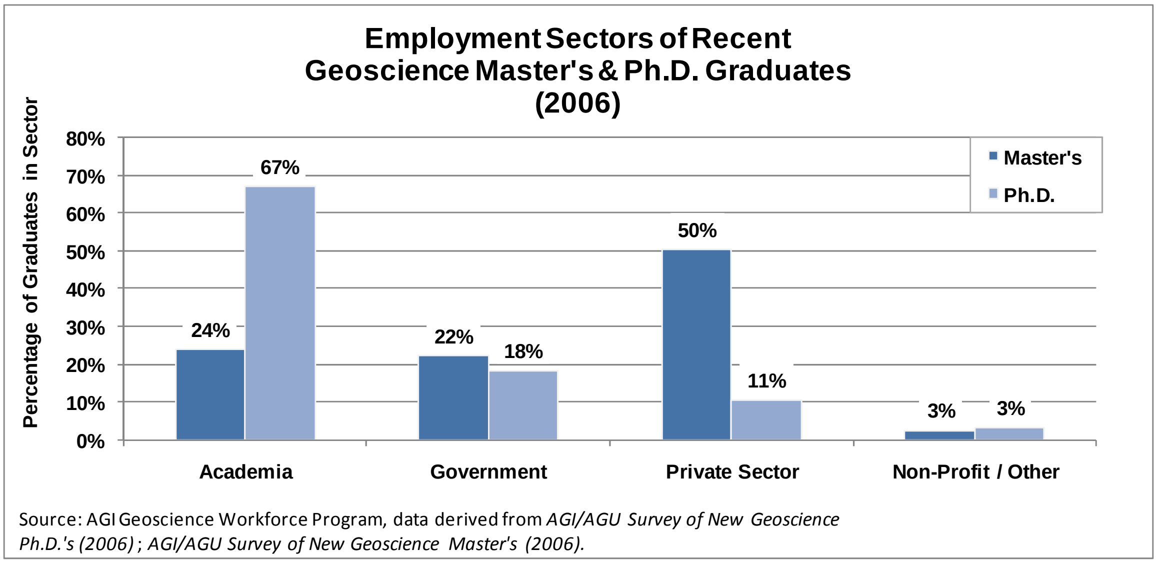


Figure 3.4: Percentage of Geoscience Graduate Degree Recipients Working in Different Employment Sectors

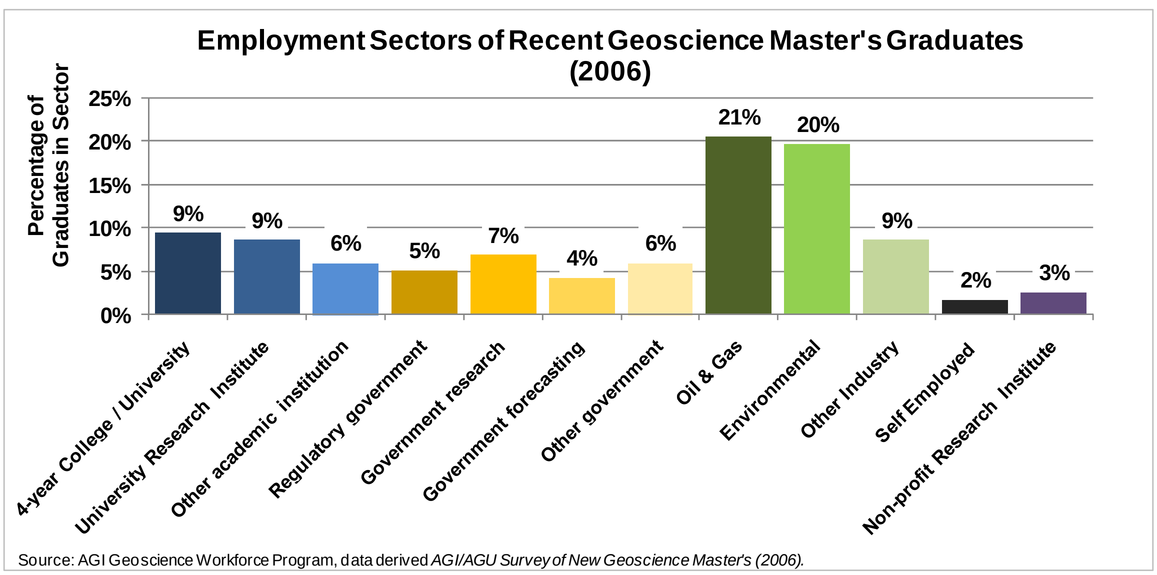


Figure 3.5: Percentage of Geoscience Master's Degree Recipients Working in Different Employment Sectors

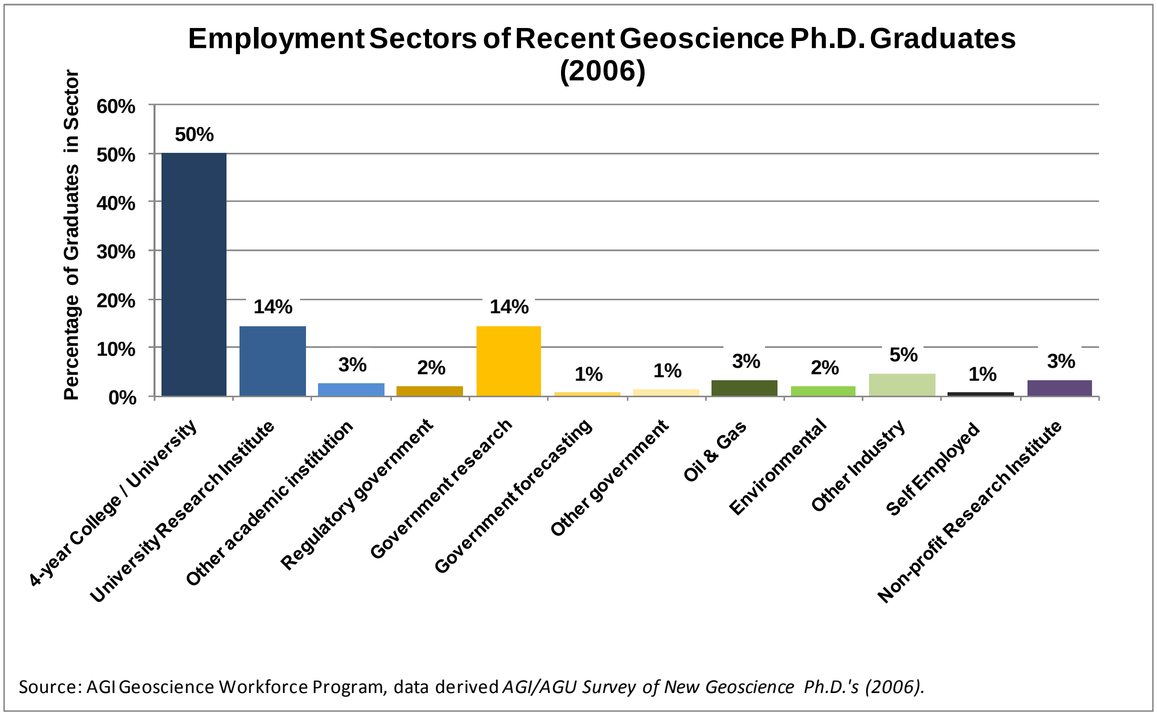


Figure 3.6: Percentage of Geoscience Ph.D. Degree Recipients Working in Different Employment Sectors

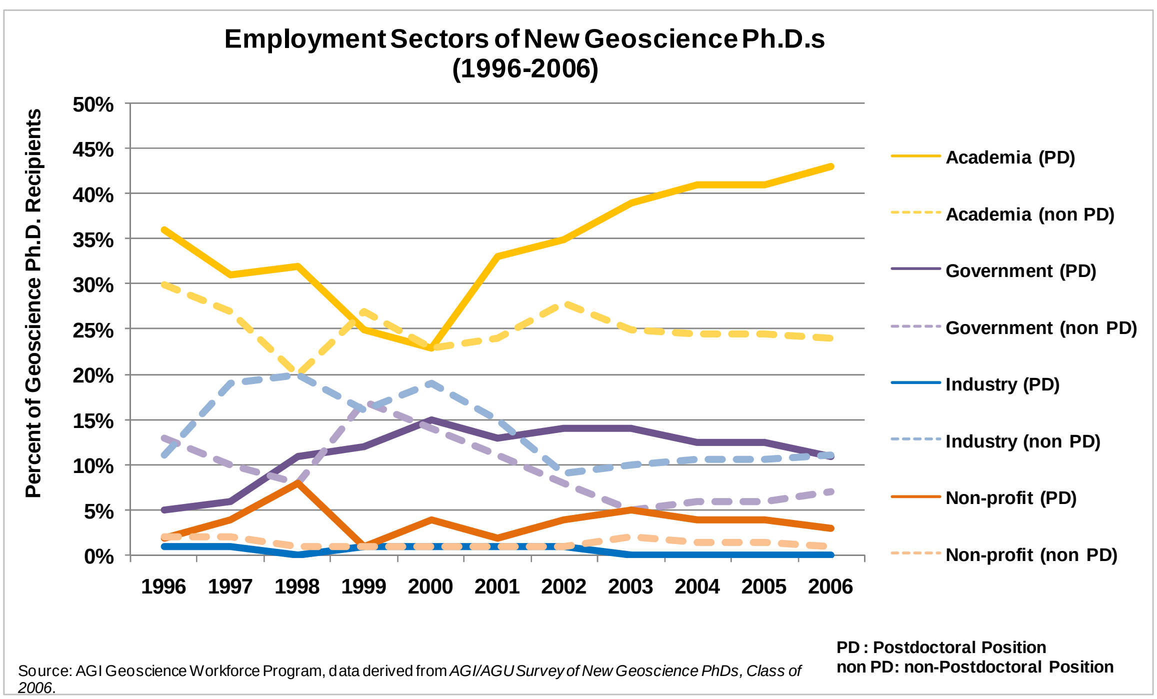


Figure 3.7: Percentage of Geoscience Ph.D. Degree Recipients Working in Post-Doctoral and Non-Post-Doctoral Positions

Since 1996, the majority of new geoscience Ph.D. graduates have entered into academic positions (both post-doctoral and non-postdoctoral). Of note, is the increase in new geoscience Ph.D. recipients taking academic post-doctoral positions since 2000. This is due to a variety of factors:

1) The dot-com bust (1999-2001) caused a decrease in job opportunities as markets shrank. As a result of the ensuing recession, more geoscience faculty began to work later into their careers, delaying retirement. As a result, there were fewer openings in faculty positions in the following years.

2) In 2000, there was a sharp increase of over two hundred million dollars in federal funding for the geosciences, the majority of which was marked for interdisciplinary geoscience research. With more faculty delaying retirement thus reducing the number of open tenure-track faculty positions, and more funding available for geoscience research at universities, more post-doctoral positions became available. New Ph.D. graduates during this period were suited for this funding environment. The majority of Ph.D. dissertations in 1999 and 2000 pertained to either interdisciplinary science (44%) or geological sciences (44%).

3) The majority (81%) of new geoscience Ph.D. recipients focus their job search on academic positions, and most (62%) plan to work in academia in the next 10 years. Additionally, geoscience doctoral recipients have a more positive attitude about the academic sector than they do of other employment sectors. Conversely, new geoscience Master's recipients focus their job searches primarily in the private and government sectors, and most new geoscience Master's degree recipients plan to work in either the private sector or academe in the next 10 years. Three-quarters of new geoscience Master's degree recipients find employment within 3 months of job searching, and over 80 percent of new Ph.D. recipients find employment within 6 months of job searching.

Starting Salaries of Recent Geoscience Graduates

Geoscience starting salaries were competitive with other science and engineering fields in 2007. Bachelor's geoscience graduates, generally employed in the environmental and hydrology industry, earned an average of $31,366 p.a. compared to $31,258 for life scientists and $32,500 for chemistry students.

Recent geoscience Master's recipients had the highest starting salaries in the oil & gas industry, with an average of $81,300 per year, according to a new AGI/AGU study of recent geoscience graduates. This salary level is significantly higher than the average starting salary of all science Master's degree recipients, who earned an average of $46,873 per year. New doctorate recipients in all fields of science earned an average salary of $62,059 in the private sector, while new geosciences doctorates commanded an average salary of $72,600.

Industry	Average Salary	Median Salary
Oil & Gas Industry	$81,300	$82,500
Environmental Industry	$47,500	$45,550
Government	$46,200	$45,000

Table 3.4: Starting Salaries for New Geoscience Master's Degree Recipients
(Source: AGI Geoscience Workforce Program, data derived from *AGI/AGU Survey of New Geoscience Master's, Class of 2006*)

Industry	Average Salary	Median Salary
Postdoc- Academia	$43,100	$42,000
Postdoc-Government	$55,200	$53,000
Potentially Permanent - Academia	$51,900	$52,500
Private Sector	$72,500	$71,000

Table 3.5: Starting Salaries for New Geoscience Ph.D. Degree Recipients
(Source: AGI Geoscience Workforce Program, data derived from *AGI/AGU Survey of New Geoscience PhD's, Class of 2006*)

Skills Used by New Geoscience Master's and Doctoral Degree Recipients

Unsurprisingly, a higher percentage of geoscience doctorates use cognitive skills, technical skills, and use knowledge from their research field as well as a broad knowledge of geoscience. In part, this may be because the majority of geoscience doctorates enter into academia where these skills, developed during their academic training, are continued to be used. The majority of geoscience Master's graduates find work in the private sector or in government positions where cognitive skills are used, but specific technical skills may not be used. Of note is the high percentage of geoscience Master's graduates that use knowledge from their research field and those who use a broad knowledge of the geosciences in their jobs.

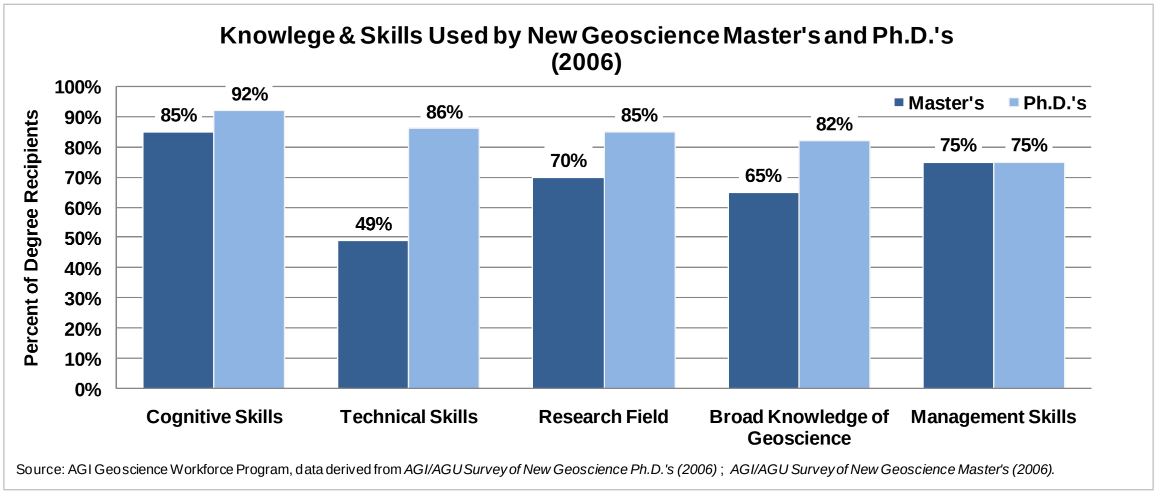


Figure 3.8: Knowledge and Skills Used by Geoscience Graduate Degree Recipients

For geoscience Master's degrees, cognitive skill percentages are down-weighted by those in government positions and the other skills and knowledge percentages are down-weighted by those working in the environmental industry. Those geoscience Master's graduates working in the oil & gas Industry use all of the knowledge and skills across all categories more than those geoscience Master's graduates working in other sectors, and more than geoscience Ph.D. graduates working in the private sector.

	Cognitive Skills	Technical Skills	Research Field	Broad Knowledge of Geoscience	Management Skills
Ph.D.'s					
Any Post-doctoral position	96%	94%	97%	90%	70%
Potentially Permanent - Academe	89%	75%	79%	79%	82%
Private Sector	94%	75%	44%	75%	75%
All Other Sectors	80%	81%	77%	65%	81%
Average for all Ph.D.'s	**92%**	**86%**	**85%**	**82%**	**75%**
Master's					
	Cognitive Skills	**Research Field**	**Technical Skills**	**Broad Knowledge of Geoscience**	**Management Skills**
Oil & Gas Industry	100%	79%	69%	71%	79%
Environmental Industry	82%	70%	39%	52%	78%
Government	77%	77%	54%	65%	77%
All Other	84%	67%	43%	68%	71%
Average for all Master's	**85%**	**70%**	**49%**	**65%**	**75%**

Table 3.6: Knowledge and Skills Used by New Geoscience Ph.D. and Master's Degree Recipients (2006) (Source: AGI Geoscience Workforce Program, data derived from *AGI/AGU Survey of New Geoscience PhD's, Class of 2006* and from *AGI/AGU Survey of New Geoscience Master's, Class of 2006*)

Demographics of the Geoscience Profession

The participation of women in environmental science and geoscience occupations decreased by 8 percent from 2003 to 2006, but rebounded in 2007 to 30 percent. The participation of minorities in these occupations remains under 10 percent with Hispanics having the lowest percentage of all minorities for 2006 and 2007.

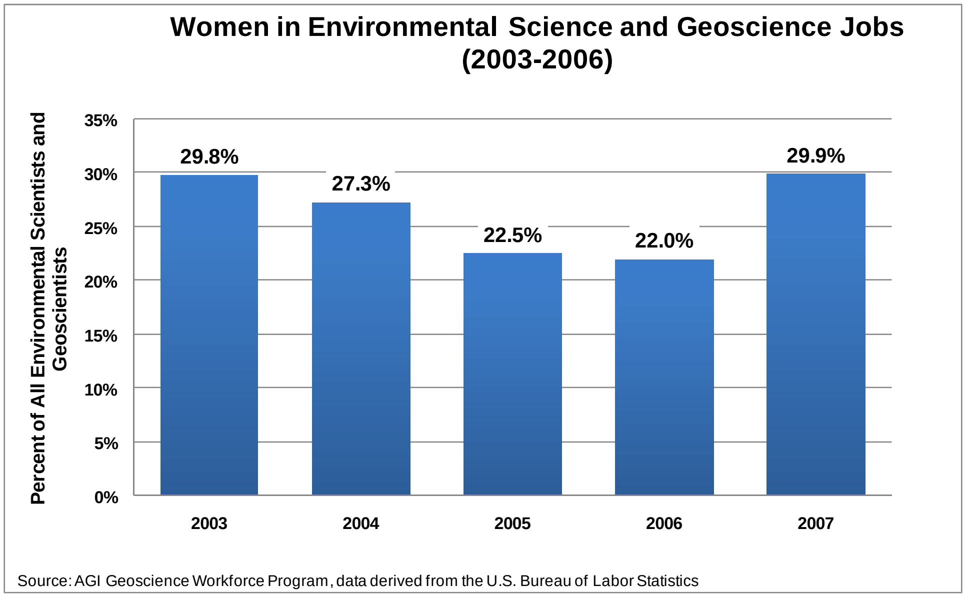


Figure 3.9: Percentage of Women in Environmental Science and Geoscience Occupations

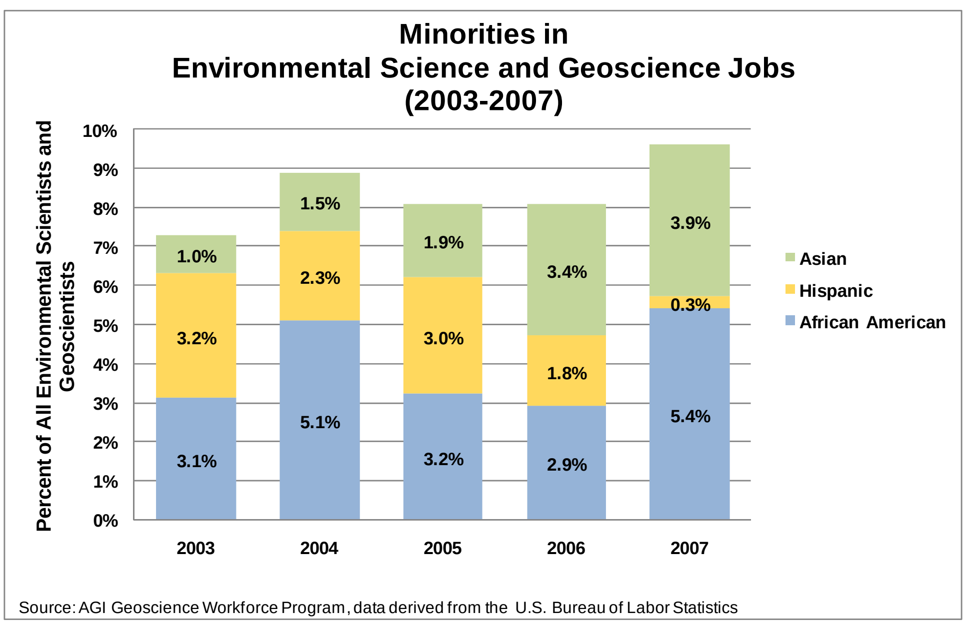


Figure 3.10: Percentage of Minorities in Environmental Science and Geoscience Occupations

Workforce Age Demographics

The majority of geoscientists in the workforce are within 15 years of retirement age. Data from federal sources, professional societies, and industry indicate this imbalance of the age of geoscientists in the profession. The percentage of geoscientists between 31 and 35 years of age is less than half of geoscientists between 51 and 55 years old. All geoscientist occupations in the government, with the exception of meteorologists and oceanographers, have experienced an age shift towards the 50 to 54 year old age group between 2003 and 2007. This shift is most pronounced in the age demographics of mining engineers and petroleum engineers.

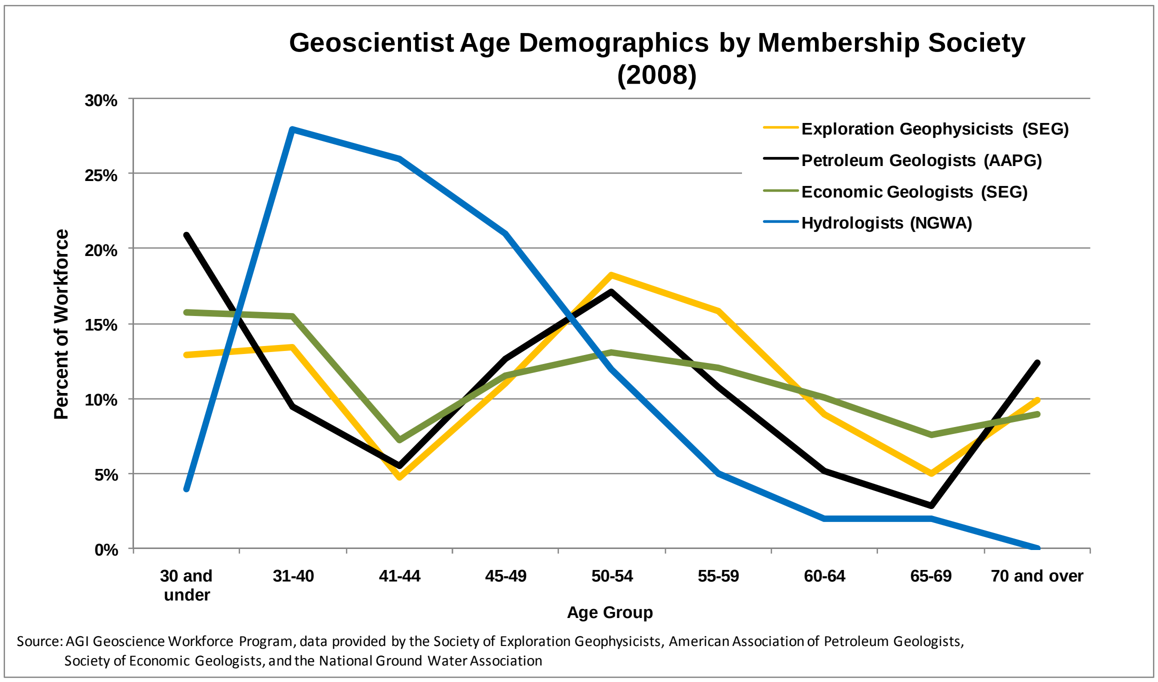


Figure 3.11: Geoscience Age Demographics by Membership Society

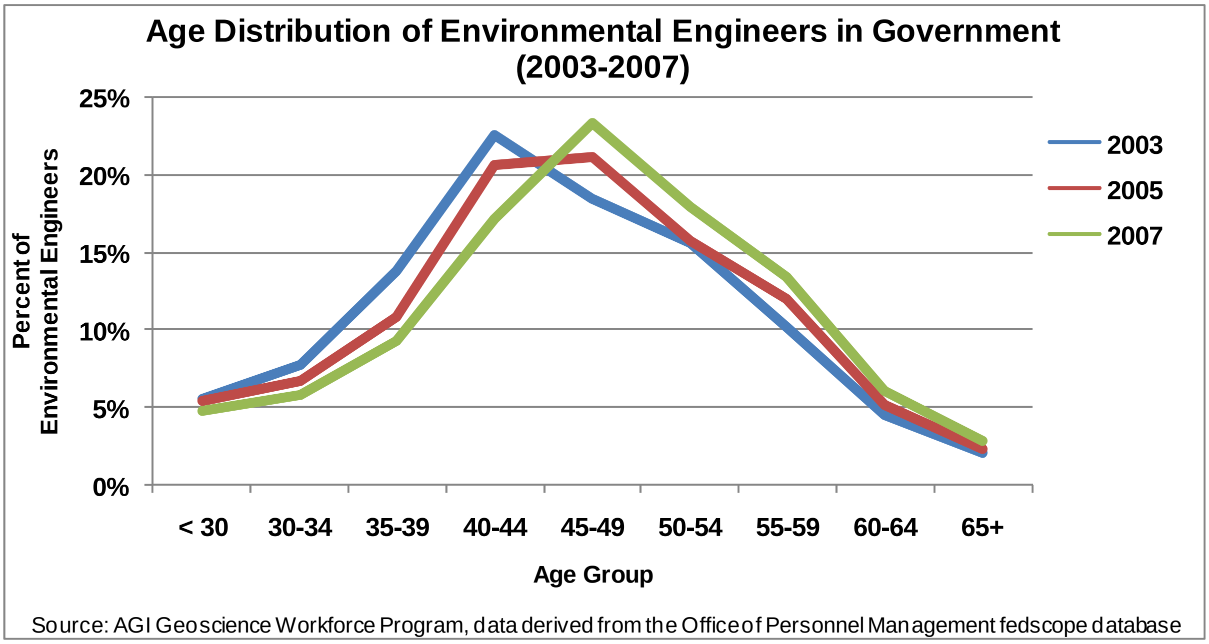


Figure 3.12: Age Distribution of Environmental Engineers in Government

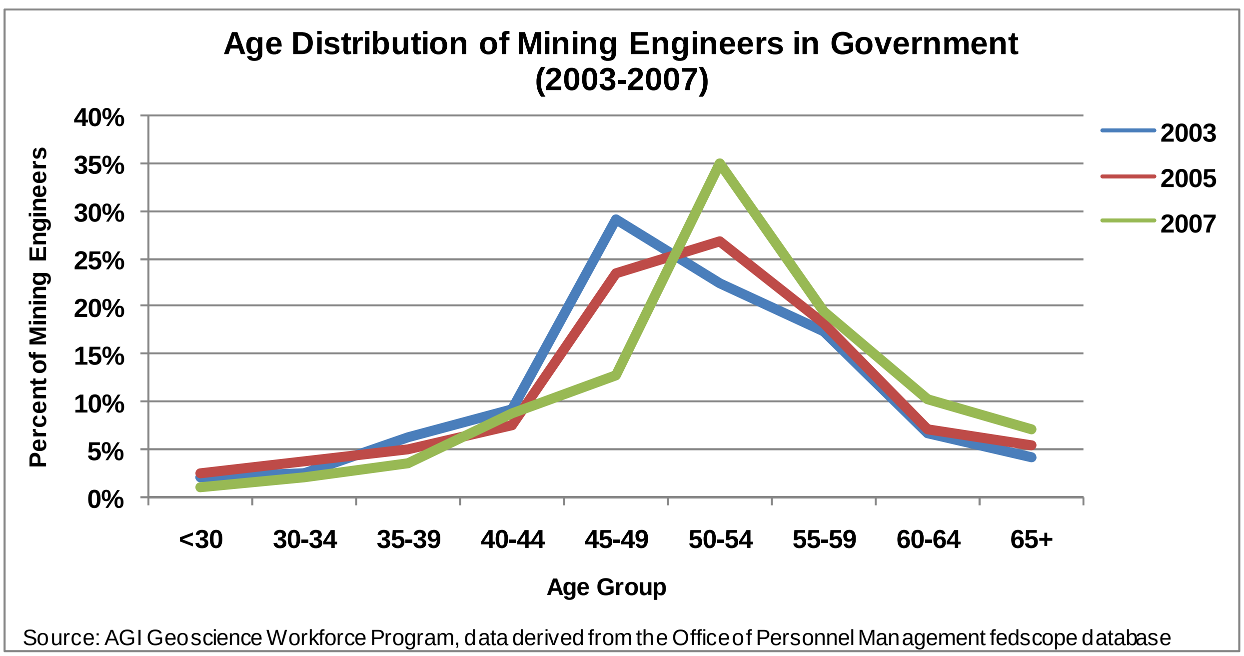


Figure 3.13: Age Distribution of Mining Engineers in Government

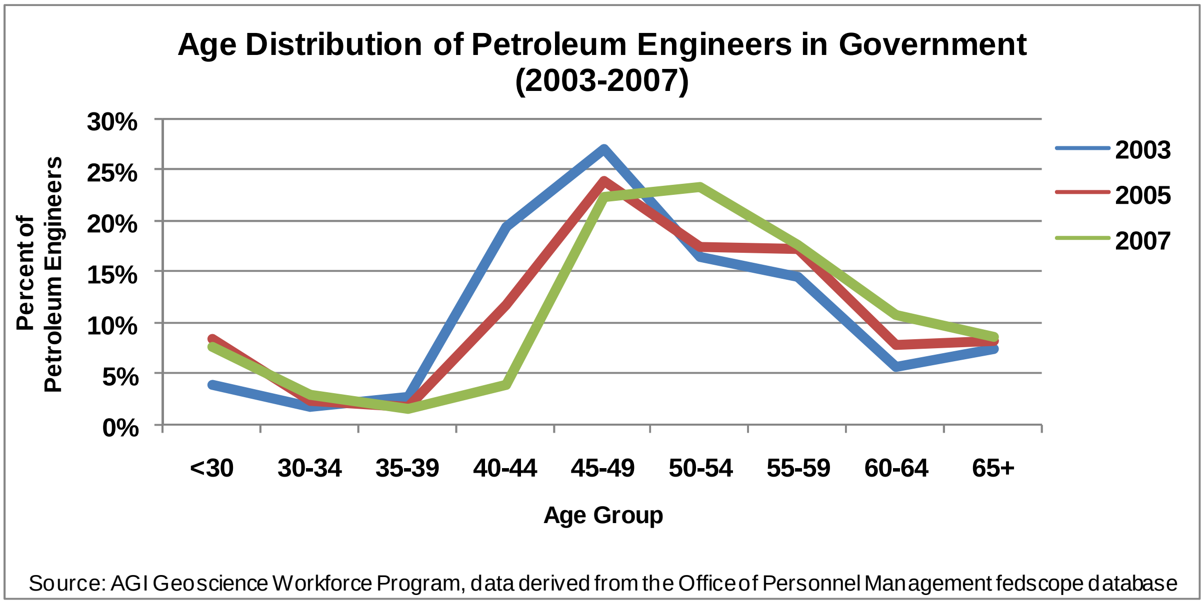


Figure 3.14: Age Distribution of Petroleum Engineers in Government

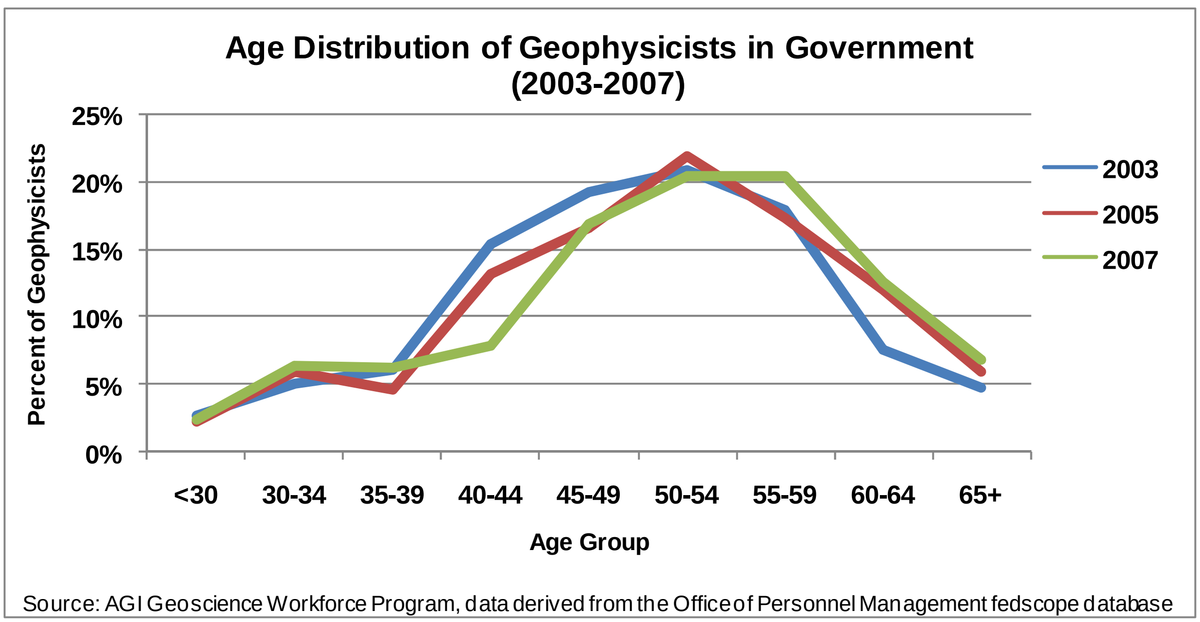


Figure 3.15: Age Distribution of Geophysicists in Government

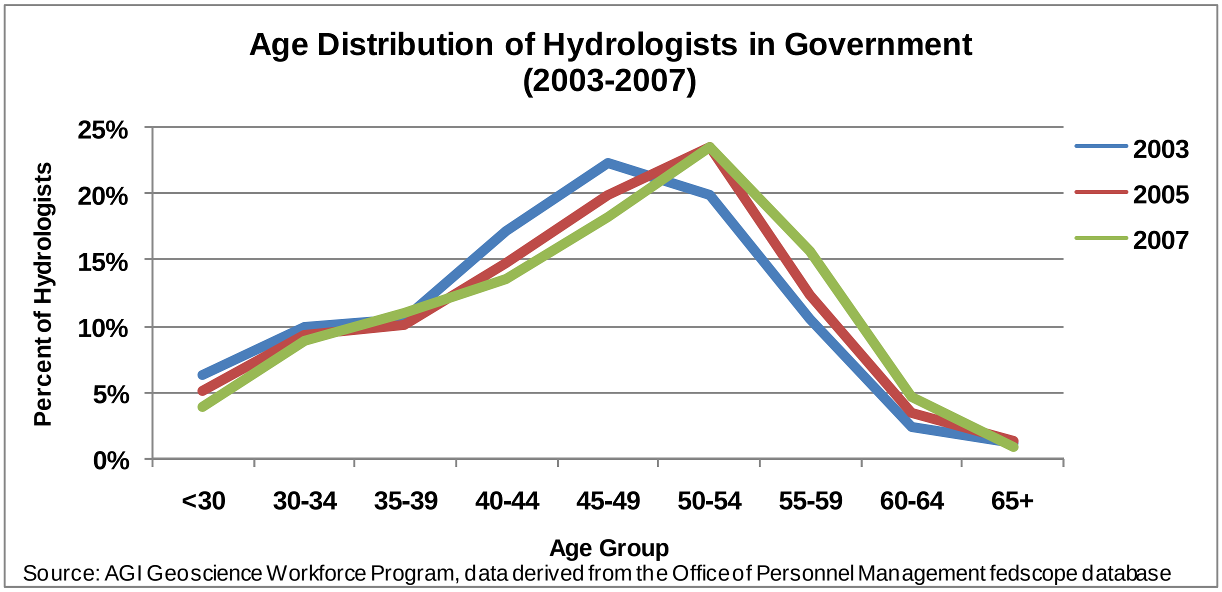


Figure 3.16: Age Distribution of Hydrologists in Government

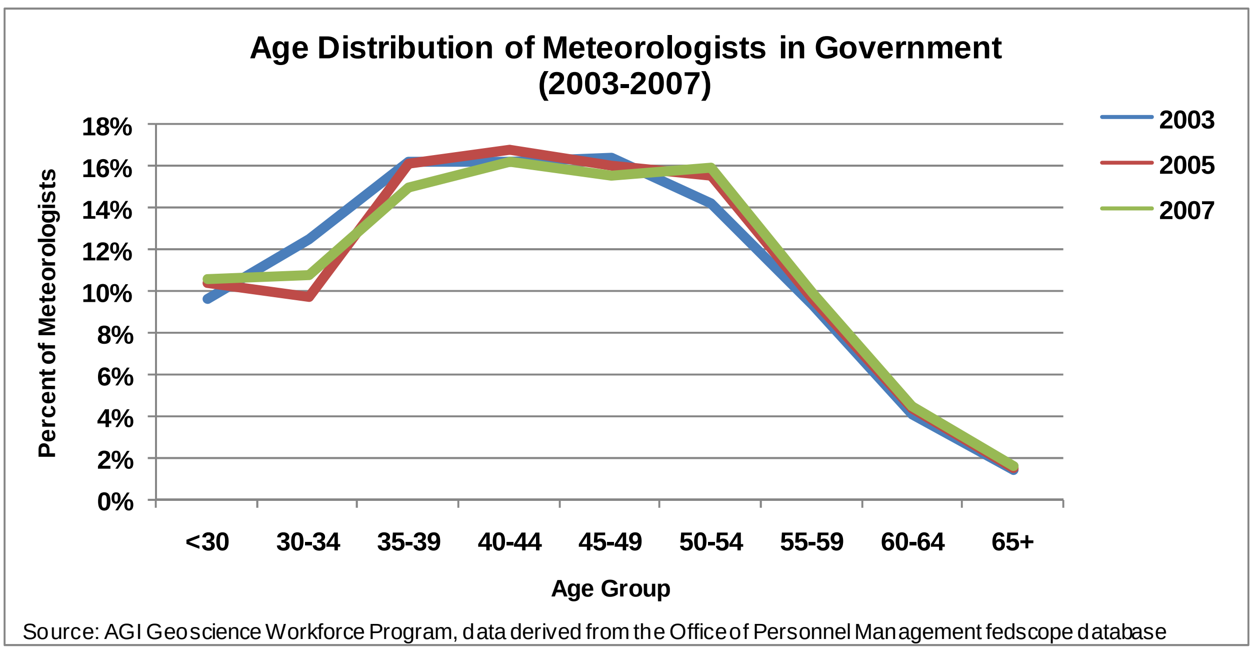


Figure 3.17: Age Distribution of Meteorologists in Government

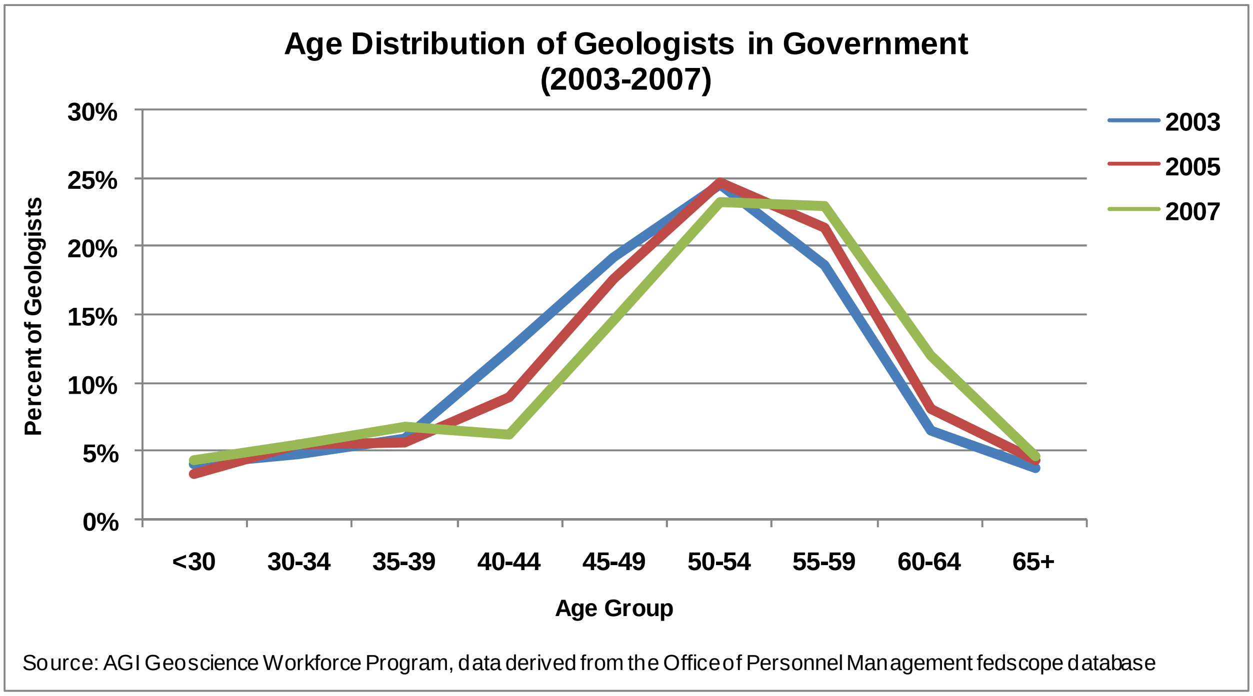


Figure 3.18: Age Distribution of Geologists in Government

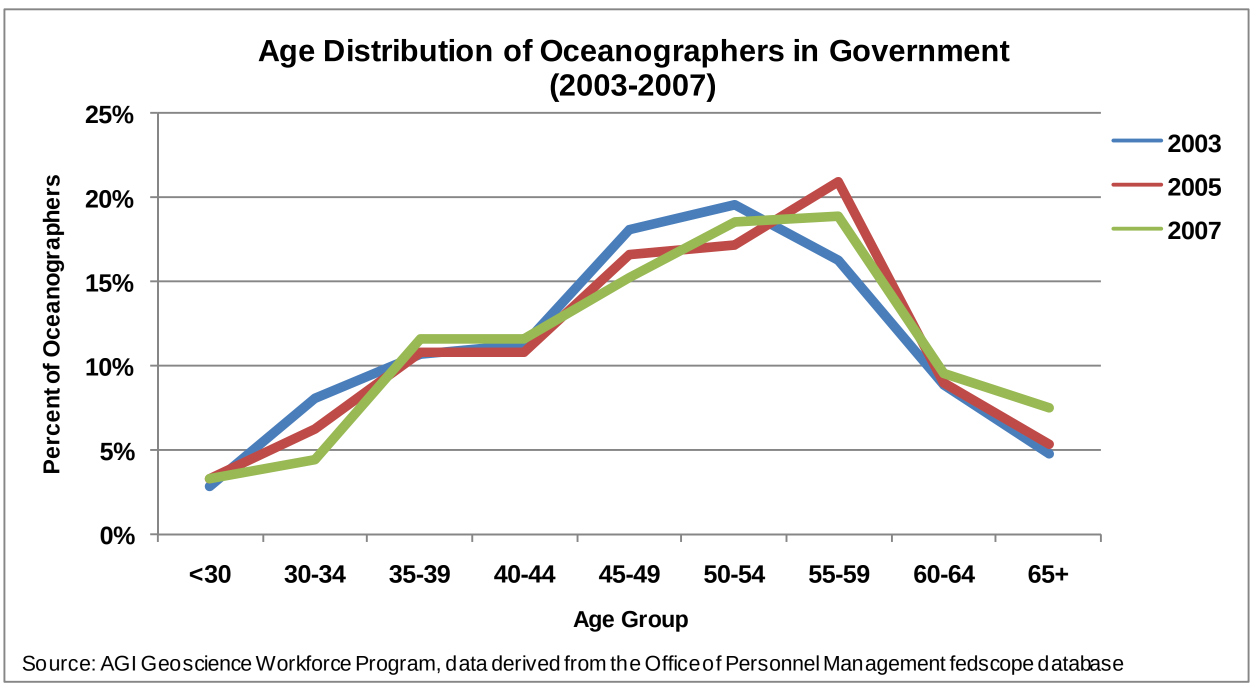


Figure 3.19: Age Distribution of Oceanographers in Government

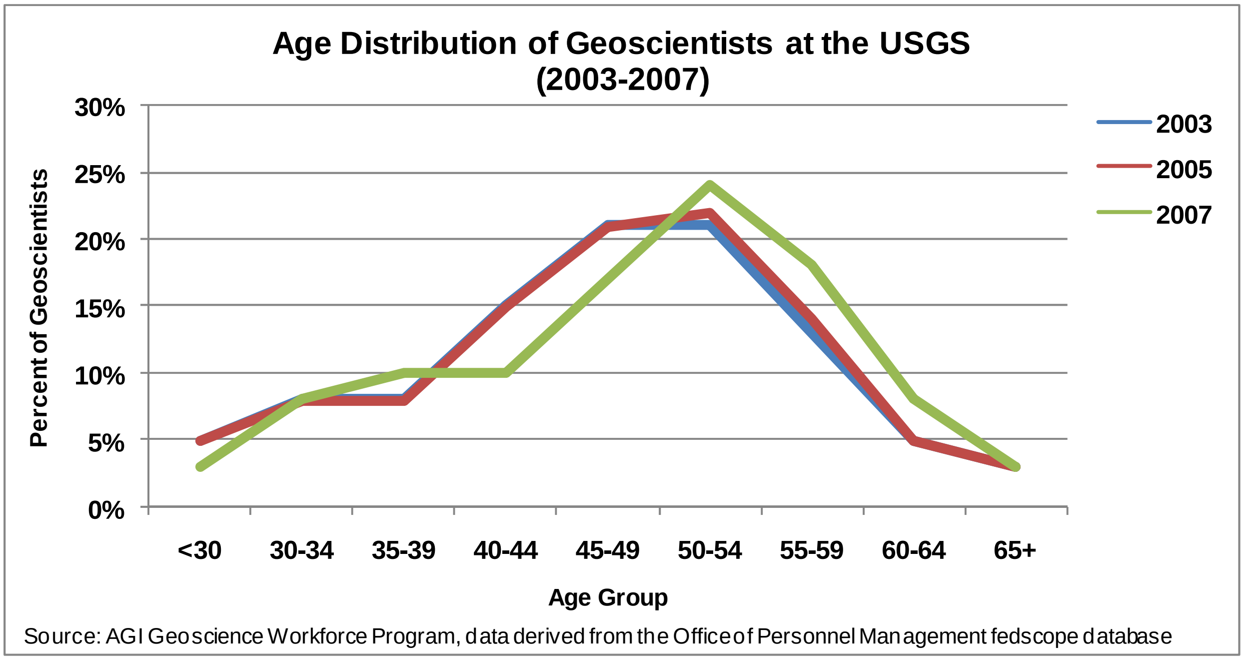


Figure 3.20: Age Distribution of Geologists at the USGS

In oil & gas companies, which typically offer the highest salaries of all geoscience employing industries, the supply of new geoscientists falls short of replacement needs. The number of younger geoscientists in their early 30's is approximately half the number of those nearing retirement age.

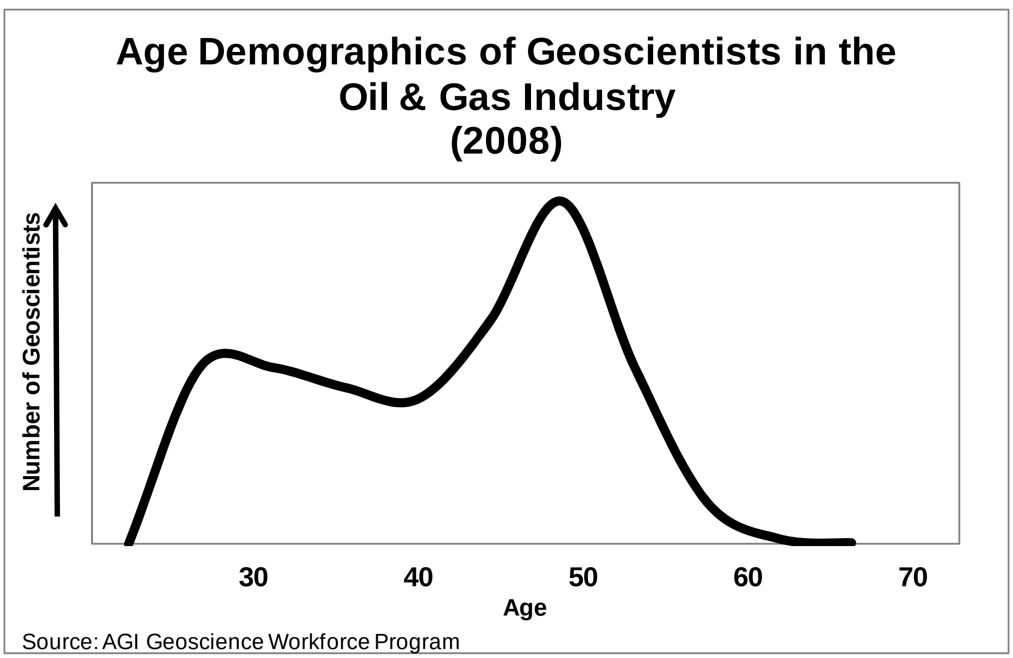


Figure 3.21: Age Distribution of Geoscientists in the Oil & Gas Industry

Additionally the supply of geoscientists is not expected to meet the demand for geoscientists over the next 20 years. Even with an optimistic 3 percent increase in graduate geoscience students entering the petroleum industry and a conservative of 2 percent growth in annual demand for geoscientists after 2011, by 2030, the unmet demand for geoscientists in the petroleum industry will be approximately 30,000. If the supply of foreign geoscience graduates is added to the U.S. graduate pool, the gap is not significantly narrowed.

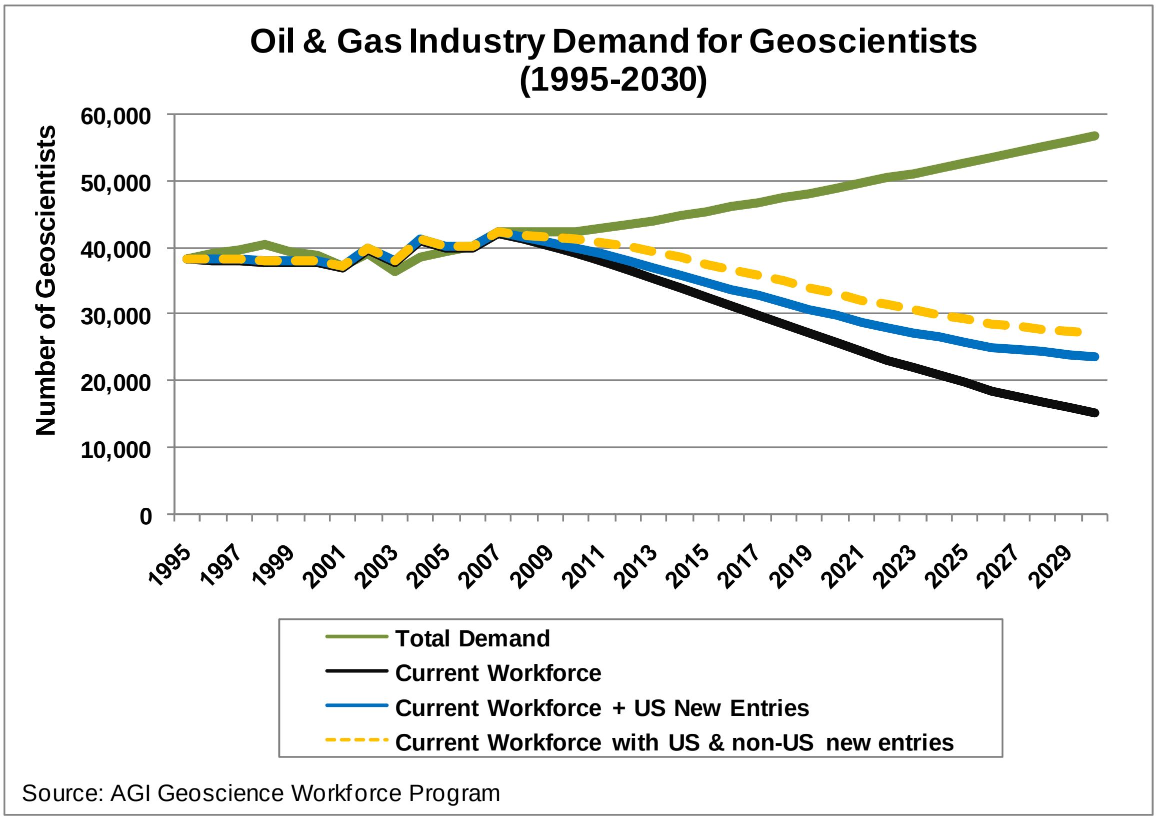


Figure 3.22: Oil & Gas Industry Geoscientist Supply and Demand

In the mining industry, the age demographic trends are similar to other geoscience employing sectors for all mining (except oil & gas extraction), but not for support activities. Support activities for mining and oil & gas is the only geoscience employing industry with the demographics that will provide for the replacement of the older generation of geoscientists who will retire within the next 15 years.

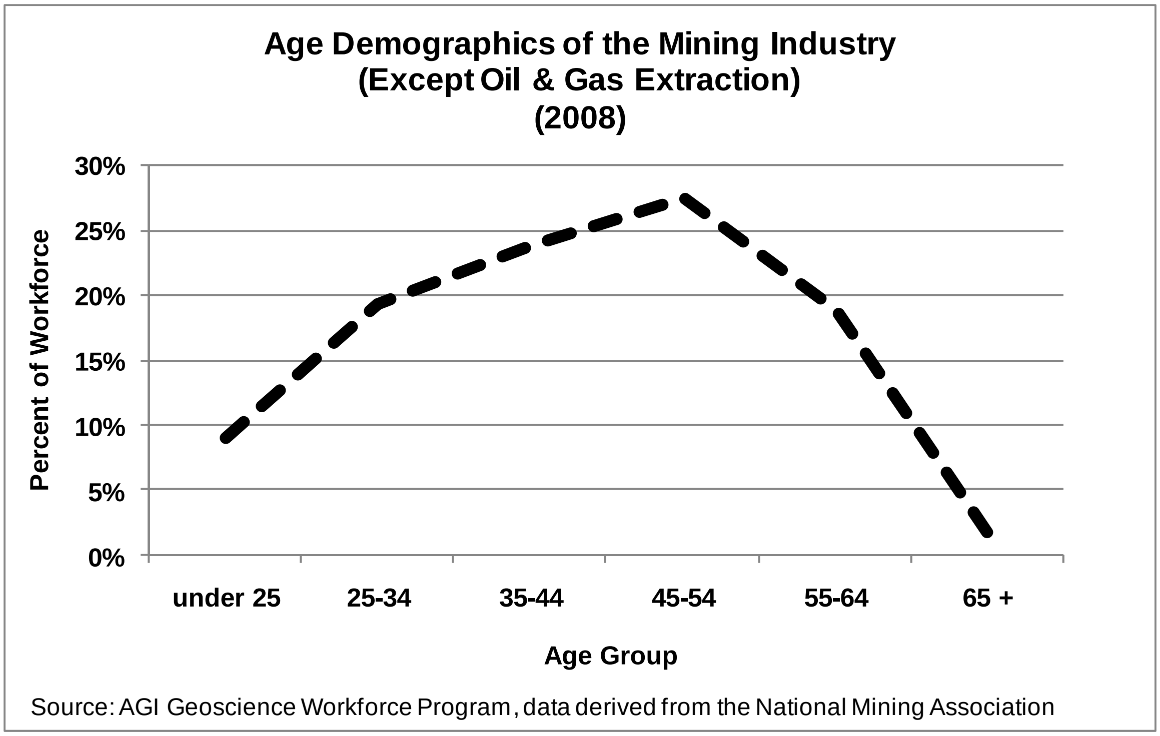


Figure 3.23: Age Distribution of Geoscientists in Mining

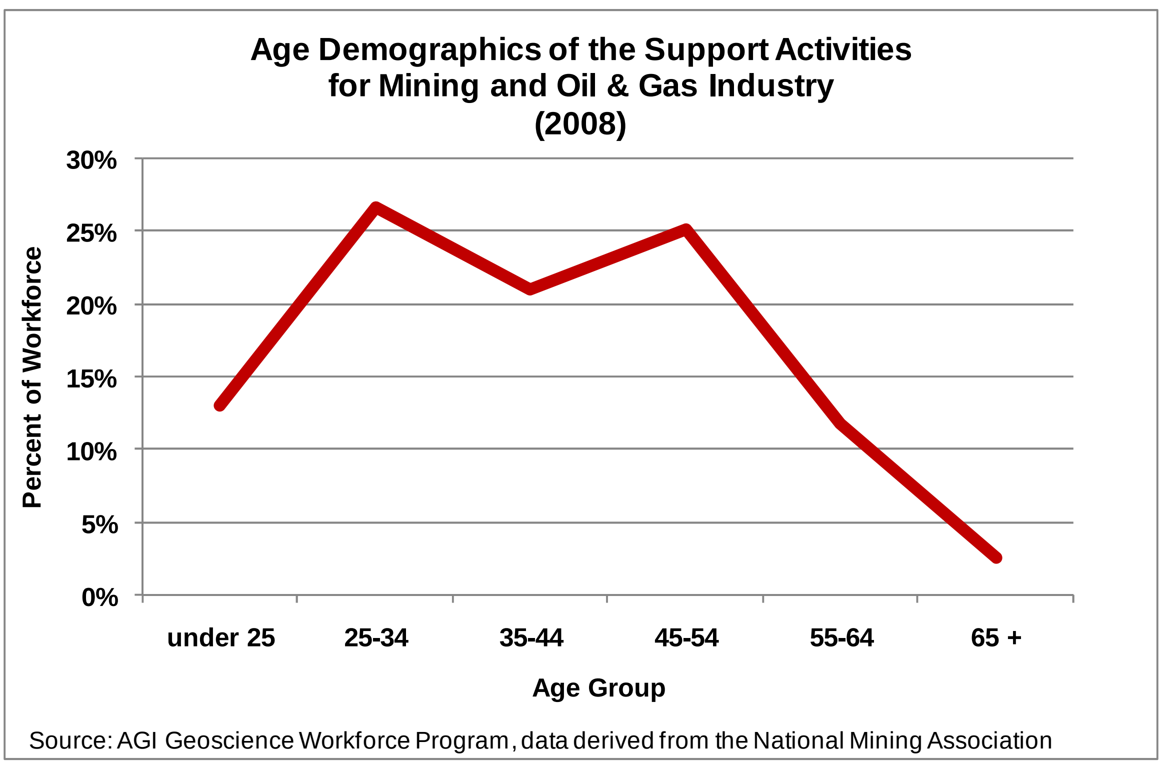


Figure 3.24: Age Distribution of Geoscientists in Support Activities for Mining and Oil & Gas

In academia, tenure-track geoscience faculty progress steadily through the academic ranks from assistant professor to full professor by the age of 60. Full professors tend to work later into their career, and there is a cross-over in the population of full professors and emeritus in the 71 to 75 age range. The lack of faculty under the age of 40 reflects the growing tendency for geoscientists to take post-doctoral fellowships prior to entering the faculty ranks. Lecturers, instructors, and visiting professors comprise less than 5% of each age group. Adjunct professors, however, comprise 5-10% of each age group. This consistent percentage regardless of age reflects a trend of multiple academic appointments throughout a geoscience faculty career.

Like other geoscience industries, those with full professorships are older (late 50's to mid 70's) and there are 30 percent fewer assistant and associate faculty than full professors. Over the next 10 to 15 years, we expect the number of full professor faculty to decline and the number of emeritus faculty to increase as full professors retire and transition into emeritus faculty.

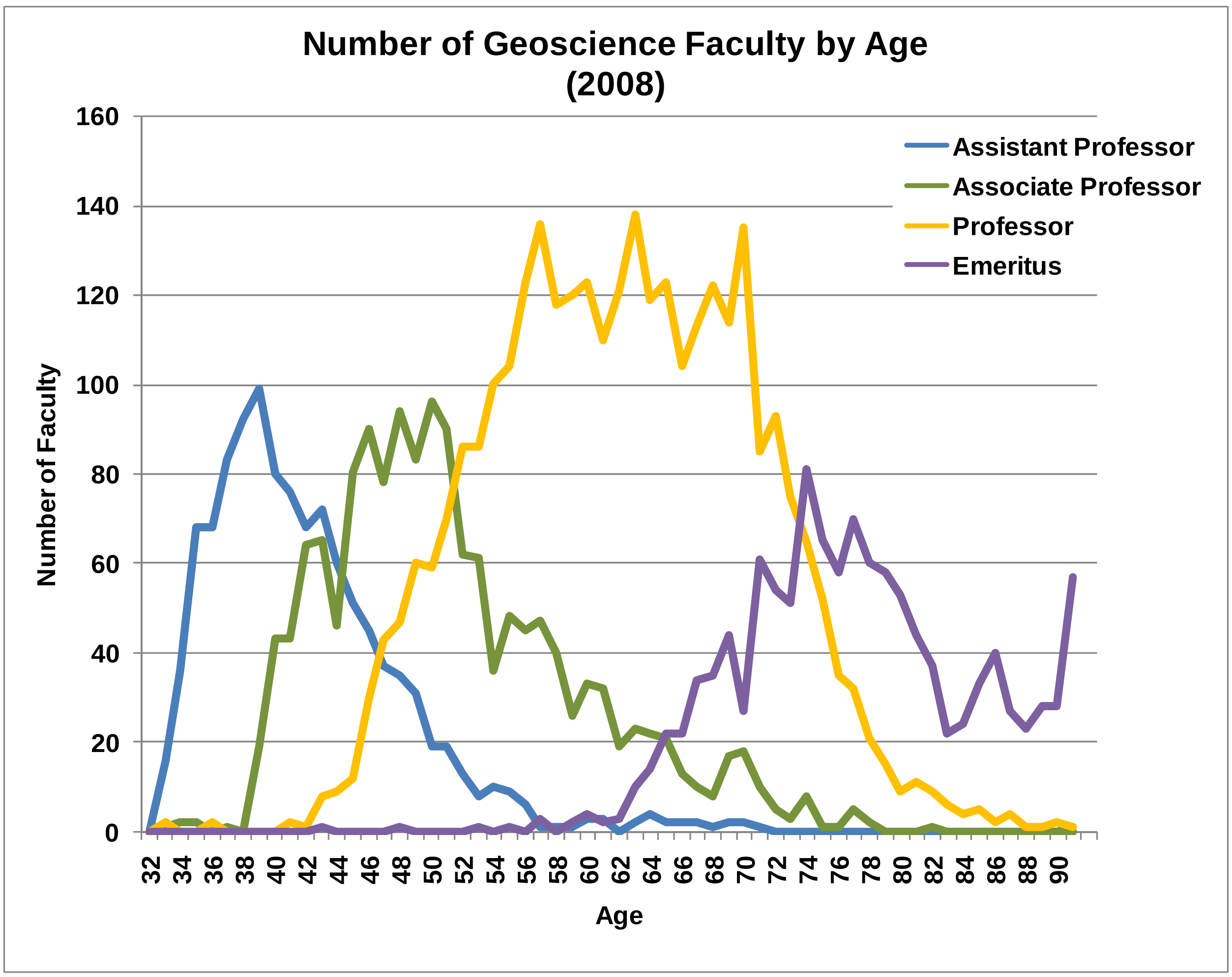


Figure 3.25: Age Distribution of Geoscientists in Academia

Geoscientist Salaries by Occupation and Industry

According to the U.S. Bureau of Labor Statistics there were a total of 266,100 U.S. geoscientist jobs in 2006, and in 2016, the projected number of U.S. geoscientist jobs will be 317,446. Overall, there is a projected 19 percent increase in the number of geoscientist jobs between 2006 and 2016. The increase in job growth will vary among industry with the professional, scientific, and technical services industry having the highest job growth (47%) of all industries that employ geoscientists.

The following table documents the number of jobs in 2006 and in 2016, as well as the 2007 mean annual salaries for geoscientists by occupation and industry. These data were derived from the U.S. Bureau of Labor Statistics.

Occupation	Industry	2006 Number Jobs	2016 Number Jobs	numeric change	% change	2007 Mean Annual Salary (OES)	2007 Number Jobs (OES)
Engineering managers (*)	Total employment, all workers	15,823	18,061	2,238	14%		
Natural sciences managers (*)	Total employment, all workers	3,446	4,084	639	19%		
Environmental Engineers	Total employment, all workers	54,341	68,161	13,819	25%		
Mining and geological engineers, including mining safety engineers	Total employment, all workers	7,070	7,774	704	10%		
Petroleum Engineers	Total employment, all workers	17,355	18,251	896	5%		
Soil and plant Scientists	Total employment, all workers	15,790	17,110	1,320	8%		
Conservation Scientists	Total employment, all workers	19,777	20,830	1,053	5%		
Atmospheric and space scientists	Total employment, all workers	8,759	9,684	925	11%		
Environmental scientists and specialists, including health	Total employment, all workers	83,267	104,142	20,874	25%		
Geoscientists, except hydrologists and geographers	Total employment, all workers	31,061	37,850	6,789	22%		
Hydrologists	Total employment, all workers	8,314	10,337	2,022	24%		
Geographers	Total employment, all workers	1,095	1,162	67	6%		
All Geoscience Occupations	**Total employment, all workers**	**266,100**	**317,446**	**51,346**	**19%**		
Engineering managers (*)	Self-employed workers, all jobs	0	0	0			
Natural sciences managers (*)	Self-employed workers, all jobs	15	16	0	1%		
Environmental Engineers	Self-employed workers, all jobs	1,444	1,538	94	7%		
Mining and geological engineers, including mining safety engineers	Self-employed workers, all jobs	0	0	0			
Petroleum Engineers	Self-employed workers, all jobs	1,599	1,629	29	2%		
Soil and plant Scientists	Self-employed workers, all jobs	3,085	3,266	182	6%		
Conservation Scientists	Self-employed workers, all jobs	773	769	-4	-1%		
Atmospheric and space scientists	Self-employed workers, all jobs	0	0	0			
Environmental scientists and specialists, including health	Self-employed workers, all jobs	1,790	1,907	117	7%		
Geoscientists, except hydrologists and geographers	Self-employed workers, all jobs	673	717	44	7%		
Hydrologists	Self-employed workers, all jobs	196	209	13	7%		
Geographers	Self-employed workers, all jobs	58	61	3	4%		
All Geoscience Occupations	**Self-employed workers, all jobs**	**9,634**	**10,112**	**478**	**5%**		
Engineering managers (*)	Oil and gas extraction	710	701	-9	-1%	$133,410	662
Natural sciences managers (*)	Oil and gas extraction	208	206	-3	-1%	$120,020	111

Occupation	Industry	2006 Number Jobs	2016 Number Jobs	numeric change	% change	2007 Mean Annual Salary (OES)	2007 Number Jobs (OES)
Environmental Engineers	Oil and gas extraction	207	204	-3	-2%	$83,120	190
Mining and geological engineers, including mining safety engineers	Oil and gas extraction	1,718	1,848	131	8%	$104,480	
Petroleum Engineers	Oil and gas extraction	7,418	8,023	605	8%	$120,950	6,740
Soil and plant Scientists	Oil and gas extraction			0			
Conservation Scientists	Oil and gas extraction			0			
Atmospheric and space scientists	Oil and gas extraction			0			
Environmental scientists and specialists, including health	Oil and gas extraction	417	410	-7	-2%	$69,890	340
Geoscientists, except hydrologists and geographers	Oil and gas extraction	5,568	6,022	454	8%	$119,430	5,550
Hydrologists	Oil and gas extraction			0			
Geographers	Oil and gas extraction			0			
All Geoscience Occupations	**Oil and gas extraction**	**16,246**	**17,414**	**1,168**	**7%**		**13,594**
Engineering managers (*)	Mining (except oil and gas)	196	201	5	2%	$94,380	203
Natural sciences managers (*)	Mining (except oil and gas)	0	0	0			0
Environmental Engineers	Mining (except oil and gas)	286	302	16	5%	$68,950	300
Mining and geological engineers, including mining safety engineers	Mining (except oil and gas)	2,017	2,112	95	5%	$69,790	2,080
Petroleum Engineers	Mining (except oil and gas)			0			
Soil and plant Scientists	Mining (except oil and gas)			0			
Conservation Scientists	Mining (except oil and gas)			0			
Atmospheric and space scientists	Mining (except oil and gas)			0			
Environmental scientists and specialists, including health	Mining (except oil and gas)	59	63	3	5%	$69,190	60
Geoscientists, except hydrologists and geographers	Mining (except oil and gas)	292	310	19	6%	$73,870	320
Hydrologists	Mining (except oil and gas)			0			
Geographers	Mining (except oil and gas)			0			
All Geoscience Occupations	**Mining (except oil and gas)**	**2,850**	**2,987**	**137**	**5%**		**2,963**
Engineering managers (*)	Support activities for mining	317	298	-19	-6%	$114,810	328
Natural sciences managers (*)	Support activities for mining	0	0	0			0
Environmental Engineers	Support activities for mining			0		$52,910	
Mining and geological engineers, including mining safety engineers	Support activities for mining	330	311	-20	-6%	$63,980	330

Occupation	Industry	2006 Number Jobs	2016 Number Jobs	numeric change	% change	2007 Mean Annual Salary (OES)	2007 Number Jobs (OES)
Petroleum Engineers	Support activities for mining	2,944	2,769	-175	-6%	$98,510	2,790
Soil and plant Scientists	Support activities for mining			0			
Conservation Scientists	Support activities for mining			0			
Atmospheric and space scientists	Support activities for mining			0			
Environmental scientists and specialists, including health	Support activities for mining			0		$54,860	50
Geoscientists, except hydrologists and geographers	Support activities for mining	2,031	1,911	-121	-6%	$93,820	2,050
Hydrologists	Support activities for mining			0			
Geographers	Support activities for mining			0			
All Geoscience Occupations	**Support activities for mining**	**5,622**	**5,288**	**-334**	**-6%**		**5,548**
Engineering managers (*)	Utilities	187	165	-22	-12%	$109,680	250
Natural sciences managers (*)	Utilities	4	4	0	-10%	$115,240	6
Environmental Engineers	Utilities	692	673	-19	-3%	$78,600	830
Mining and geological engineers, including mining safety engineers	Utilities			0		$59,090	40
Petroleum Engineers	Utilities	410	359	-52	-13%	$91,280	430
Soil and plant Scientists	Utilities			0			
Conservation Scientists	Utilities			0			
Atmospheric and space scientists	Utilities			0			
Environmental scientists and specialists, including health	Utilities	613	571	-42	-7%	$71,120	650
Geoscientists, except hydrologists and geographers	Utilities			0		$84,850	60
Hydrologists	Utilities			0			
Geographers	Utilities			0			
All Geoscience Occupations	**Utilities**	**1,907**	**1,772**	**-135**	**-7%**		**2,266**
Engineering managers (*)	Construction	43	47	4	10%	$103,560	50
Natural sciences managers (*)	Construction	0	0	0			0
Environmental Engineers	Construction	160	176	16	10%	$68,480	190
Mining and geological engineers, including mining safety engineers	Construction			0		$87,090	40
Petroleum Engineers	Construction			0			
Soil and plant Scientists	Construction			0			

Occupation	Industry	2006 Number Jobs	2016 Number Jobs	numeric change	% change	2007 Mean Annual Salary (OES)	2007 Number Jobs (OES)
Conservation Scientists	Construction			0			
Atmospheric and space scientists	Construction			0			
Environmental scientists and specialists, including health	Construction	189	206	18	9%	$57,120	200
Geoscientists, except hydrologists and geographers	Construction			0		$62,790	30
Hydrologists	Construction			0			
Geographers	Construction			0			
All Geoscience Occupations	**Construction**	**392**	**430**	**38**	**10%**		**510**
Engineering managers (*)	Manufacturing	681	555	-126	-18%	$114,540	624
Natural sciences managers (*)	Manufacturing	47	45	-1	-2%	$123,800	48
Environmental Engineers	Manufacturing	3,550	3,075	-475	-13%	$77,700	3,000
Mining and geological engineers, including mining safety engineers	Manufacturing			0		$82,510	50
Petroleum Engineers	Manufacturing	1,138	867	-271	-24%	$112,950	1,580
Soil and plant Scientists	Manufacturing	86	74	-12	-14%	$66,550	120
Conservation Scientists	Manufacturing			0			
Atmospheric and space scientists	Manufacturing	139	139	1	1%	$76,780	50
Environmental scientists and specialists, including health	Manufacturing	1,104	995	-109	-10%	$63,860	830
Geoscientists, except hydrologists and geographers	Manufacturing			0		$112,200	
Hydrologists	Manufacturing			0			
Geographers	Manufacturing			0			
All Geoscience Occupations	**Manufacturing**	**6,745**	**5,751**	**-994**	**-15%**		**6,302**
Engineering managers (*)	Wholesale trade	93	98	4	4%	$121,630	88
Natural sciences managers (*)	Wholesale trade	24	26	1	6%	$124,400	23
Environmental Engineers	Wholesale trade	313	358	44	14%	$76,720	180
Mining and geological engineers, including mining safety engineers	Wholesale trade			0			
Petroleum Engineers	Wholesale trade			0		$120,590	180
Soil and plant Scientists	Wholesale trade	1,657	1,744	87	5%	$63,960	1,620
Conservation Scientists	Wholesale trade			0			
Atmospheric and space scientists	Wholesale trade			0			

Occupation	Industry	2006 Number Jobs	2016 Number Jobs	numeric change	% change	2007 Mean Annual Salary (OES)	2007 Number Jobs (OES)
Environmental scientists and specialists, including health	Wholesale trade	116	115	-1	-1%	$68,590	110
Geoscientists, except hydrologists and geographers	Wholesale trade			0		$135,760	80
Hydrologists	Wholesale trade			0			
Geographers	Wholesale trade			0			
All Geoscience Occupations	**Wholesale trade**	**2,203**	**2,340**	**136**	**6%**		**2,281**
Engineering managers (*)	Transportation and warehousing	64	48	-16	-25%	$112,640	56
Natural sciences managers (*)	Transportation and warehousing	0	0	0			0
Environmental Engineers	Transportation and warehousing	227	204	-23	-10%	$80,950	230
Mining and geological engineers, including mining safety engineers	Transportation and warehousing			0			
Petroleum Engineers	Transportation and warehousing	357	241	-116	-33%	$96,570	330
Soil and plant Scientists	Transportation and warehousing			0			
Conservation Scientists	Transportation and warehousing			0			
Atmospheric and space scientists	Transportation and warehousing	54	59	5	10%	$73,780	60
Environmental scientists and specialists, including health	Transportation and warehousing	132	116	-16	-12%	$69,560	150
Geoscientists, except hydrologists and geographers	Transportation and warehousing			0			
Hydrologists	Transportation and warehousing			0			
Geographers	Transportation and warehousing			0			
All Geoscience Occupations	**Transportation and warehousing**	**834**	**668**	**-166**	**-20%**		**826**
Engineering managers (*)	Information	41	45	4	9%	$118,570	42
Natural sciences managers (*)	Information	1	1	0	11%	$109,730	1
Environmental Engineers	Information			0			
Mining and geological engineers, including mining safety engineers	Information			0			
Petroleum Engineers	Information			0		$99,080	
Soil and plant Scientists	Information			0			
Conservation Scientists	Information			0			
Atmospheric and space scientists	Information	566	624	58	10%	$82,540	550
Environmental scientists and specialists, including health	Information			0			
Geoscientists, except hydrologists and geographers	Information			0		$85,550	

Occupation	Industry	2006 Number Jobs	2016 Number Jobs	numeric change	% change	2007 Mean Annual Salary (OES)	2007 Number Jobs (OES)
Hydrologists	Information			0			
Geographers	Information			0			
All Geoscience Occupations	**Information**	**609**	**671**	**62**	**10%**		**592**
Engineering managers (*)	Finance and insurance	3	4	1	31%	$116,930	2
Natural sciences managers (*)	Finance and insurance	1	2	0	21%	$127,090	1
Environmental Engineers	Finance and insurance			0			
Mining and geological engineers, including mining safety engineers	Finance and insurance			0			
Petroleum Engineers	Finance and insurance	195	256	61	31%	$102,900	110
Soil and plant Scientists	Finance and insurance			0			
Conservation Scientists	Finance and insurance			0			
Atmospheric and space scientists	Finance and insurance			0			
Environmental scientists and specialists, including health	Finance and insurance			0			
Geoscientists, except hydrologists and geographers	Finance and insurance	145	204	59	41%	$89,650	140
Hydrologists	Finance and insurance			0			
Geographers	Finance and insurance			0			
All Geoscience Occupations	**Finance and insurance**	**344**	**466**	**122**	**35%**		**252**
Engineering managers (*)	Professional, scientific, and technical services	6,537	9,443	2,905	44%	$120,680	6,253
Natural sciences managers (*)	Professional, scientific, and technical services	1,712	2,409	697	41%	$126,530	1,616
Environmental Engineers	Professional, scientific, and technical services	27,322	40,044	12,722	47%	$76,520	26,800
Mining and geological engineers, including mining safety engineers	Professional, scientific, and technical services	1,949	2,433	484	25%	$74,430	2,280
Petroleum Engineers	Professional, scientific, and technical services	1,186	1,694	508	43%	$128,110	2,160
Soil and plant Scientists	Professional, scientific, and technical services	2,991	3,839	848	28%	$67,990	2,940
Conservation Scientists	Professional, scientific, and technical services	856	1,188	332	39%	$51,650	880
Atmospheric and space scientists	Professional, scientific, and technical services	3,617	4,527	911	25%	$72,350	4,010
Environmental scientists and specialists, including health	Professional, scientific, and technical services	35,298	54,455	19,157	54%	$68,300	36,020
Geoscientists, except hydrologists and geographers	Professional, scientific, and technical services	13,588	19,728	6,140	45%	$73,720	14,690
Hydrologists	Professional, scientific, and technical services	3,883	5,975	2,092	54%	$71,180	3,770

Occupation	Industry	2006 Number Jobs	2016 Number Jobs	numeric change	% change	2007 Mean Annual Salary (OES)	2007 Number Jobs (OES)
Geographers	Professional, scientific, and technical services	187	264	76	41%	$56,970	200
All Geoscience Occupations	**Professional, scientific, and technical services**	**99,127**	**145,999**	**46,872**	**47%**		**101,619**
Engineering managers (*)	Architectural, engineering, and related services	4,290	5,688	1,398	33%	$114,730	4,193
Natural sciences managers (*)	Architectural, engineering, and related services	254	332	78	31%	$101,000	257
Environmental Engineers	Architectural, engineering, and related services	15,811	22,044	6,234	39%	$74,320	14,980
Mining and geological engineers, including mining safety engineers	Architectural, engineering, and related services	1,499	1,737	238	16%	$70,240	1,860
Petroleum Engineers	Architectural, engineering, and related services	620	791	171	28%	$134,210	1,450
Soil and plant Scientists	Architectural, engineering, and related services	573	710	137	24%	$61,720	500
Conservation Scientists	Architectural, engineering, and related services	131	155	24	19%	$62,450	180
Atmospheric and space scientists	Architectural, engineering, and related services			0		.	
Environmental scientists and specialists, including health	Architectural, engineering, and related services	12,289	16,788	4,499	37%	$62,860	12,390
Geoscientists, except hydrologists and geographers	Architectural, engineering, and related services	7,572	9,665	2,093	28%	$73,540	7,860
Hydrologists	Architectural, engineering, and related services	2,173	3,051	878	40%	$75,270	2,070
Geographers	Architectural, engineering, and related services	110	141	31	28%	$58,910	120
All Geoscience Occupations	**Architectural, engineering, and related services**	**45,323**	**61,103**	**15,781**	**35%**		**45,860**
Engineering managers (*)	Testing laboratories	134	159	24	18%	$118,450	121
Natural sciences managers (*)	Testing laboratories	98	116	18	18%	$100,390	97
Environmental Engineers	Testing laboratories	1,034	1,273	239	23%	$65,350	900
Mining and geological engineers, including mining safety engineers	Testing laboratories	112	138	26	23%	$49,130	
Petroleum Engineers	Testing laboratories			0		$66,380	80
Soil and plant Scientists	Testing laboratories	466	574	108	23%	$62,310	420
Conservation Scientists	Testing laboratories			0			
Atmospheric and space scientists	Testing laboratories			0			
Environmental scientists and specialists, including health	Testing laboratories	2,691	3,313	622	23%	$57,740	2,560
Geoscientists, except hydrologists and geographers	Testing laboratories	509	626	118	23%	$64,020	540
Hydrologists	Testing laboratories			0			
Geographers	Testing laboratories			0			
All Geoscience Occupations	**Testing laboratories**	**5,045**	**6,199**	**1,155**	**23%**		**4,718**

Occupation	Industry	2006 Number Jobs	2016 Number Jobs	numeric change	% change	2007 Mean Annual Salary (OES)	2007 Number Jobs (OES)
Engineering managers (*)	Computer systems design and related services	23	31	8	33%	$137,270	53
Natural sciences managers (*)	Computer systems design and related services	1	1	0	33%	$119,310	2
Environmental Engineers	Computer systems design and related services			0		$81,160	240
Mining and geological engineers, including mining safety engineers	Computer systems design and related services			0			
Petroleum Engineers	Computer systems design and related services			0			
Soil and plant Scientists	Computer systems design and related services			0			
Conservation Scientists	Computer systems design and related services			0			
Atmospheric and space scientists	Computer systems design and related services			0			
Environmental scientists and specialists, including health	Computer systems design and related services			0		$90,040	
Geoscientists, except hydrologists and geographers	Computer systems design and related services	175	237	61	35%	$88,360	170
Hydrologists	Computer systems design and related services			0			
Geographers	Computer systems design and related services			0			
All Geoscience Occupations	**Computer systems design and related services**	**199**	**269**	**69**	**35%**		**465**
Engineering managers (*)	Management, scientific, and technical consulting services	1,159	2,017	858	74%	$111,670	1,337
Natural sciences managers (*)	Management, scientific, and technical consulting services	535	931	396	74%	$113,470	618
Environmental Engineers	Management, scientific, and technical consulting services	7,838	13,992	6,154	79%	$77,870	9,650
Mining and geological engineers, including mining safety engineers	Management, scientific, and technical consulting services			0		$105,140	240
Petroleum Engineers	Management, scientific, and technical consulting services	393	701	308	79%	$129,520	540
Soil and plant Scientists	Management, scientific, and technical consulting services	764	1,363	600	79%	$68,020	1,060
Conservation Scientists	Management, scientific, and technical consulting services	463	772	309	67%	$44,730	570
Atmospheric and space scientists	Management, scientific, and technical consulting services	685	1,222	538	79%	$58,240	750
Environmental scientists and specialists, including health	Management, scientific, and technical consulting services	17,802	31,781	13,979	79%	$69,460	18,370
Geoscientists, except hydrologists and geographers	Management, scientific, and technical consulting services	5,000	8,926	3,926	79%	$72,780	5,610
Hydrologists	Management, scientific, and technical consulting services	1,530	2,732	1,202	79%	$65,990	1,520
Geographers	Management, scientific, and technical consulting services			0		$52,510	
All Geoscience Occupations	**Management, scientific, and technical consulting services**	**36,168**	**64,439**	**28,270**	**78%**		**40,265**
Engineering managers (*)	Scientific research and development services	412	418	6	1%	$140,260	378

Occupation	Industry	2006 Number Jobs	2016 Number Jobs	numeric change	% change	2007 Mean Annual Salary (OES)	2007 Number Jobs (OES)
Natural sciences managers (*)	Scientific research and development services	592	659	67	11%	$134,860	477
Environmental Engineers	Scientific research and development services	3,324	3,546	222	7%	$86,530	1,830
Mining and geological engineers, including mining safety engineers	Scientific research and development services	149	159	10	7%	$70,730	
Petroleum Engineers	Scientific research and development services	84	89	6	7%	$103,270	70
Soil and plant Scientists	Scientific research and development services	1,655	1,765	111	7%	$70,260	1,370
Conservation Scientists	Scientific research and development services	262	261	-1	0%	$65,240	130
Atmospheric and space scientists	Scientific research and development services	1,929	2,058	129	7%	$89,370	1,630
Environmental scientists and specialists, including health	Scientific research and development services	3,999	4,263	264	7%	$72,400	3,840
Geoscientists, except hydrologists and geographers	Scientific research and development services	814	869	54	7%	$78,030	1,040
Hydrologists	Scientific research and development services	177	189	12	7%	$68,100	
Geographers	Scientific research and development services			0		$56,650	30
All Geoscience Occupations	**Scientific research and development services**	**13,396**	**14,276**	**879**	**7%**		**10,795**
Engineering managers (*)	Other professional, scientific, and technical services	4	5	1	27%	$128,560	5
Natural sciences managers (*)	Other professional, scientific, and technical services	6	8	2	29%	$113,630	7
Environmental Engineers	Other professional, scientific, and technical services			0			
Mining and geological engineers, including mining safety engineers	Other professional, scientific, and technical services			0			
Petroleum Engineers	Other professional, scientific, and technical services	70	86	16	23%	$30,300	
Soil and plant Scientists	Other professional, scientific, and technical services			0			
Conservation Scientists	Other professional, scientific, and technical services			0			
Atmospheric and space scientists	Other professional, scientific, and technical services	881	1,087	206	23%	$48,260	1,370
Environmental scientists and specialists, including health	Other professional, scientific, and technical services			0			
Geoscientists, except hydrologists and geographers	Other professional, scientific, and technical services			0			
Hydrologists	Other professional, scientific, and technical services			0			
Geographers	Other professional, scientific, and technical services			0			
All Geoscience Occupations	**Other professional, scientific, and technical services**	**961**	**1,185**	**225**	**23%**		**1,382**
Engineering managers (*)	Management of companies and enterprises	250	280	30	12%	$122,020	353
Natural sciences managers (*)	Management of companies and enterprises	42	47	5	12%	$128,440	68
Environmental Engineers	Management of companies and enterprises	908	1,047	139	15%	$77,920	950

Occupation	Industry	2006 Number Jobs	2016 Number Jobs	numeric change	% change	2007 Mean Annual Salary (OES)	2007 Number Jobs (OES)
Mining and geological engineers, including mining safety engineers	Management of companies and enterprises	249	287	38	15%	$91,190	310
Petroleum Engineers	Management of companies and enterprises			0		$109,360	1,070
Soil and plant Scientists	Management of companies and enterprises	227	261	35	15%	$66,200	270
Conservation Scientists	Management of companies and enterprises			0			
Atmospheric and space scientists	Management of companies and enterprises			0			
Environmental scientists and specialists, including health	Management of companies and enterprises	693	799	106	15%	$73,490	640
Geoscientists, except hydrologists and geographers	Management of companies and enterprises	396	457	61	15%	$107,160	430
Hydrologists	Management of companies and enterprises			0			
Geographers	Management of companies and enterprises			0			
All Geoscience Occupations	**Management of companies and enterprises**	**2,766**	**3,180**	**414**	**15%**		**4,091**
Engineering managers (*)	Administrative and support and waste management and remediation services	168	224	56	33%	$111,900	196
Natural sciences managers (*)	Administrative and support and waste management and remediation services	12	16	4	30%	$106,470	16
Environmental Engineers	Administrative and support and waste management and remediation services	2,541	3,544	1,003	39%	$75,630	2,720
Mining and geological engineers, including mining safety engineers	Administrative and support and waste management and remediation services			0		$76,060	40
Petroleum Engineers	Administrative and support and waste management and remediation services			0		$125,580	130
Soil and plant Scientists	Administrative and support and waste management and remediation services	133	156	23	17%	$58,080	210
Conservation Scientists	Administrative and support and waste management and remediation services			0			
Atmospheric and space scientists	Administrative and support and waste management and remediation services			0			
Environmental scientists and specialists, including health	Administrative and support and waste management and remediation services	1,559	2,031	472	30%	$62,260	1,730
Geoscientists, except hydrologists and geographers	Administrative and support and waste management and remediation services	278	357	79	28%	$73,400	260
Hydrologists	Administrative and support and waste management and remediation services			0			
Geographers	Administrative and support and waste management and remediation services			0			
All Geoscience Occupations	**Administrative and support and waste management and remediation services**	**4,691**	**6,328**	**1,636**	**35%**		**5,301**
Engineering managers (*)	Waste management and remediation services	189	255	66	35%	$110,340	196
Natural sciences managers (*)	Waste management and remediation services	23	31	8	34%	$104,620	20
Environmental Engineers	Waste management and remediation services	2,158	3,032	874	41%	$76,820	2,340

Occupation	Industry	2006 Number Jobs	2016 Number Jobs	numeric change	% change	2007 Mean Annual Salary (OES)	2007 Number Jobs (OES)
Mining and geological engineers, including mining safety engineers	Waste management and remediation services			0			
Petroleum Engineers	Waste management and remediation services			0			
Soil and plant Scientists	Waste management and remediation services			0			
Conservation Scientists	Waste management and remediation services			0			
Atmospheric and space scientists	Waste management and remediation services			0			
Environmental scientists and specialists, including health	Waste management and remediation services	1,010	1,306	296	29%	$59,930	840
Geoscientists, except hydrologists and geographers	Waste management and remediation services	84	111	27	32%	$62,250	90
Hydrologists	Waste management and remediation services			0			
Geographers	Waste management and remediation services			0			
All Geoscience Occupations	**Waste management and remediation services**	**3,465**	**4,736**	**1,271**	**37%**		**3,486**
Engineering managers (*)	Colleges, universities, and professional schools, public and private	39	42	3	8%	$97,910	30
Natural sciences managers (*)	Colleges, universities, and professional schools, public and private	108	117	9	8%	$102,360	103
Environmental Engineers	Colleges, universities, and professional schools, public and private	267	299	32	12%	$63,750	220
Mining and geological engineers, including mining safety engineers	Colleges, universities, and professional schools, public and private			0			
Petroleum Engineers	Colleges, universities, and professional schools, public and private			0		$42,250	50
Soil and plant Scientists	Colleges, universities, and professional schools, public and private	1,945	2,176	231	12%	$50,740	1,610
Conservation Scientists	Colleges, universities, and professional schools, public and private	284	297	13	4%	$54,780	270
Atmospheric and space scientists	Colleges, universities, and professional schools, public and private	741	829	88	12%	$79,250	780
Environmental scientists and specialists, including health	Colleges, universities, and professional schools, public and private	4,554	5,095	541	12%	$55,020	3,670
Geoscientists, except hydrologists and geographers	Colleges, universities, and professional schools, public and private	1,474	1,649	175	12%	$69,150	1,360
Hydrologists	Colleges, universities, and professional schools, public and private	61	68	7	12%	$56,440	50
Geographers	Colleges, universities, and professional schools, public and private			0		$48,130	60
All Geoscience Occupations	**Colleges, universities, and professional schools, public and private**	**9,472**	**10,570**	**1,098**	**12%**		**8,203**
Engineering managers (*)	Federal government, excluding postal service	1,072	1,049	-23	-2%	$117,000	816
Natural sciences managers (*)	Federal government, excluding postal service	1,339	1,311	-28	-2%	$101,740	1,144

Occupation	Industry	2006 Number Jobs	2016 Number Jobs	numeric change	% change	2007 Mean Annual Salary (OES)	2007 Number Jobs (OES)
Environmental Engineers	Federal government, excluding postal service	4,258	4,026	-233	-5%	$87,950	3,850
Mining and geological engineers, including mining safety engineers	Federal government, excluding postal service	210	199	-11	-5%	$83,500	170
Petroleum Engineers	Federal government, excluding postal service	321	303	-18	-5%	$90,570	280
Soil and plant Scientists	Federal government, excluding postal service	2,756	2,605	-151	-5%	$72,800	1,840
Conservation Scientists	Federal government, excluding postal service	7,588	8,513	925	12%	$66,840	6,810
Atmospheric and space scientists	Federal government, excluding postal service	3,204	3,029	-175	-5%	$87,720	2,940
Environmental scientists and specialists, including health	Federal government, excluding postal service	6,247	5,906	-341	-5%	$85,770	5,660
Geoscientists, except hydrologists and geographers	Federal government, excluding postal service	2,602	2,460	-142	-5%	$88,820	2,350
Hydrologists	Federal government, excluding postal service	2,324	2,197	-127	-5%	$76,030	2,070
Geographers	Federal government, excluding postal service	664	627	-36	-5%	$71,780	620
All Geoscience Occupations	**Federal government, excluding postal service**	**32,585**	**32,224**	**-361**	**-1%**		**28,551**
Engineering managers (*)	State government, excluding education and hospitals	429	654	225	52%	$85,780	657
Natural sciences managers (*)	State government, excluding education and hospitals	517	789	271	52%	$69,940	733
Environmental Engineers	State government, excluding education and hospitals	6,772	6,646	-127	-2%	$65,000	6,150
Mining and geological engineers, including mining safety engineers	State government, excluding education and hospitals	274	269	-5	-2%		
Petroleum Engineers	State government, excluding education and hospitals			0			
Soil and plant Scientists	State government, excluding education and hospitals	474	465	-9	-2%	$55,140	370
Conservation Scientists	State government, excluding education and hospitals	3,329	3,049	-280	-8%	*	3,230
Atmospheric and space scientists	State government, excluding education and hospitals			0			
Environmental scientists and specialists, including health	State government, excluding education and hospitals	19,720	19,351	-369	-2%	$53,530	18,840
Geoscientists, except hydrologists and geographers	State government, excluding education and hospitals	2,925	2,870	-55	-2%	$55,390	2,810
Hydrologists	State government, excluding education and hospitals	1,277	1,253	-24	-2%	$59,400	1,140
Geographers	State government, excluding education and hospitals			0			
All Geoscience Occupations	**State government, excluding education and hospitals**	**35,717**	**35,345**	**-372**	**-1%**		**33,930**
Engineering managers (*)	Local government, excluding education and hospitals	2,577	995	-1,582	-61%	$96,080	985
Natural sciences managers (*)	Local government, excluding education and hospitals	402	155	-247	-61%	$86,900	161
Environmental Engineers	Local government, excluding education and hospitals	4,816	5,410	594	12%	$65,740	5,070
Mining and geological engineers, including mining safety engineers	Local government, excluding education and hospitals			0			

Occupation	Industry	2006 Number Jobs	2016 Number Jobs	numeric change	% change	2007 Mean Annual Salary (OES)	2007 Number Jobs (OES)
Petroleum Engineers	Local government, excluding education and hospitals			0			
Soil and plant Scientists	Local government, excluding education and hospitals	557	626	69	12%	$53,760	520
Conservation Scientists	Local government, excluding education and hospitals	3,610	3,666	56	2%	*	3,410
Atmospheric and space scientists	Local government, excluding education and hospitals			0			
Environmental scientists and specialists, including health	Local government, excluding education and hospitals	9,628	10,816	1,188	12%	$56,740	9,790
Geoscientists, except hydrologists and geographers	Local government, excluding education and hospitals	66	75	8	12%	$67,380	90
Hydrologists	Local government, excluding education and hospitals	451	507	56	12%	$64,590	530
Geographers	Local government, excluding education and hospitals	62	69	8	12%	$54,240	70
All Geoscience Occupations	**Local government, excluding education and hospitals**	**54,305**	**22,318**	**-31,987**	**-59%**		**20,626**

Data derived from the U.S. Bureau of Labor Statistics, Occupational Employment Statistics National Employment Matrix 2007

(*): 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.

The "Status of the Geoscience Workforce" Report

The "Status of the Geoscience Workforce" report provides a comprehensive benchmark of the geoscience profession. The report is based on original data collected by the American Geological Institute as well as from existing data from federal data sources, professional membership organizations, and industry data sources. The report synthesizes all available data for the geosciences, from the supply and training of new students, to workforce demographics and employment projections, to trends in geoscience research funding and economic indicators. The report is available as a complete document, as well as on a per chapter basis. It will be available for download from AGI's website: http://www.agiweb.org/.

Report Summary

This 32 page summary provides an in-depth summary of each chapter of the report.

Chapter 1: Trends in Geoscience Education from K-12 through Community College

This chapter examines the student participation in geoscience education at the K-12 level and includes data on state requirements for earth science education in middle and high school, and data pertaining to the number of earth science high school teachers. The chapter also examines trends in college bound students including SAT scores, aspirations for higher education, and choice of college major. Additionally, this chapter examines the availability of geoscience education at community colleges and examines the trends in Associate degrees conferred from geoscience programs at these institutions.

Chapter 2: Trends in Geoscience Education at Four-Year Institutions

This chapter summarizes all available data pertaining to geoscience enrollments, degrees conferred, field camp attendance, and funding of geoscience undergraduate and graduate students. The chapter also explores trends in department size, faculty numbers and research specialties, and funding of geoscience research at the university level.

Chapter 3: Geoscience Employment Sectors

This chapter explores the transition of geoscience graduates into the workforce, age demographics of the industries where geoscientists work, and projected workforce demand. Data pertaining to the current number of jobs and projected number of jobs in 2016 is also provided, as is current salary information for each profession.

Chapter 4: Economic Metrics and Drivers of the Geoscience Pipeline

This chapter provides data on productive activity (number of oil rigs, mines, etc.), commodity pricing and output, gross domestic product, and market capitalization of the industries where geoscientists work.

Appendix A: Defining the Geosciences

This appendix outlines how geoscience occupations and industries are defined in federal data sources. Additionally, the appendix details the working definition proposed by AGI for tracking the geoscience occupation.

Acknowledgements

The AGI Geoscience Workforce program would like to thank the AGI Foundation for funding of the program and this report. The AGI Geoscience Workforce Program would also like to thank the following people, organizations, companies, and industries that provided data for this report, including:

Dr. Penny Morton, University of Minnesota-Duluth, who provided all field camp attendance data; Barry Jay Katz, ChevronTexaco for the "*2003 Report on the Status of Academic Geoscience Departments*"; American Association of Petroleum Geologists (AAPG); American Geophysical Union; Baker Hughes; College Board; Council of Chief State School Officers (CCSSO); Econostats.com; Energy Information Administration; Google Finance; Indexmundi.com; InflationData.com; Industry and corporate data collaborators; Integrated Postsecondary Education Data System (IPEDS); Kitco.com; National Center for Education Statistics (NCES); National Ground Water Association (NGWA); National Mining Association; National Science Foundation Division of Science Resources Statistics; National Science Foundation Award Database; OANDA.com; Office of Personnel Management; Society of Economic Geologists (SEG); Society of Exploration Geophysicists (SEG); U.S. Bureau of Economic Analysis; U.S. Bureau of Labor Statistics; U.S. Department of Education; U.S. Geological Survey.

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Questions and More Information

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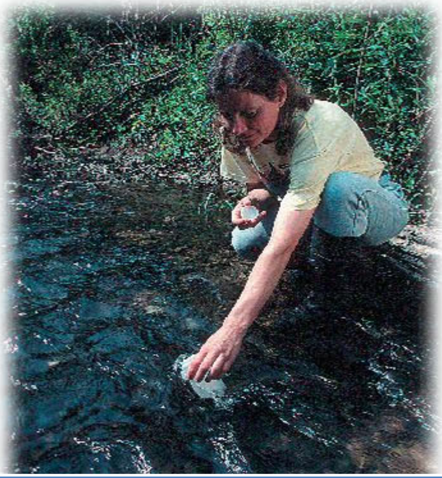

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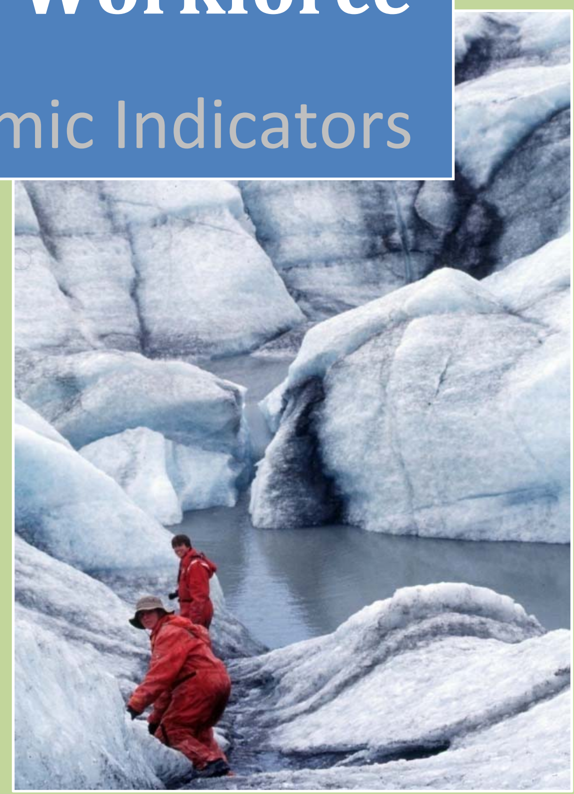
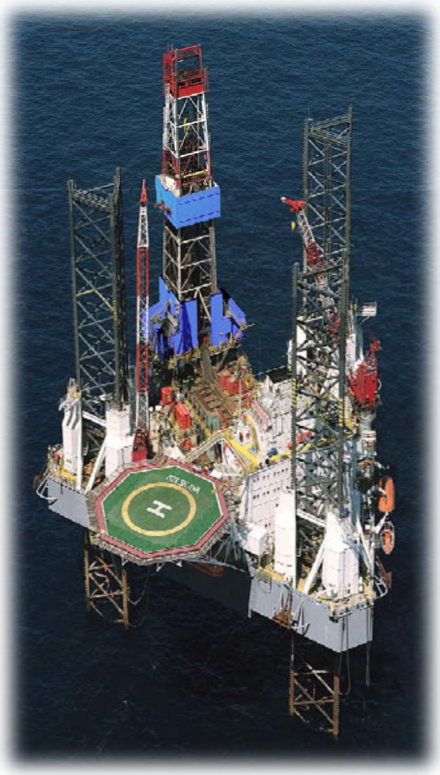
Status of the Geoscience Workforce

Chapter 4: Geoscience Economic Indicators





American Geological Institute

February 2009

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Table of Contents

Geoscience Economic Indicators:

Metrics and Drivers of the Geoscience Workforce

Overall, total federal research funding for geoscience has increased steadily since 1970. However, the percentage of all federal funding for research and development applied to the geosciences has decreased by 3 percent since 1998. Since 1970, the majority of total federal geoscience research funding has been applied to atmospheric sciences. Of note is the increase in the percentage of funding for interdisciplinary geoscience research since 1986 which is most apparent in the applied research trends. Of additional interest is the decrease in funding for oceanographic research (1989 to 1995) and geological science research (1995 to 1998) and the less drastic drop in atmospheric research (1995 to 2003). Federal research funds are allocated to federal agencies, industrial firms, universities and colleges, non-profit institutions, and federally-funded research and development centers. Therefore it is unsurprising that trends in total research funding and research funding applied to universities vary (see Chapter 2 for college and university geoscience funding trends).

Information pertaining to industry funding of geoscience research is limited. Data on company research and development funds are available from the NSF / SRS Industry R&D Funding reports for the mining, extraction, and support industries. Unfortunately, this data is aggregated so distinct trends for these three industries cannot be investigated. However, the abrupt switch from development to research funding that occurred between 2001 and 2002 is evident. This trend is also coincident with the drop in commodity output, gross operating surplus, and taxes on production and imports for the oil & gas extraction industry, a reduction in GDP for all three industries, and a decrease in rig and well counts.

A number of geoscience industries are responsible for generating important commodities that keep our society running, such as oil & gas and mining. All commodity price indices generally follow the energy (fuel) price index; however it is interesting to note that there is some independence of metal price indices from energy price indices. Nickel, zinc, lead and uranium peaked prior to oil, and tin and aluminum peaked at the same time as oil, thus creating a bi-modal peak in the metal price index.

Total domestic commodity output data from 2002 through 2006 indicate a steady increase for both oil & gas extraction and for support activities for mining and oil & gas. Both industries show a drop in commodity output during the last recession between 2001 and 2002. Of note is the leveling off of commodity output for oil & gas extraction between 2005 and 2006 and the increase in output in the support

Did you know?

- The percent of all federal funding for R&D applied to the geosciences has decreased by 3 percent since 1998.
- The total geoscience GDP was $60.7 billion in 2006 which was 0.46% of the national GDP.
- Between 1994 and 2006 the mine waste-to-materials handled ratio decreased by 50% for industrial mineral mines and by 20% for metal ore mines.
- Total U.S. non-fuel mineral production increased 20% between 2005 and 2006. In 2006, the total U.S. non-fuel mineral production was $66.5 billion in 2006.
- Total market capitalization of the geoindustries was approximately $133 billion in 2008.

activities for mining and oil & gas industry. Mining (except oil & gas) commodity output is relatively steady until 2003 when it begins to increase slightly until 2006. Interestingly, the support activities for mining and oil & gas industry has the lowest taxes and since 2004, higher commodity output and gross operating surplus than the mining (except oil & gas) industry.

The geoscience component of GDP represents the direct first-order economic contribution of geoscientists to the U.S. economy. The geoscience component of industry gross domestic product more than doubled between 2002 and 2006. Total geoscience GDP in 2002 was $26.6 billion and in $60.7 billion in 2006. Additionally, the geoscience component of national GDP, which increased from 0.25% in 2002 to 0.46% in 2006. Total geoscience industry GDP is projected to increase to $73.8 billion by 2016 with all industries increasing except the Environmental remediation / Geotechnical industry. The Environmental remediation / Geotechnical industry is expected to contract by approximately 20% between 2006 and 2016, with GDP dropping from $15.7 billion in 2006 to $12.6 billion in 2016.

Productive activity in geoscience industries has increased steadily over the past decade. In the oil & gas industry, the number of rigs has increased steadily (with the exception of a drop during 2001-2002) since 1999. The majority of this increase can be attributed to the increase in onshore and natural gas rigs. Unlike the oil & gas industry, the mining industry has not seen the same amount of productivity growth. The total growth in this industry was due solely to the increase of 2,000 U.S. sand, gravel, and stone mines. The number of U.S. mineral ore and industrial mineral mines (excluding sand, gravel, and stone mines) slowly decreased between 1997 and 2006.

Sand, gravel, and stone mines increased the amount of material handled between 1994 and 2006 by 1,018 million metric tons. Despite the decrease in the number of industrial mineral and metal ore mines, industrial mineral mines increased the amount of material handled by 810 million metric tons and metal ore mines reduced the material handled by 546 million metric tons between 1994 and 2006.

The value of non-fuel mineral production in the U.S. is primarily driven by industrial minerals (including sand, gravel, and stone). Since 2003, there has been a steady increase in U.S. non-fuel mineral production for both metals and industrial minerals. The dip in non-fuel metals production between 1997 and 2003 was driven by the sharp drop in commodity prices and U.S. exploration and operations.

Market capitalization of geoscience industries was calculated based on a set of 77 major companies from the following industries: Cement & Aggregates, Coal, Environmental, Metals & Mining, Natural Gas, Oilfield Services, Petroleum (both Integrated and Producing), Precious Metals, and Water Utility. By far, integrated petroleum companies contribute the most (approximately $100 billion) to the total current market capitalization of geoscience industries, followed by oilfield services ($12 billion) and natural gas companies ($6 million). Water utilities and precious metal companies contribute the least to the total market capitalization at just under $1 billion.

Federal Research Funding of Geoscience Research

Total federal research funds are allocated to federal agencies, industrial firms, universities and colleges, non-profit institutions, and federally funded research and development centers. Therefore it is not surprising that trends in total research funding and research funding applied to universities are different (see Chapter 2 for college and university geoscience funding trends).

Overall, the total amount of federal research funding for geoscience research has increased steadily since 1970; however the percentage of all federal funding for research and development applied to the geosciences has decreased by 3 percent since 1998. Since 1970, the majority of total federal geoscience research funding has been applied to atmospheric science research. Of note is the increase in the percentage of funding applied to interdisciplinary geoscience research since 1986 which is most apparent in the applied research funding trends. Of additional interest are the drops in funding for oceanographic research (1989 to 1995) and geological science research (1995 to 1998) and the less drastic drop in atmospheric research (1995 to 2003) that are most evident in the basic research funding trends.

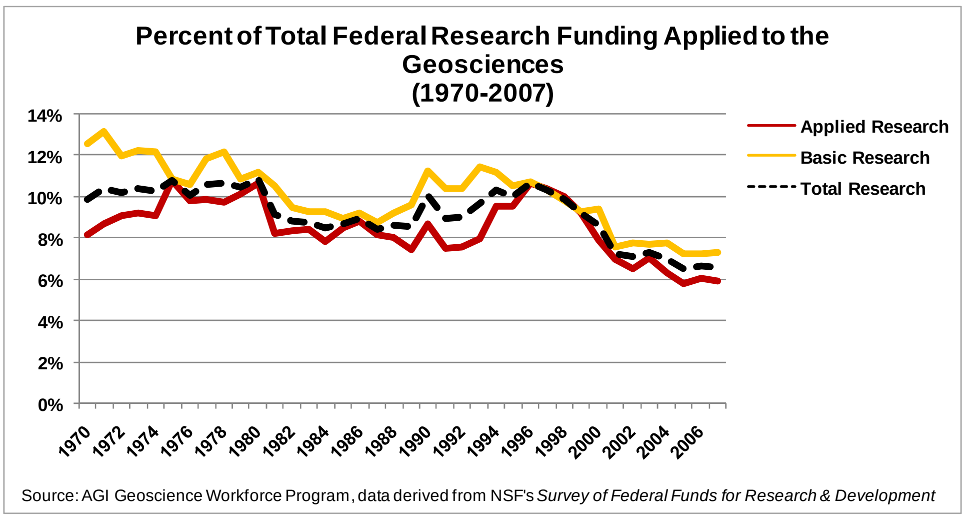

Figure 4.1: Percent of Federal Research Funding Applied to the Geosciences

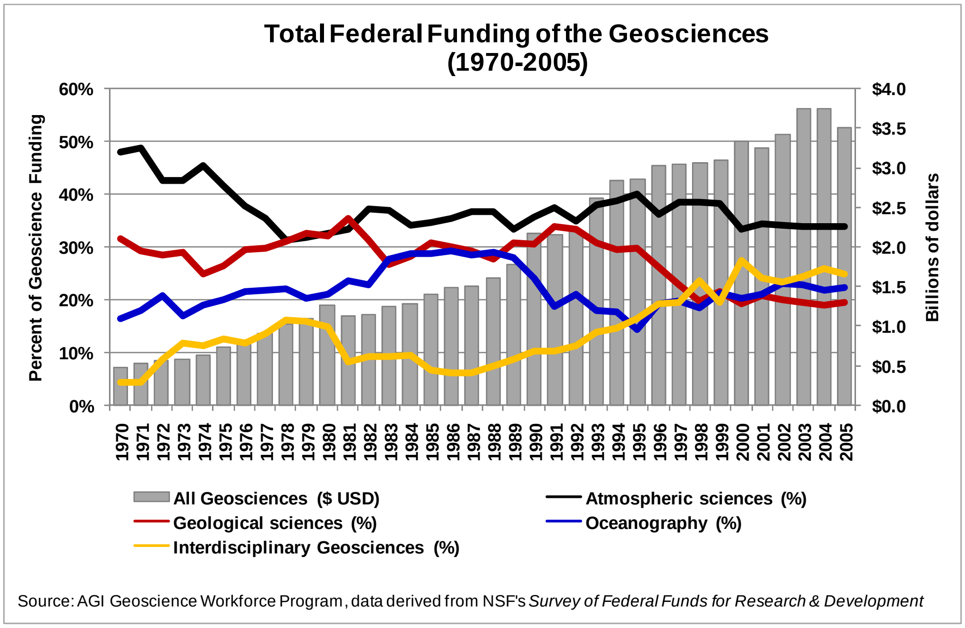

Figure 4.2: Total Federal Research Funding of the Geosciences

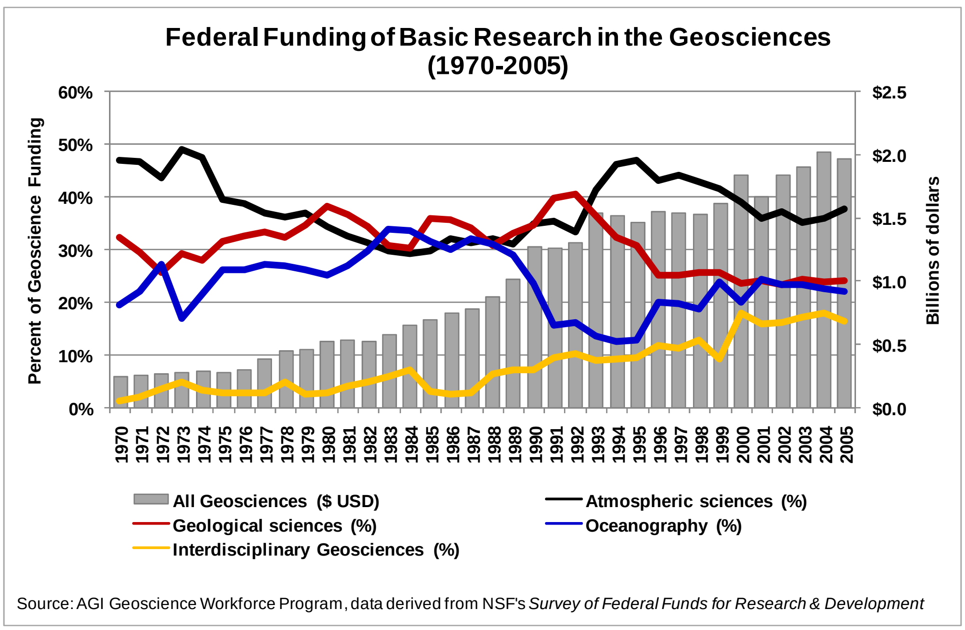

Figure 4.3: Federal Funding of Basic Research in the Geosciences

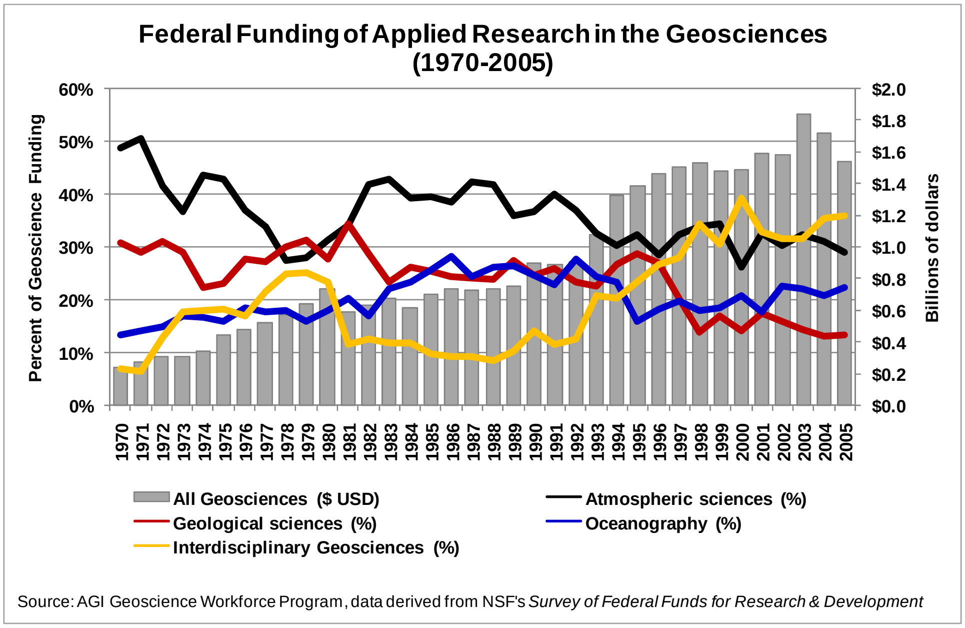

Figure 4.4: Federal Funding of Applied Research in the Geosciences

Trends in geoscience funding differ by federal agency. The Department of Agriculture primarily funds geological science and atmospheric science. Between 1976 and 1990, geological science research received just over 60 percent of all geoscience research funds, and after 1990, atmospheric science research received approximately 90 percent of all geoscience research funding.

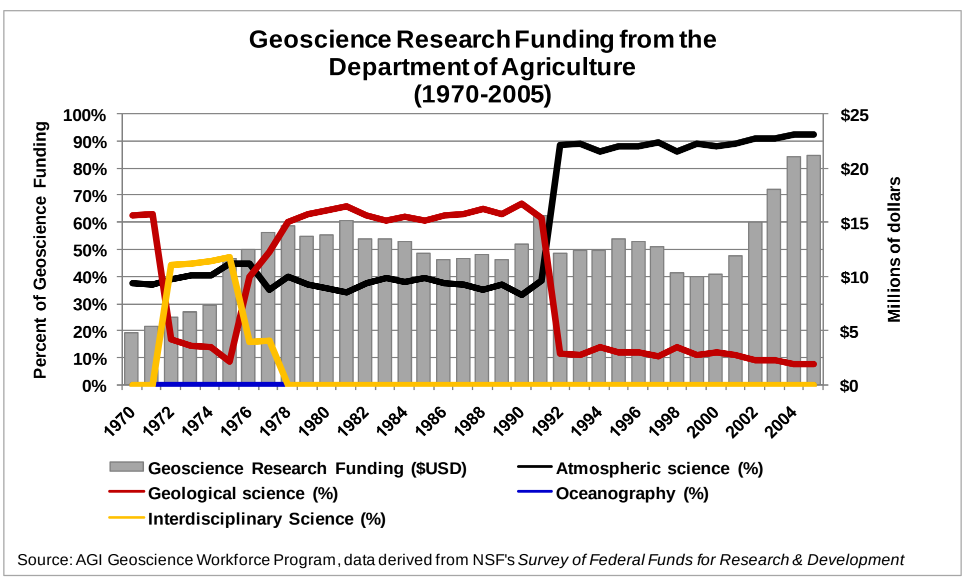

Figure 4.5: Geoscience Research Funding from the Department of Agriculture

The Department of Commerce primarily funds oceanographic and atmospheric research. From 1970 to 1990 the percentage of funds applied to atmospheric research dropped from 70 to 25 percent while the percentage of funds applied to oceanographic research increased from 10 to 70 percent. From 1996 to 2005, funding for each sub-discipline hovered around 40 percent.

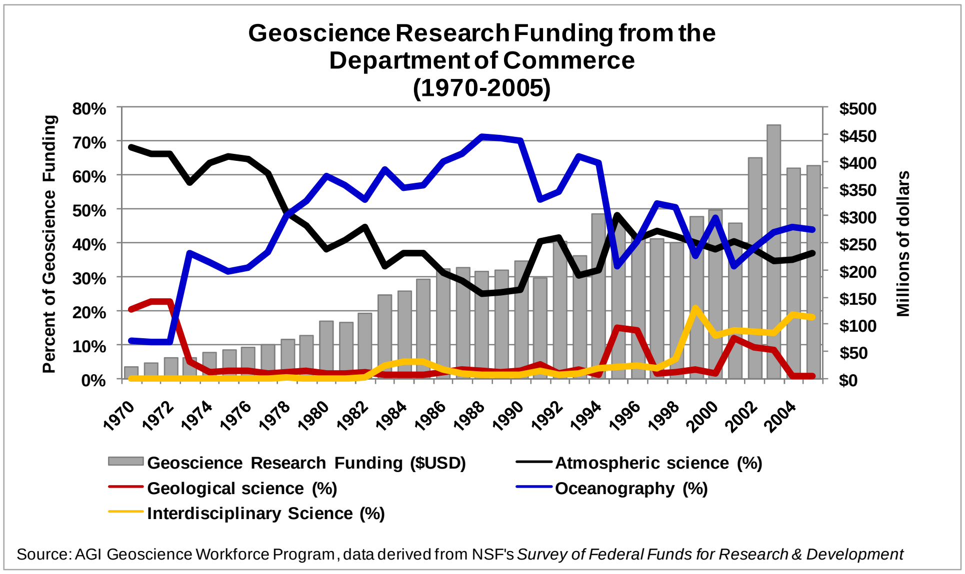

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Figure 4.6: Geoscience Research Funding from the Department of Commerce

Atmospheric research received the highest percentage of funding of all geoscience sub-disciplines from the Department of Defense between 1970 and 1990. However, the funding for this sub-discipline began to decline in 1983. Funding for geological science research by the Department of Defense peaked between 1984 and 1994 and quickly declined thereafter. Of note is the brief peak in funding for interdisciplinary research (1995 to 1999) followed by the increase in funding for oceanographic research that began in 1999.

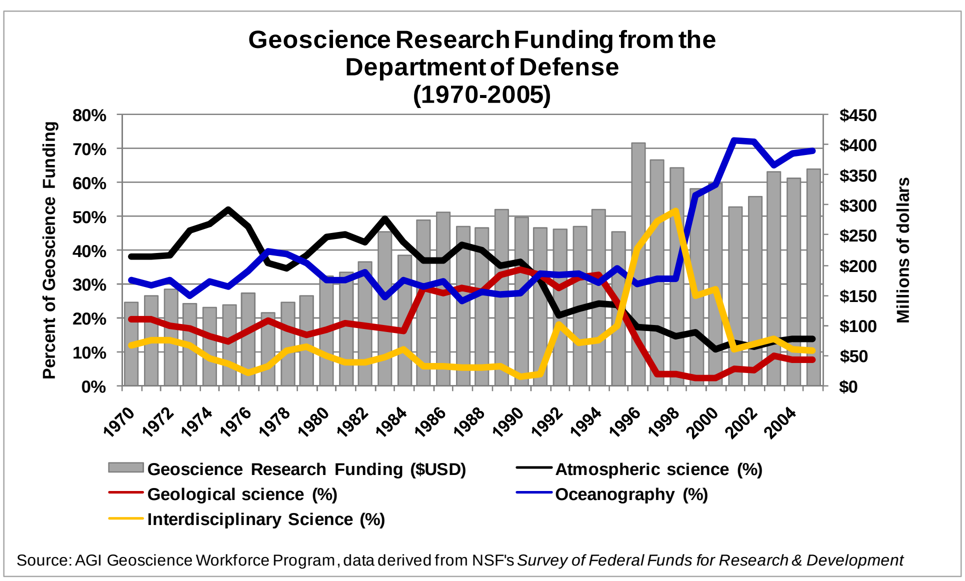


Figure 4.7: Geoscience Research Funding from the Department of Defense

Geological science, atmospheric science and interdisciplinary geoscience research have received the majority of geoscience funding from the Department of Energy at different periods of time since 1970. Geological science research received the majority of funding between 1961 and 1989 and from 2003 to 2005. Atmospheric science received the majority of funding from 1970 to 1974. Interdisciplinary research received the majority of funding during two separate intervals: 1976 to 1980 and 1994 to 1999.

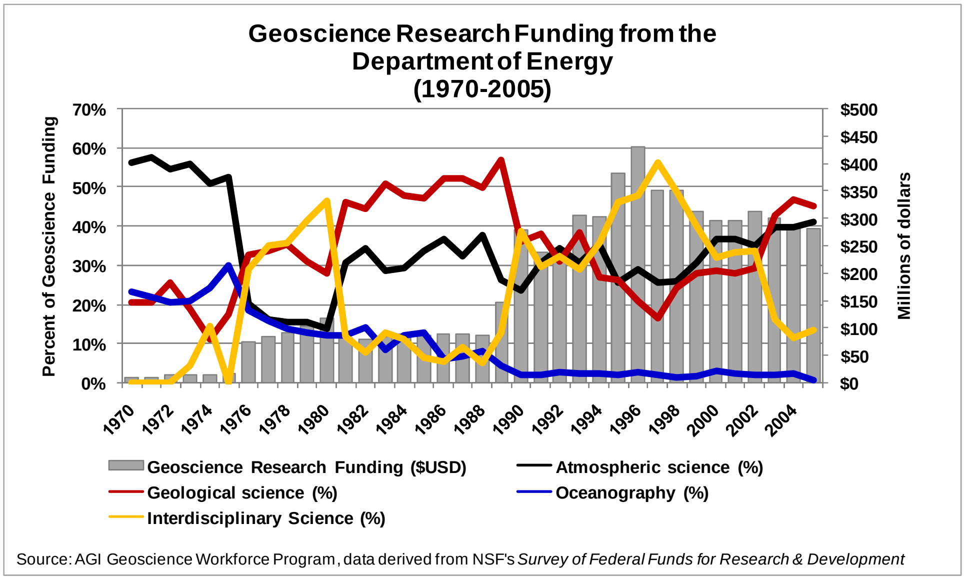


Figure 4.8: Geoscience Research Funding from the Department of Energy

The Department of Interior primarily funds geological science research. An interesting inflection point in the funding trend is the sharp increase (~ 40%) in interdisciplinary research and decrease in geological science funding that occurred between 1997 and 1998. This is most likely attributed to a reclassification of geological science research to interdisciplinary research during this year.

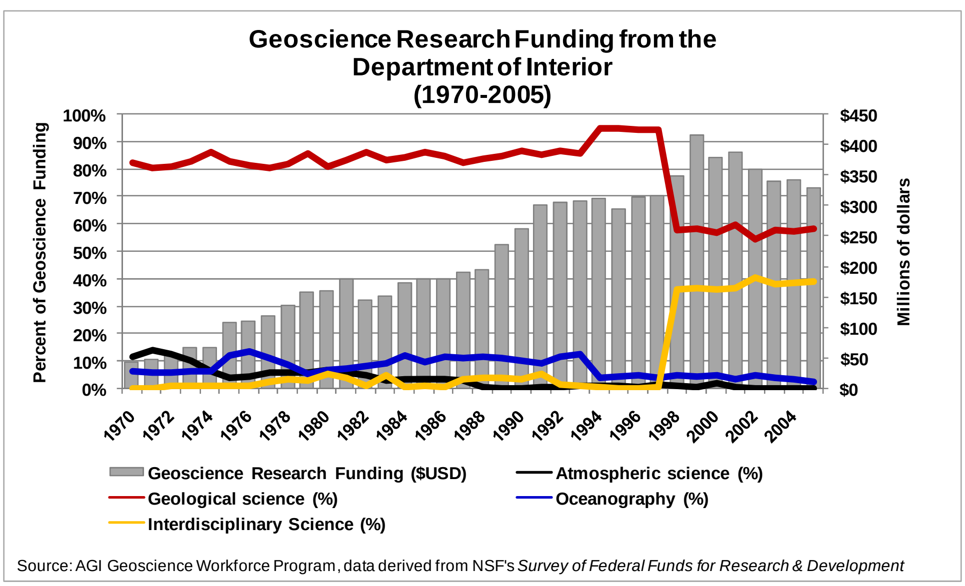


Figure 4.9: Geoscience Research Funding from the Department of Interior

The majority of research funding from the Environmental Protection Agency (EPA) has primarily been applied to atmospheric research (1971 to 1975, and 1983 to 1993). Geological sciences received the most funding of all geoscience sub-disciplines between 1976 and 1982. From 1994 to 1999, interdisciplinary research and atmospheric science research received similar amounts of funding from the EPA. After 1999, interdisciplinary research received the majority of funding from the EPA.

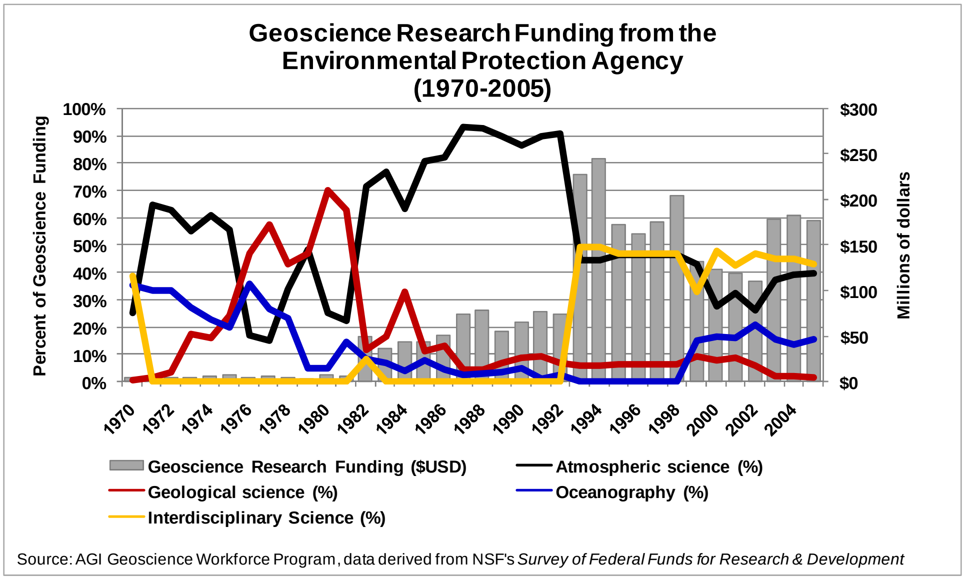


Figure 4.10: Geoscience Research Funding from the Environmental Protection Agency

The majority of geoscience research funding from National Aeronautics and Space Administration is applied to atmospheric research. Between 1972 and 1990, 20 to 30 percent of geoscience funding from NASA was applied to interdisciplinary research. Geological sciences have received between 10 to 30 percent of geoscience funding since 1970.

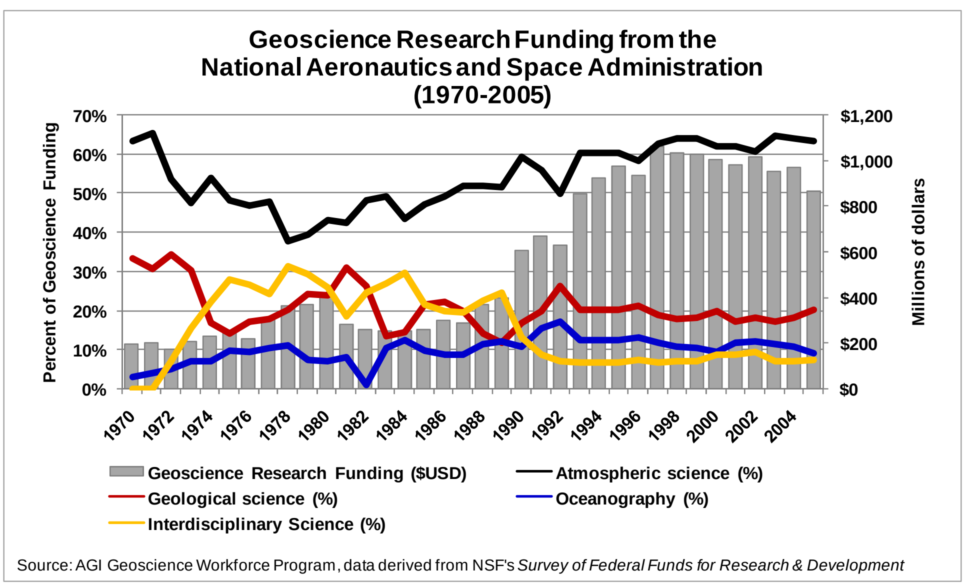


Figure 4.11: Geoscience Research Funding from the National Aeronautics and Space Administration

Atmospheric research, oceanographic research, and geological science research have received the majority of geoscience funds from the National Science Foundation at different time periods from 1970 to 2005. Oceanographic research received the majority of funding during the 1980's and from 1996 to 2005. Atmospheric research received the majority of NSF geoscience funding from 1973 to 1979. Geological science research received the majority of funding from 1991 to 1995. However, the sharp drop in oceanographic research and sharp increase in interdisciplinary research suggests that there may have been a reclassification of oceanographic research to interdisciplinary research during this interval.

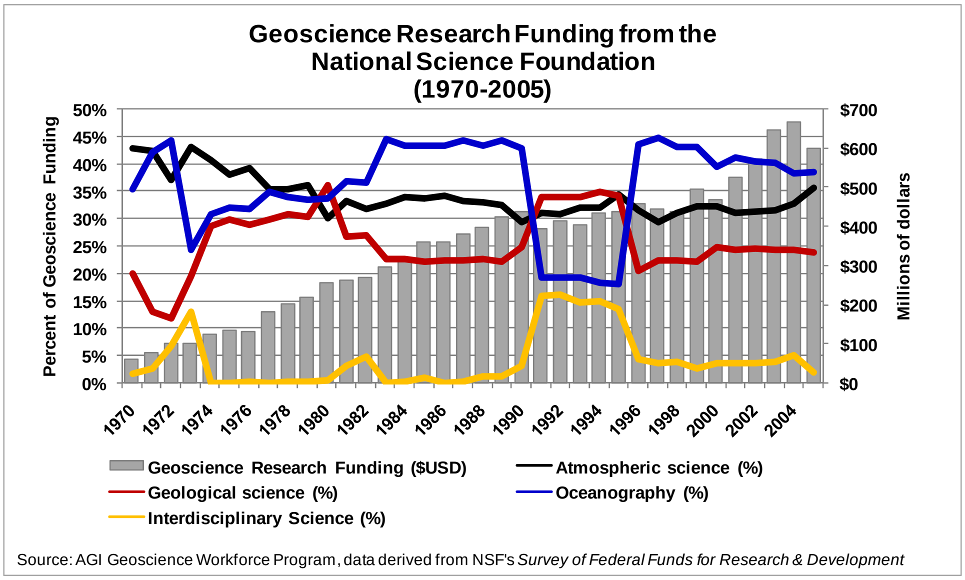


Figure 4.12: Geoscience Research Funding from the National Science Foundation

Information pertaining to industry funding of geoscience research is limited. Data pertaining to the trends in company research and development funds are available from the NSF / SRS Industry R&D Funding reports for the mining, extraction & support industries. Unfortunately, this data is aggregated so distinct trends for these three industries cannot be investigated. However, of note is the abrupt switch from development to research funding that occurred between 2001 and 2002. This trend is also coincident with the drop in commodity output, gross operating surplus, and taxes on production and imports for the oil & gas extraction industry, productive activity (rig counts, a reduction in GDP for all three industries, and a decrease in rig counts and well counts.

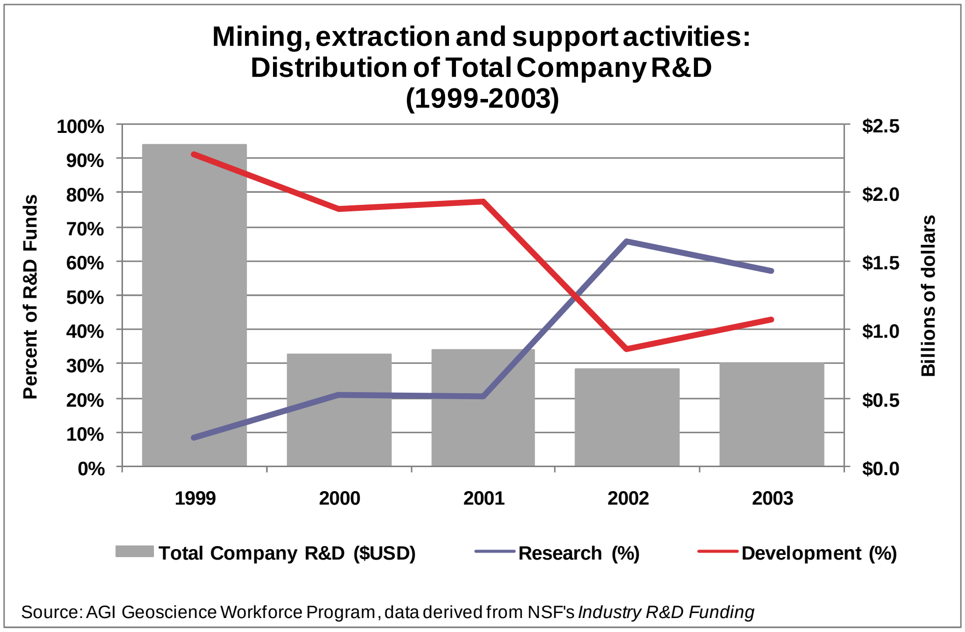


Figure 4.13: Distribution of Total Company R&D for the Mining, Extraction & Support Activities Industries

Commodity Pricing and Output

The drop in the dollar has caused concern in oil-producing countries which use it as the basis for the commodity, and often their currency. Figure 4.14 shows the spot market price of crude oil per barrel (BBL) in US dollars and in euros from 1999 to 2008. The price of oil has grown faster relative to the dollar than to the euro. Yet, a portion of the rise in oil prices is due to the fall of the value of the dollar. Figure 4.14 also shows the number of barrels of crude oil per cost of an ounce of gold, demonstrating the parallel growth in commodity pricing.

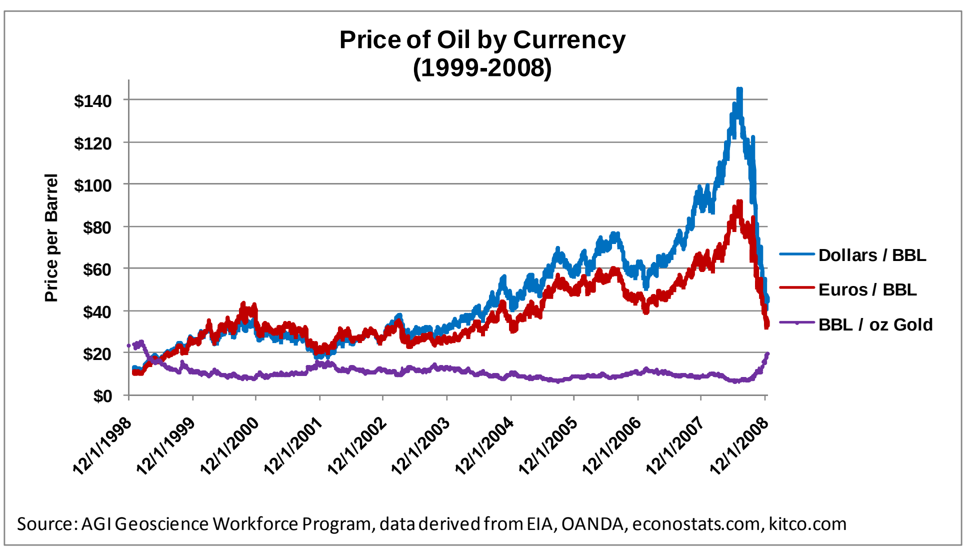


Figure 4.14: Price of Oil by Currency and by Gold

A number of geoscience industries are responsible for generating important commodities that keep our society running, such as oil & gas and mining. All commodity price indices generally follow the energy (fuel) price index. However, it is interesting to note that there is some independence of metal price indices from energy price indices. Nickel, zinc, lead, and uranium peaked prior to oil, and tin and aluminum peaked at the same time as oil, thus creating a bi-modal peak in the metal price index.

Food and beverage commodity price indices follow the trend of the energy (fuel) price index; however it is interesting to note that the metals price index does not follow the energy price index as closely. The metals price index has a bi-modal peak that is representative of those metals that peaked prior to the peak in oil (nickel, zinc, lead, and uranium) and those that peaked at the same time as oil (tin, and aluminum). Copper interestingly has three peaks, the first beginning in 2006 and the last ending with the drop in oil prices.

With the exception of a small peak in 2008 that is concurrent with the peak in oil prices, commodity prices for beef and pork do not follow the trend in oil price like other commodities. Prices for grains (soybeans, rice, wheat, barley, and corn) peaked and declined at about the same time as the spike in oil prices. Soybean prices, which tracked oil prices from 2001 to 2003, decreased between 2004 and 2006, and later increased and peaked as oil prices shot up in 2007 and then peaked in 2008. Wheat prices, interestingly, started to decline in early 2008, about five months prior to the drop in oil prices. Rice prices which were slowly increasing since 2000, shot up by $615 per metric ton between January and May 2008 and decreased quickly thereafter.

Natural gas prices, although similar in the overall trend to oil prices, have much more variability when compared to oil prices. Natural gas prices have two peaks that occur before the large spike in prices at the end of 2008: 1) In late 2000 / early 2001 and 2) in late 2005.

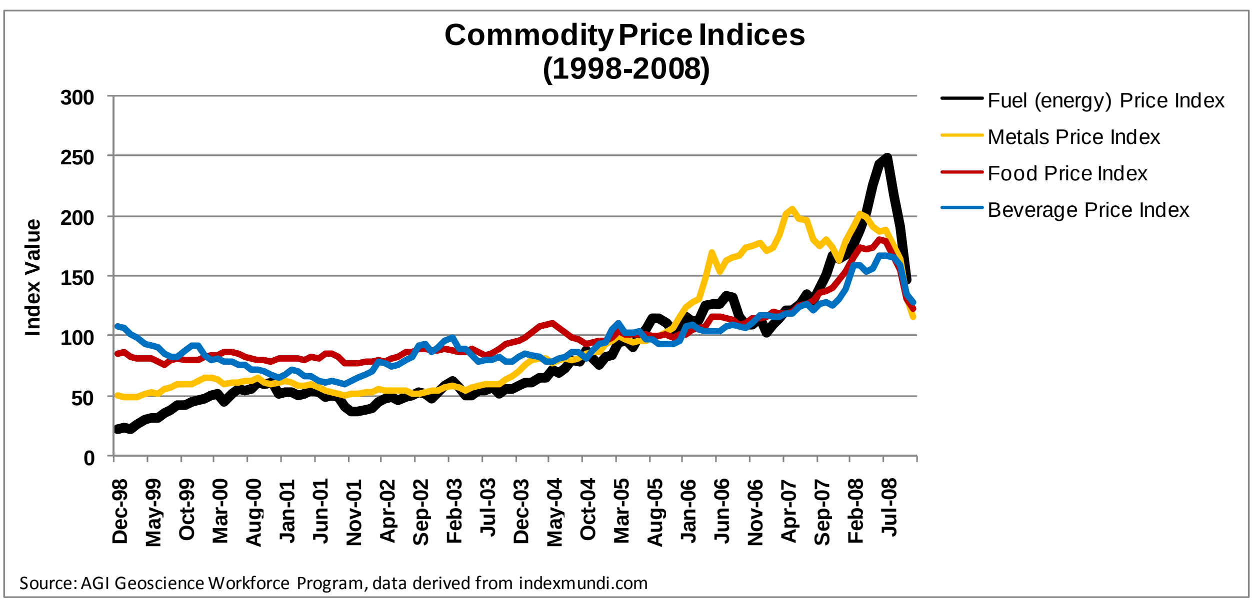


Figure 4.15: Commodity Price Indices

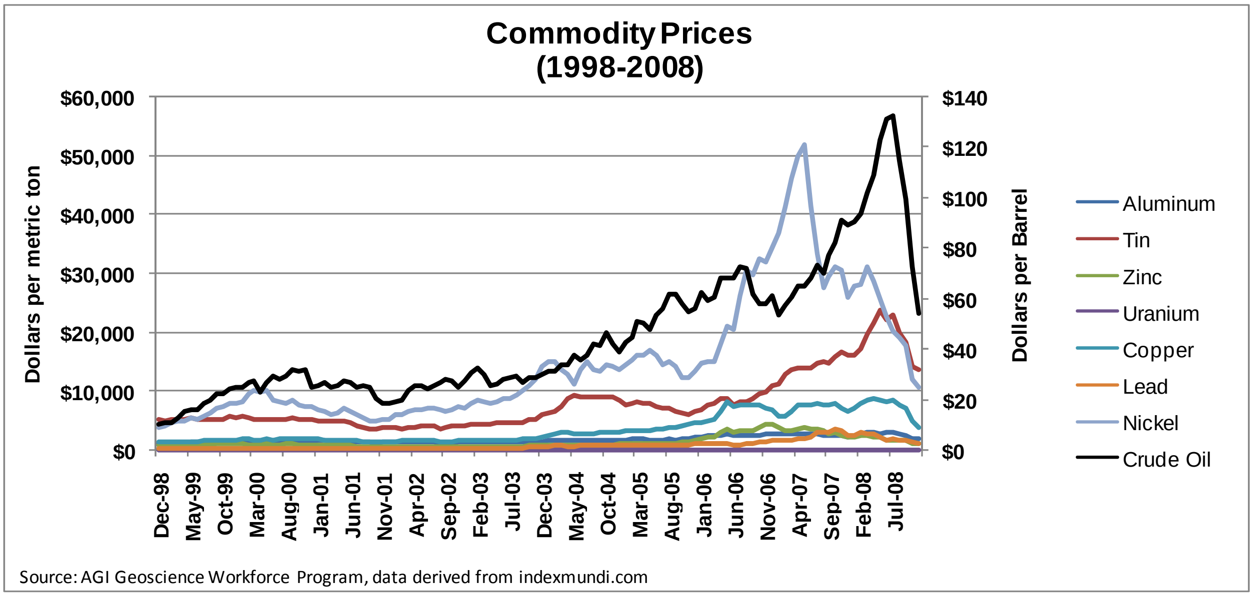


Figure 4.16: Commodity Prices for Metals and Oil

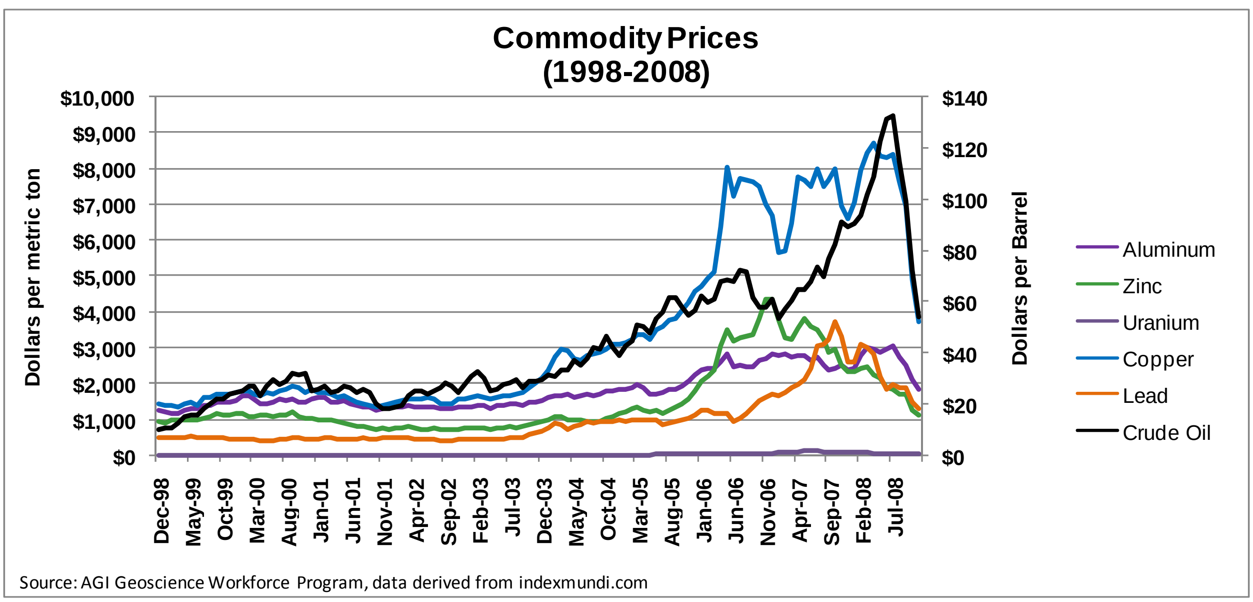


Figure 4.17: Commodity Prices for Selected Metals and Oil

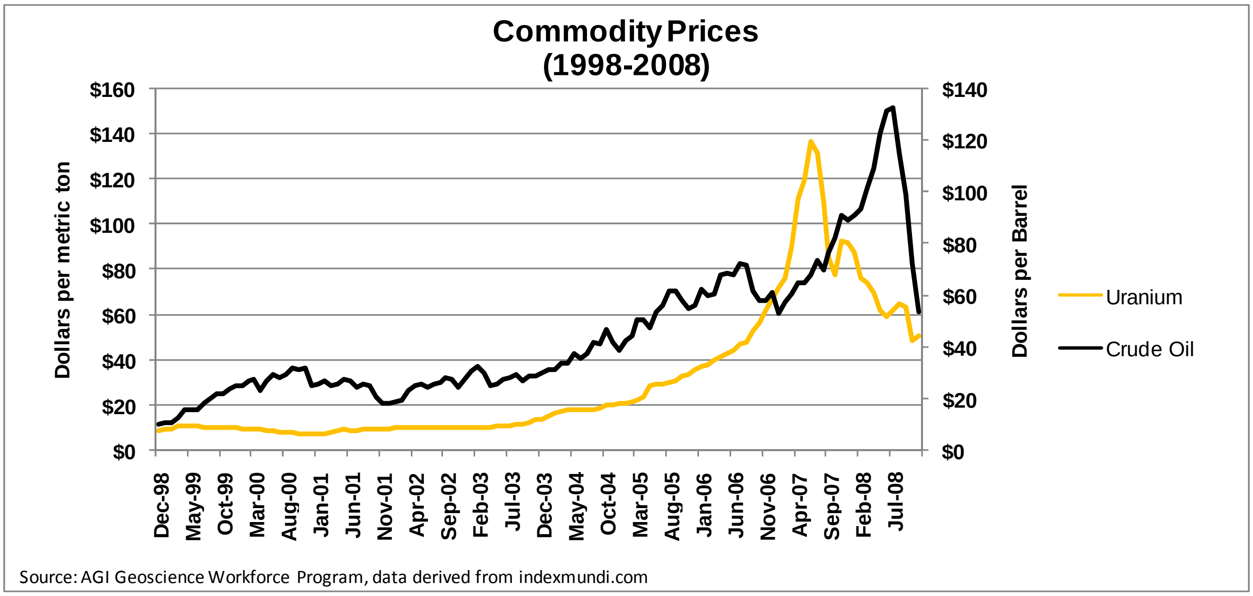


Figure 4.18: Commodity Prices for Uranium and Oil

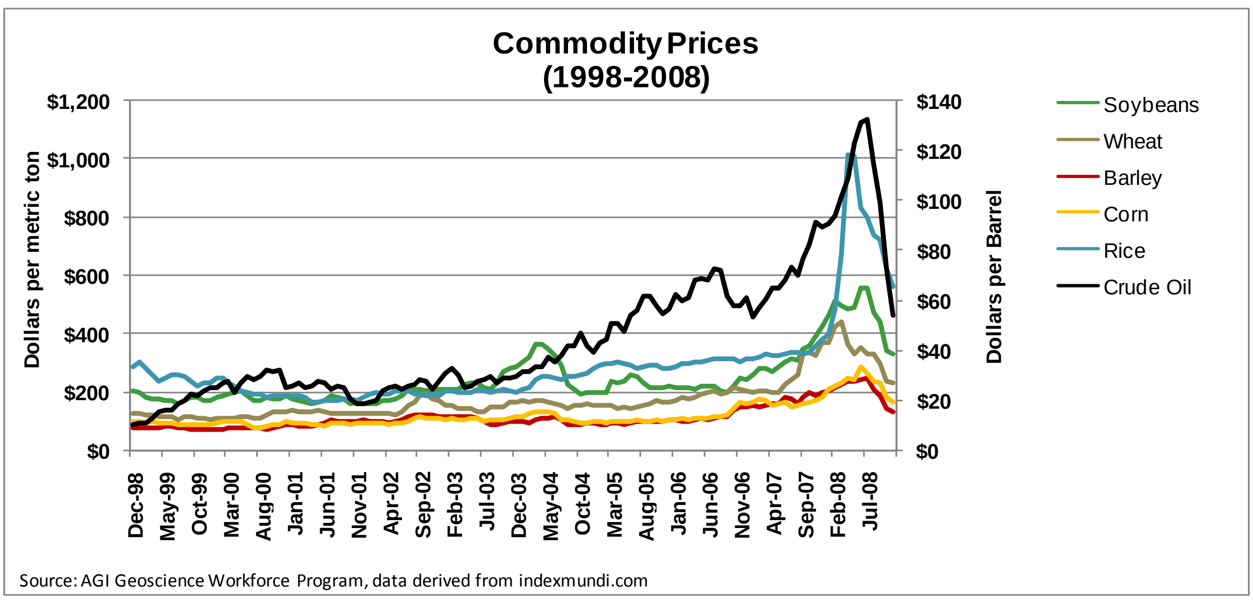


Figure 4.19: Commodity Prices for Grains and Oil

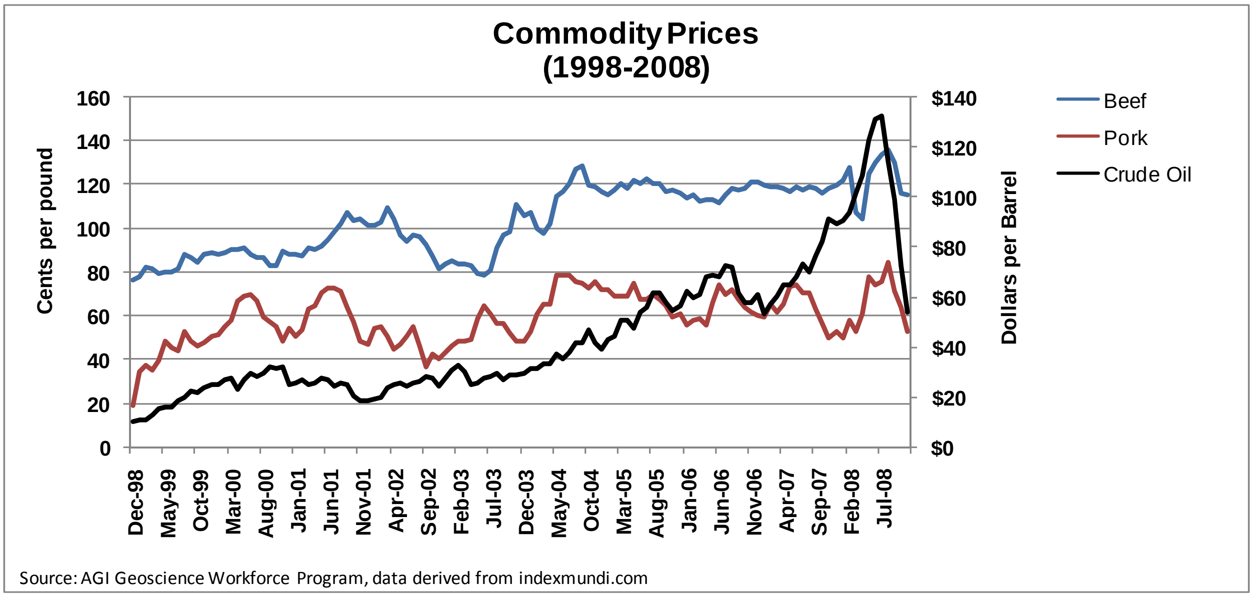


Figure 4.20: Commodity Prices for Beef, Pork and Oil

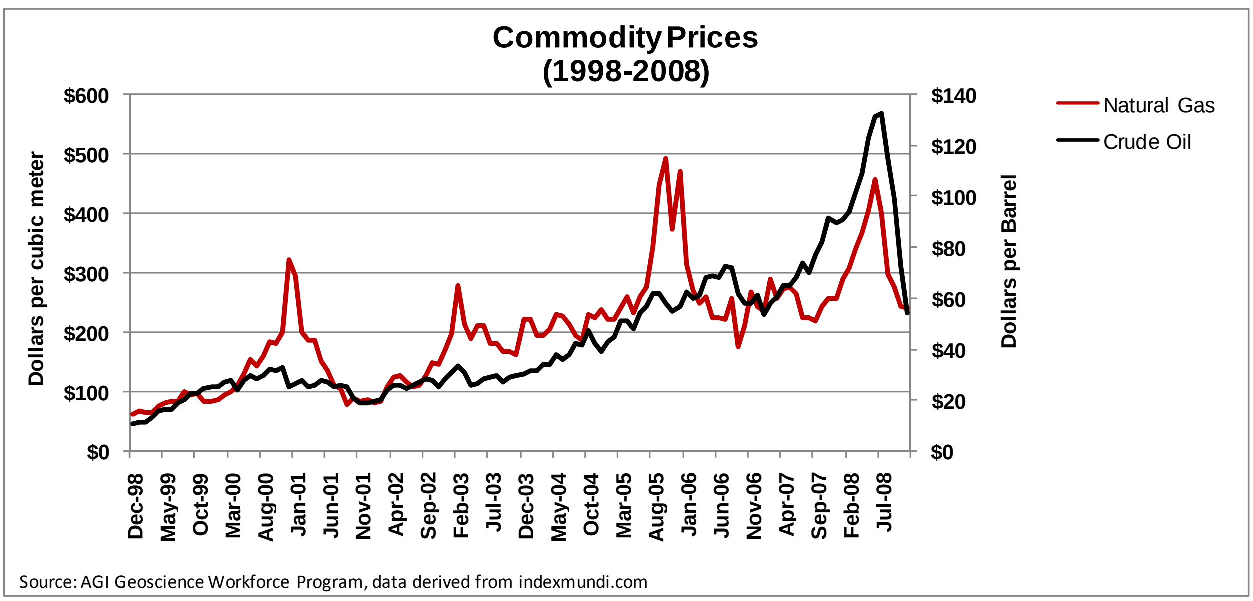


Figure 4.21: Commodity Prices for Natural Gas and Oil

Total domestic commodity output data from 2002 through 2006 indicate a steady increase for both oil & gas extraction and for support activities for mining and oil & gas. Both industries show a drop in commodity output during the last recession between 2001 and 2002. Of note is the leveling of commodity output for oil & gas extraction between 2005 and 2006 and the increase in output in the support activities for mining and oil & gas industry. Mining (except oil & gas) commodity output is relatively steady until 2003 when it begins to increase slightly until 2006. Interestingly, the support activities for mining and oil & gas industry has the lowest taxes and since 2004, higher commodity output and gross operating surplus than the mining (except oil & gas) industry.

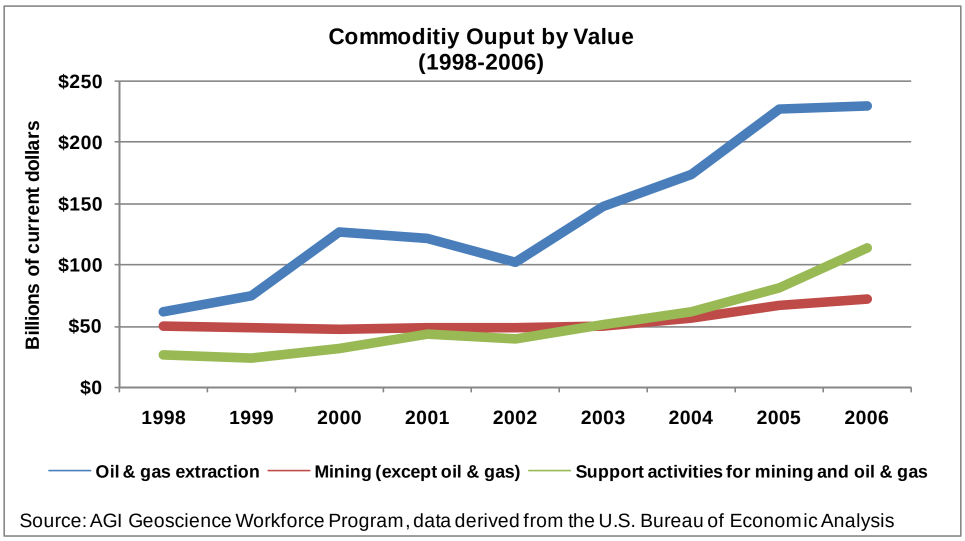


Figure 4.22: Commodity Output for the Mining, Oil & Gas Extraction, and Support Industries

Gross operating surplus for oil & gas extraction increased far more quickly than for the mining (except oil & gas) and support activities for mining and oil & gas industries between 1998 and 2006. The recession in 2001-2002 can be seen in the decrease in gross operating surplus in both the oil & gas extraction and support activities for mining industries. Additionally, as in the commodity output data, between 2005 and 2006, the increase in gross operating surplus slowed for the oil & gas extraction industry and shot up for the support activities for mining and oil & gas industry.

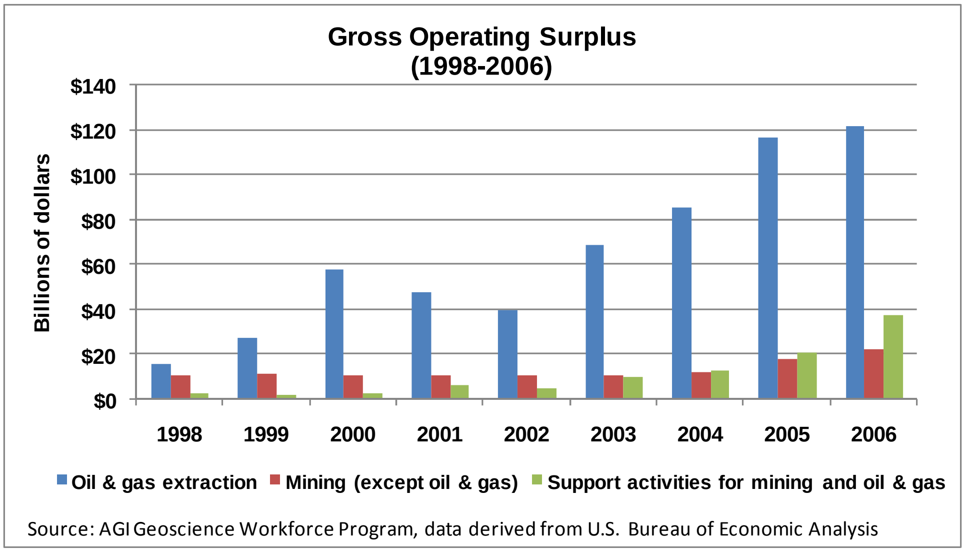


Figure 4.23: Gross Operating Surplus for the Mining, Oil & Gas Extraction, and Support Industries

In examining the taxes on production and imports for these industries, it is not surprising that the oil & gas extraction industry has the highest taxes. Of interest is that the support activities for mining and oil & gas industry has the lowest taxes, and since 2004, higher commodity output and gross operating surplus than the mining (except oil & gas) industry.

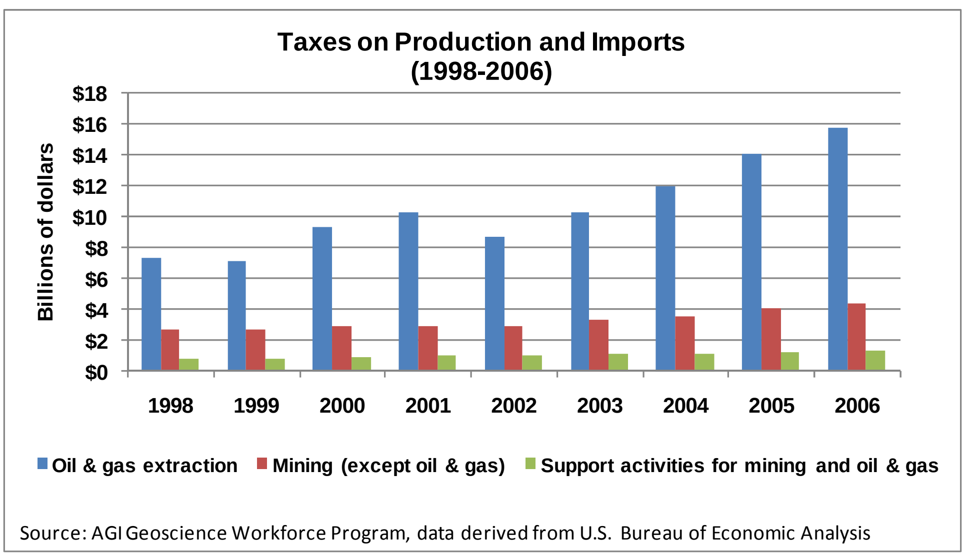


Figure 4.24: Taxes on Production & Imports for the Mining, Oil & Gas Extraction, and Support Industries

Profit margins for major energy companies have increased gradually since 2002, and declined after the second quarter of 2007. Profit margins for independent energy companies increased at a much faster rate than for major energy companies over the same period, and they also declined after the second quarter of 2007.

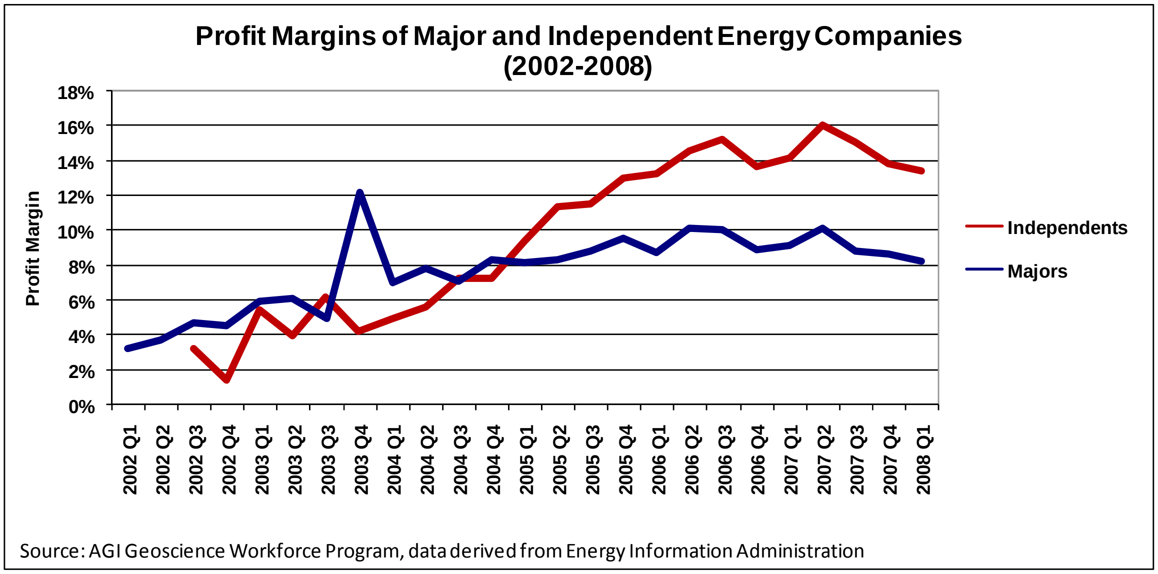


Figure 4.25: Profit Margin Increases for Independent and Major Energy Companies

Gross Domestic Product Contribution of Geoscience Industries

The geoscience component of GDP represents the direct first-order economic contribution of geoscientists to the U.S. economy. The geoscience component of industry gross domestic product more than doubled between 2002 and 2006. Total geoscience GDP in 2002 was $26.6 billion and in $60.7 billion in 2006. Additionally, the geoscience component of national GDP, which increased from 0.25% in 2002 to 0.46% in 2006. Total geoscience industry GDP is projected to increase to $73.8 billion by 2016 with all industries increasing except the Environmental remediation / Geotechnical industry. The Environmental remediation / Geotechnical industry is expected to contract by approximately 20% between 2006 and 2016, with GDP dropping from $15.7 billion in 2006 to $12.6 billion in 2016.

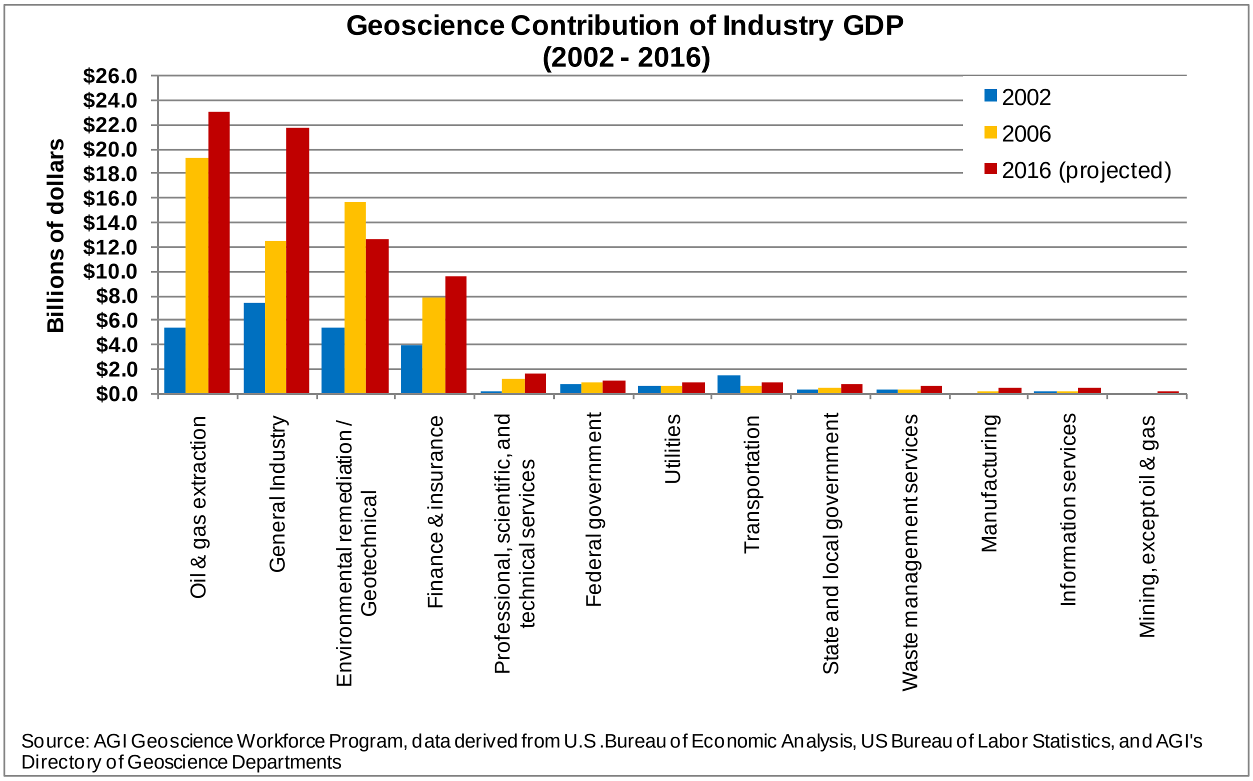


Figure 4.26: Percent of Geoscience Industry GDP Contributed by Specific Industries

Industry	GDP 2002	GDP 2006	GDP 2016 (projected)
Oil & gas extraction	$5.46	$19.19	$22.93
General Industry	$7.35	$12.51	$21.67
Environmental remediation / Geotechnical	$5.39	$15.70	$12.55
Finance & insurance	$4.02	$7.93	$9.57
Professional, scientific, and technical services	$0.22	$1.26	$1.59
Federal government	$0.79	$0.95	$1.05
Utilities	$0.65	$0.75	$0.93
Transportation	$1.56	$0.75	$0.90
State and local government	$0.33	$0.56	$0.75
Waste management services	$0.32	$0.38	$0.56
Manufacturing	$0.07	$0.29	$0.49
Information services	$0.15	$0.22	$0.38
Mining, except oil & gas	$0.11	$0.11	$0.20
Management of companies and enterprises	$0.02	$0.04	$0.08
Educational services	$0.04	$0.07	$0.07
Support activities for mining and oil & gas	$0.06	$0.03	$0.04
Sum Total	**$26.55**	**$60.74**	**$73.76**
Geoscience Contribution to Total U.S. GDP	*0.25%*	*0.46%*	*0.40%*

Table 4.1: Geoscience Industry GDP and US Total GDP (2002-2016)
(Data derived from the U.S. Bureau of Economic Analysis)

Productive Activity of Geoscience Industries

Productive activity in geoscience industries has increased steadily over the past decade. In the oil & gas industry, the number of drilling rigs has increased steadily (with the exception of a drop during 2001-2002) since 1999. The majority of this increase can be attributed to the increase in onshore and natural gas From 1991 to 2006, the average depth of wells remained approximately 20% more than the 1990 depth. Between 2006 and 2007, the average depth jumped to 40% more than the 1990 depth. Before 2000, the total footage drilled and total wells drilled varied between 20 and 40% less than in 1990. However, after 2000, there began a steady increase in both the number of wells drilled and total footage drilled when compared to 1990. The steepest increase in both of these indicators was between 2006 and 2007.

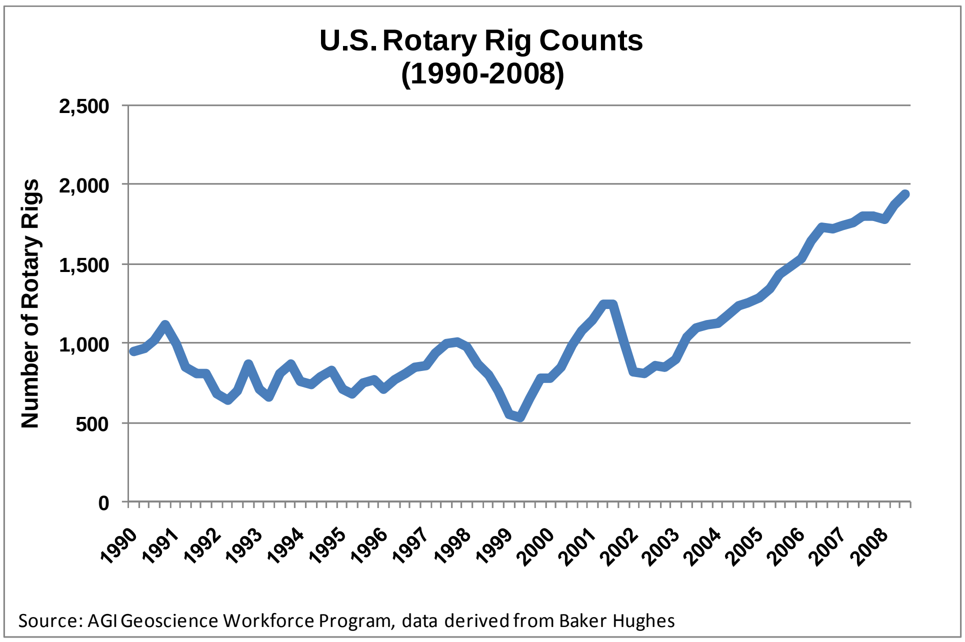
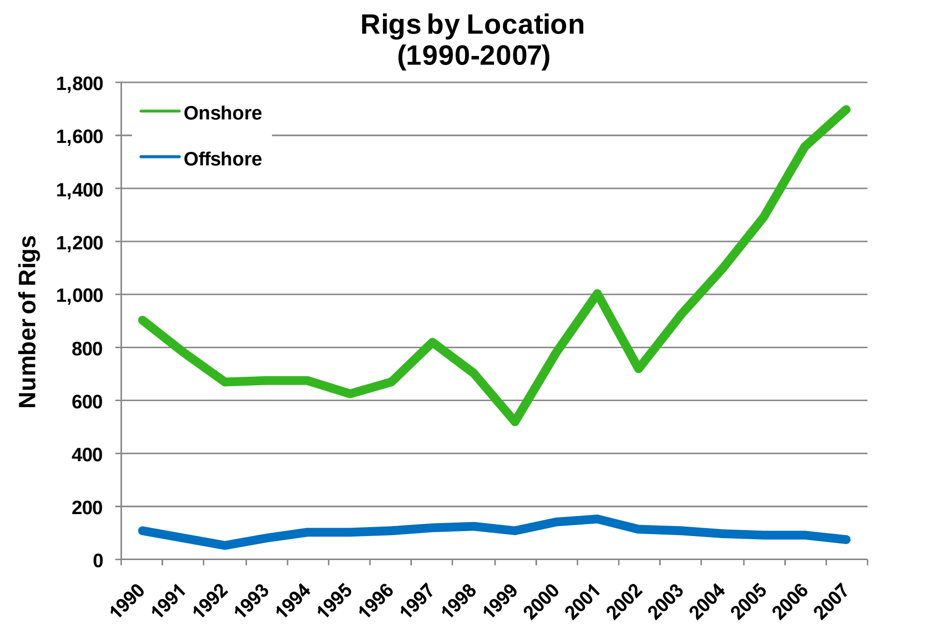
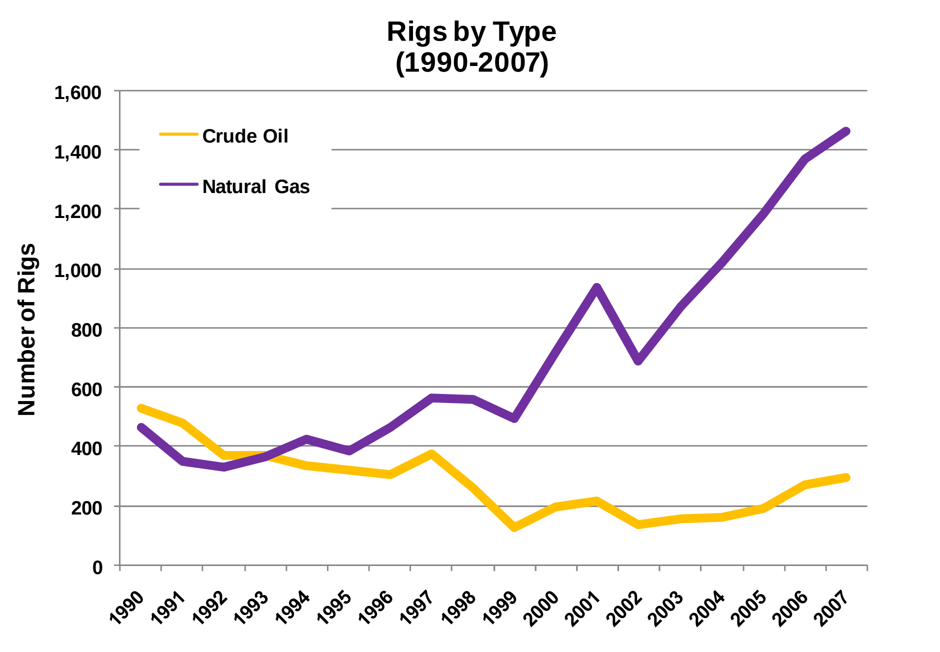


Figure 4.27: U.S. Rotary Rig Counts



Source: AGI Geoscience Workforce Program, data derived from Baker Hughes

Figure 4.28: U.S. Rigs by Location



Source: AGI Geoscience Workforce Program, data derived from Baker Hughes

Figure 4.29: U.S. Rigs by Type

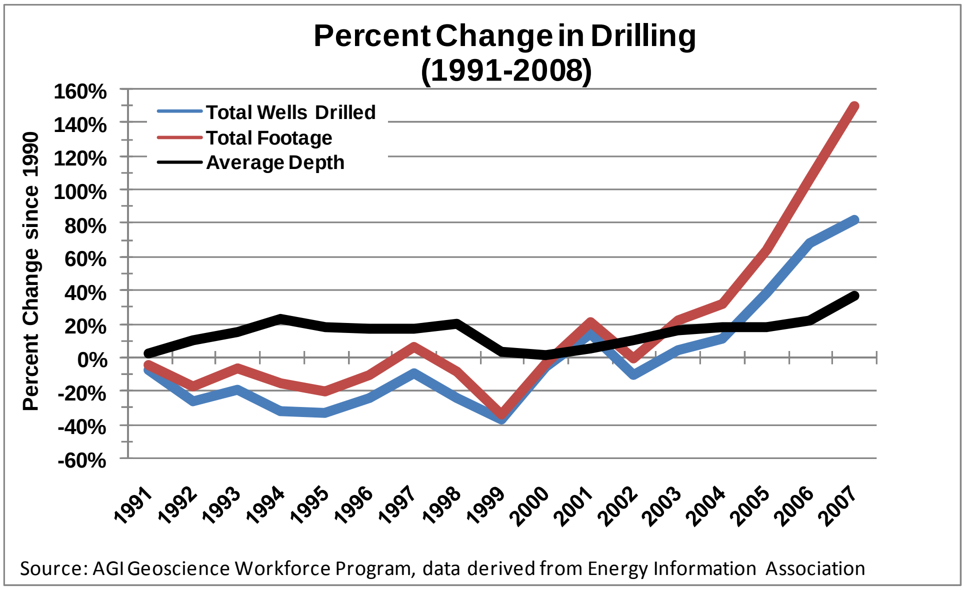


Figure 4.30: Percent Change in Drilling since 1990

Unlike the oil & gas industry, the mining industry has not seen the same amount of productivity growth. The total growth in this industry was due solely to the increase of 2,000 U.S. sand, gravel, and stone mines. The number of U.S. mineral ore and industrial mineral mines (excluding sand, gravel, and stone mines) slowly decreased between 1997 and 2006.

Sand, gravel, and stone mines increased the amount of material handled between 1994 and 2006 by 1,018 million metric tons. Despite the decrease in the number of industrial mineral and metal ore mines, industrial mineral mines increased the amount of material handled by 810 million metric tons and metal ore mines reduced the material handled by 546 million metric tons between 1994 and 2006.

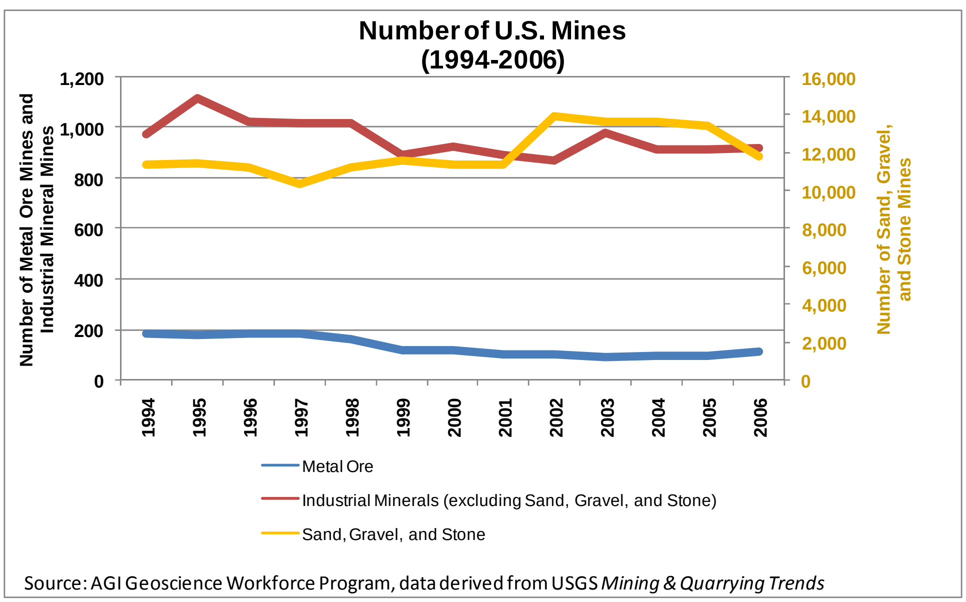


Figure 4.31: Number of U.S. Mines

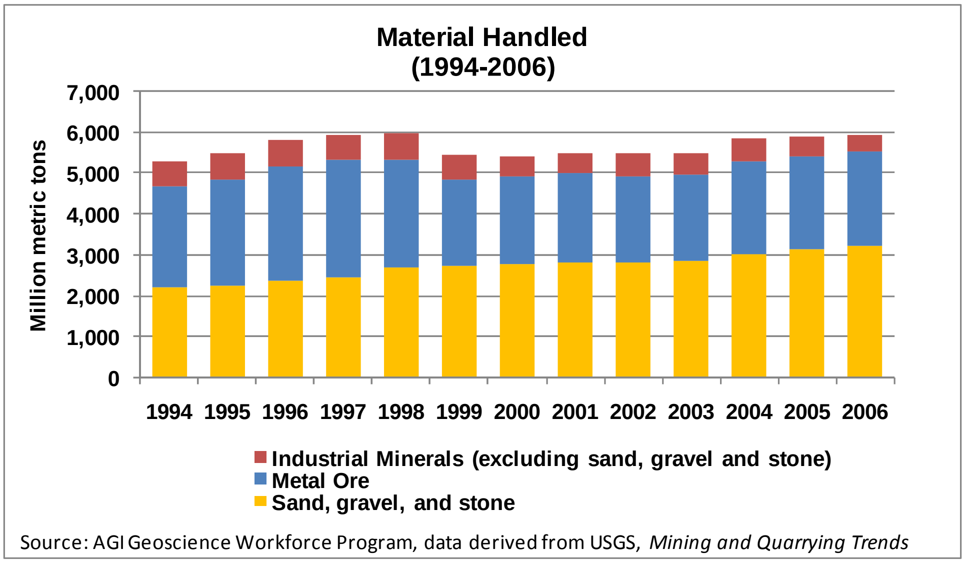


Figure 4.32: Material Handled at U.S. Mines

The amount of mine waste at both metal ore and industrial mineral mines decreased between 1994 and 2006. Mine waste for sand, gravel and stone mines only increased slightly over this period by 33 million metric tons. Additionally the mine waste-to-material handled ratio which measures efficiency has improved significantly for industrial mineral mines (50%) and by 20% for metal ore mines. Sand, gravel, and stone mines which produce the least amount of mine waste has no increase in this indicator.

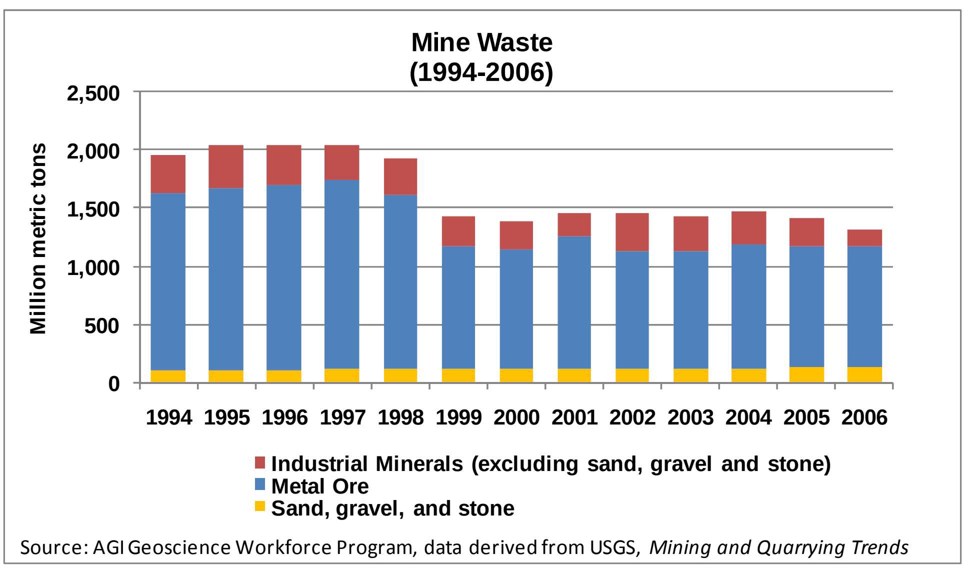


Figure 4.33: Mine Waste from U.S. Mines

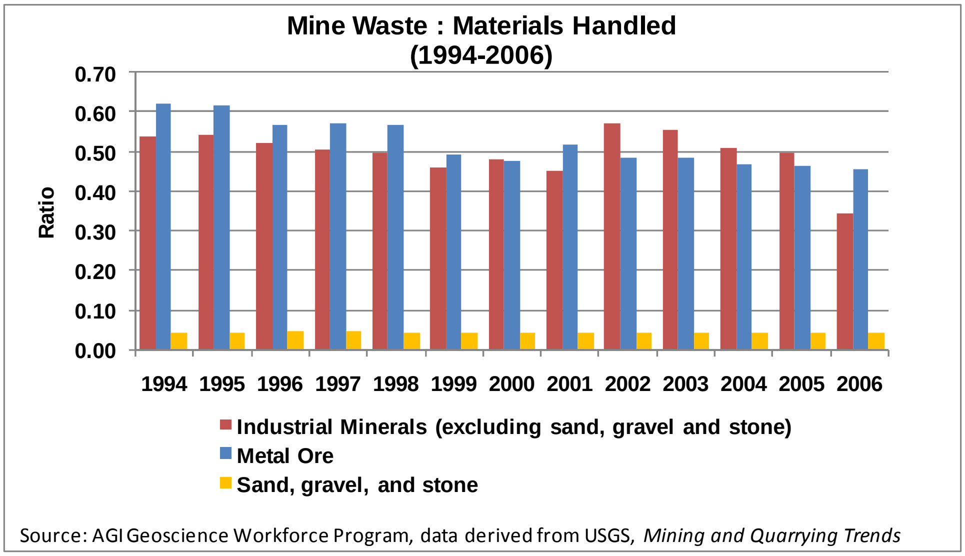


Figure 4.34: Mine Waste : Materials Handled at U.S. Mines

The value of non-fuel mineral production in the U.S. is primarily driven by industrial minerals (including sand, gravel, and stone). Since 2003, there has been a steady increase in U.S. non-fuel mineral production for both metals and industrial minerals. The dip in non-fuel metals production between 1997 and 2003 was driven by the sharp drop in commodity prices and U.S. exploration and operations.

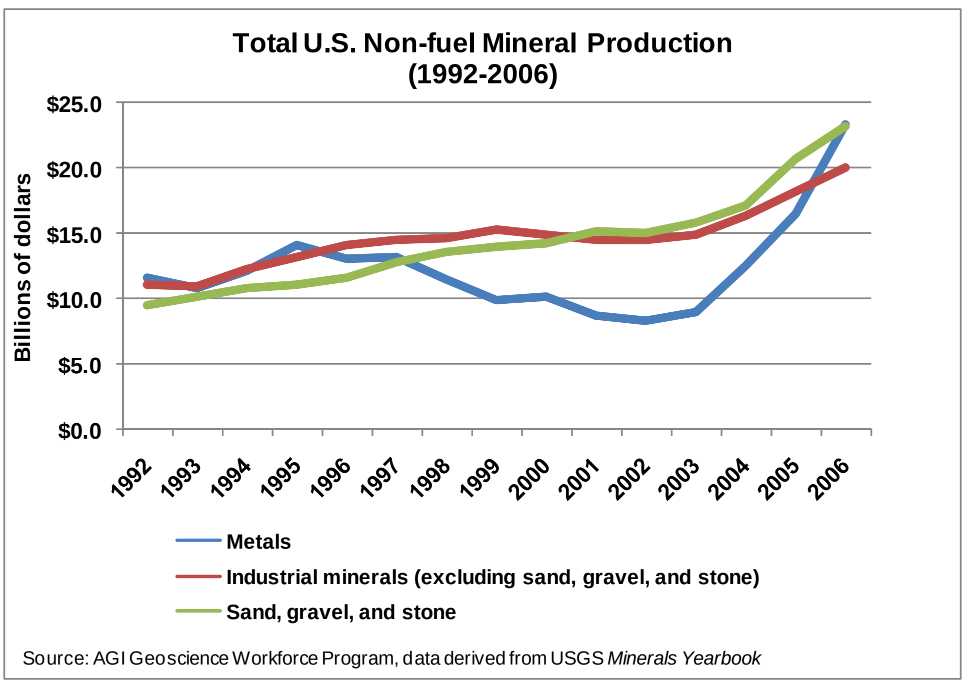


Figure 4.35: Value of Non-fuel Mineral Production from U.S. Mines

Market Capitalization of Geoscience Industries

Market capitalization of geoscience industries was calculated based on a set of 77 major companies from the following industries:

- Cement & Aggregates
- Coal
- Environmental
- Metals & Mining
- Natural Gas
- Oilfield Services
- Petroleum (both Integrated and Producing)
- Precious Metals
- Water Utility

By far, integrated petroleum companies contribute the most (approximately $100 billion) to the total current market capitalization of geoscience industries, followed by oilfield services ($12 billion) and natural gas companies ($6 million). Water utilities and precious metal companies contribute the least to the total market capitalization at just under $1 billion.

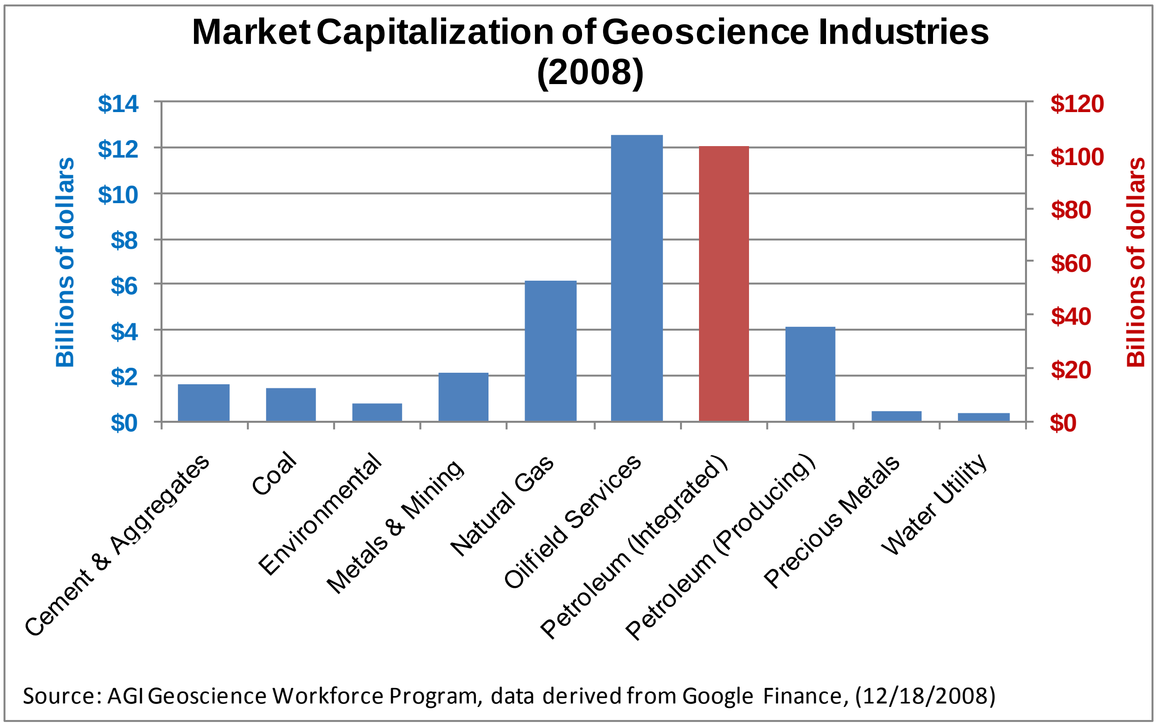


Figure 4.36: Market Capitalization of Geoscience Industries

The "Status of the Geoscience Workforce" Report

The "Status of the Geoscience Workforce" report provides a comprehensive benchmark of the geoscience profession. The report is based on original data collected by the American Geological Institute as well as from existing data from federal data sources, professional membership organizations, and industry data sources. The report synthesizes all available data for the geosciences, from the supply and training of new students, to workforce demographics and employment projections, to trends in geoscience research funding and economic indicators. The report is available as a complete document, as well as on a per chapter basis. It will be available for download from AGI's website: http://www.agiweb.org/.

Report Summary

This 32 page summary provides an in-depth summary of each chapter of the report.

Chapter 1: Trends in Geoscience Education from K-12 through Community College

This chapter examines the student participation in geoscience education at the K-12 level and includes data on state requirements for earth science education in middle and high school, and data pertaining to the number of earth science high school teachers. The chapter also examines trends in college bound students including SAT scores, aspirations for higher education, and choice of college major. Additionally, this chapter examines the availability of geoscience education at community colleges and examines the trends in Associate degrees conferred from geoscience programs at these institutions.

Chapter 2: Trends in Geoscience Education at Four-Year Institutions

This chapter summarizes all available data pertaining to geoscience enrollments, degrees conferred, field camp attendance, and funding of geoscience undergraduate and graduate students. The chapter also explores trends in department size, faculty numbers and research specialties, and funding of geoscience research at the university level.

Chapter 3: Geoscience Employment Sectors

This chapter explores the transition of geoscience graduates into the workforce, age demographics of the industries where geoscientists work, and projected workforce demand. Data pertaining to the current number of jobs and projected number of jobs in 2016 is also provided, as is current salary information for each profession.

Chapter 4: Economic Metrics and Drivers of the Geoscience Pipeline

This chapter provides data on productive activity (number of oil rigs, mines, etc.), commodity pricing and output, gross domestic product, and market capitalization of the industries where geoscientists work.

Appendix A: Defining the Geosciences

This appendix outlines how geoscience occupations and industries are defined in federal data sources. Additionally, the appendix details the working definition proposed by AGI for tracking the geoscience occupation.

Acknowledgements

The AGI Geoscience Workforce program would like to thank the AGI Foundation for funding of the program and this report. The AGI Geoscience Workforce Program would also like to thank the following people, organizations, companies, and industries that provided data for this report, including:

Dr. Penny Morton, University of Minnesota-Duluth, who provided all field camp attendance data; Barry Jay Katz, ChevronTexaco for the "*2003 Report on the Status of Academic Geoscience Departments*"; American Association of Petroleum Geologists (AAPG); American Geophysical Union; Baker Hughes; College Board; Council of Chief State School Officers (CCSSO); Econostats.com; Energy Information Administration; Google Finance; Indexmundi.com; InflationData.com; Industry and corporate data collaborators; Integrated Postsecondary Education Data System (IPEDS)***;*** Kitco.com; National Center for Education Statistics (NCES); National Ground Water Association (NGWA); National Mining Association; National Science Foundation Division of Science Resources Statistics; National Science Foundation Award Database; OANDA.com; Office of Personnel Management; Society of Economic Geologists (SEG); Society of Exploration Geophysicists (SEG); U.S. Bureau of Economic Analysis; U.S. Bureau of Labor Statistics; U.S. Department of Education; U.S. Geological Survey.

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Questions and More Information

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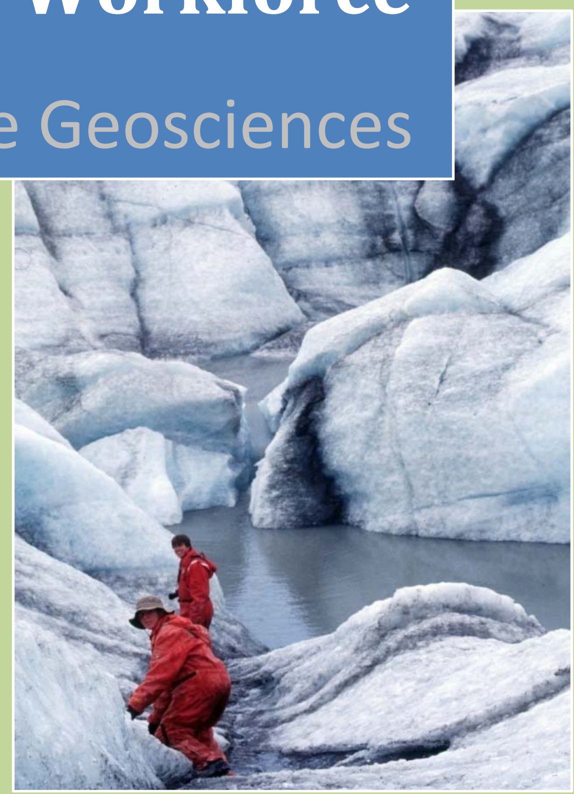
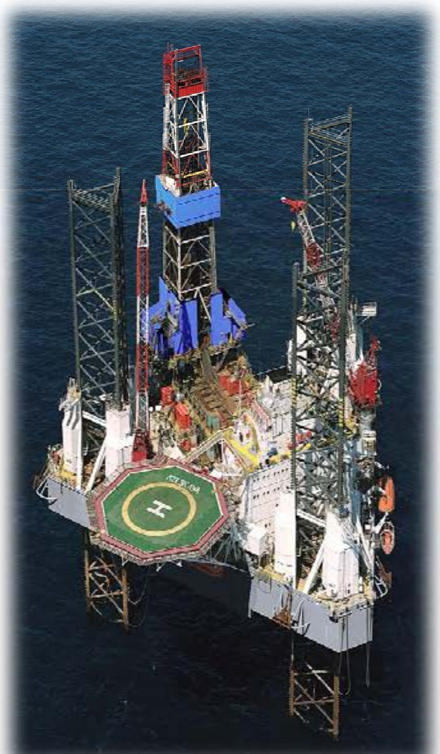
2009

Status of the Geoscience Workforce

Appendix A: Defining the Geosciences



American Geological Institute

February 2009

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Table of Contents

Defining the Geosciences

Given its complexity, the geoscience occupation is difficult to define under existing nomenclature. This is due to the 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 the data collection (national occupation trends, science & engineering trends, education vs. occupation, internal classification codes, etc.), the characteristics of the population surveyed, and the focus of the organization.

Federal policy and funding is in part determined by the economic activity and employment trends of a given profession. Accurate measurement and analysis of the geoscience profession are thus central to successful decisions that support the improvement of the geosciences in the U.S. The lack of a consistent definition of geosciences across data sources is a major handicap for the geoscience profession, both for cultivating the future geoscience workforce and for characterizing geoscience economic drivers. Attracting new students into geoscience degree programs is influenced by federal statistics (current and projected employment numbers, salary information, funding, etc.) about the geosciences. Currently, the geoscience profession is poorly characterized by federal data sources. At best, geoscientists are spread across several occupational classifications that are vague in their definition. In addition, the lack of consistency makes establishing baseline metrics for the measurement of the geoscience contribution to the economy very difficult.

To address this issue, AGI is establishing a working definition for the geoscience profession in order to improve comparability of data across sources and time periods. Now that the national census is a rolling monthly survey, the Standard Occupational Classification (SOC) codes will now be updated every 5 to 10 years. This is an opportunity for AGI and its partners to edit the SOC codes so that they capture the depth and breadth of the geoscience profession, clearly define it, and estimate employment over at least 5 years. This data can then be included in a proposal to federal data agencies to more accurately represent the occupation.

Many federal data sources use the Classification of 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 National Center for Education Statistics use the Classification of Instructional Programs (CIP) is to classify educational programs including fields of study and program completions. The CIP website (http://nces.ed.gov/pubs2002/cip2000/index.asp) also has an online application that allows for the cross-referencing of instructional programs to the Standard Occupational Classification codes.

CIP codes that refer to geoscience programs are:

CIP Code	Title	Description
1.1201	Soil Science and Agronomy, General	A program that generally focuses on the scientific classification of soils, soil properties, and their relationship to agricultural crops. Includes instruction in soil chemistry, soil physics, soil biology, soil fertility, morphogenesis, mineralogy, hydrology, agronomy, and soil conservation and management
1.1202	Soil Chemistry and Physics	A program that focuses on the application of chemical and physical principles to research and analysis concerning the nature and properties of soils and the conservation and management of soils. Includes instruction in soil and fluid mechanics, mineralogy, sedimentology, thermodynamics, geomorphology, environmental systems, analytical methods, and organic and inorganic chemistry
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. Includes instruction in biology, chemistry, physics, geosciences, climatology, statistics, and mathematical modeling

CIP Code	Title	Description
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
14.0805	Water Resources Engineering	A program that prepares individuals to apply mathematical and scientific principles to the design, development and operational evaluation of systems for collecting, storing, moving, conserving and controlling surface- and groundwater, including water quality control, water cycle management, management of human and industrial water requirements, water delivery, and flood control
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, health 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 communications systems
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

CIP Code	Title	Description
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
30.1801	Natural Sciences	A program with a combined or undifferentiated focus on one or more of the physical and biological sciences
40.0101	Physical Sciences	A program that focuses on the major topics, concepts, processes, and interrelationships of physical phenomena as studied in any combination of physical science disciplines
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 behavioral 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

CIP Code	Title	Description
40.0601	Geology/Earth Science, 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, magnetrometry, 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 life forms, ecosystems, and geologic 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 of 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

CIP Code	Title	Description
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
45.0701	Geography	A program that focuses on the 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

The College Board

The College Board (http://www.collegeboard.com) has its own definitions for geoscience educational programs which it lists on its careers site. For the SAT Reasoning Test, the geoscience coursework is listed under “Natural Sciences”. This heading includes biology, chemistry, physics, geology/earth or space science, and other sciences. Intended college major choices include “Natural Resources and Conservation”, “Multi/Interdisciplinary Studies”, “Physical Sciences”, and “Engineering”.

Test scores, goals for higher education, and related information published by the College Board are used for various purposes. Universities and colleges use test scores in conjunction with other relevant application information to assess an incoming student’s preparedness for academic study. Counselors use the information to provide students with information about course selection, college programs, and career pathways. Recruiters also use the information to assess the relative strengths of students and their preparedness for certain careers. Additionally, the data provided by the College Board is used by researchers to study trends in academic performance between disciplines as well as trends in national academic performance relative to other countries.

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.

Occupational Classifications

Standard Occupational Classification Codes

The U.S. Census Bureau, U.S. Bureau of Labor Statistics, and National Science Foundation (NSF) use the 2000 Standard Occupational Classification (SOC) codes (http://www.bls.gov/soc/home.htm) to classify geoscientists; however, each organization has a different focus for its surveying and data collection. The Office of Personnel Management uses its *Handbook of Occupational Groups and Families* to define occupations.

Data from the U.S. Census Bureau and 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 because geoscientists fall within twenty-three occupational categories in the SOC codes, thirteen occupational categories within the National Science Foundation's National Survey of College Graduates, sixteen occupational series within the OPM's *Handbook of Occupational Groups and Families.*

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 Sciences Managers. Geoscience teachers at post-secondary institutions are grouped into 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 geoscientsts that occur in the SOC codes (such as post-secondary geoscience teachers) also occur within the National Science Foundation's classification schema.

Geoscientists are found in the following SOC definitions:

SOC Code	SOC Title	Definition
11-9041	Engineering Managers	Plan, direct, or coordinate activities in such fields as architecture and engineering or research and development in these fields. Exclude "Natural Sciences Managers"
11-9121	Natural Sciences Managers	Plan, direct, or coordinate activities in such fields as life sciences, physical sciences, mathematics, statistics, and research and development in these fields. Exclude "Engineering Managers" (11-9041) and "Computer and Information Systems Managers" (11-3021)
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, water and sewage systems, and waste disposal units. Include architectural, structural, traffic, ocean, and geo-technical engineers. Exclude "Hydrologists" (19-2043)
17-2081	Environmental Engineers	Design, plan, or perform engineering duties in the prevention, control, and remediation of environmental health hazards utilizing various engineering disciplines. Work may include waste treatment, site remediation, or pollution control technology
17-2151	Mining and Geological Engineers, Including Mining Safety Engineers	Determine the location and plan 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
17-2171	Petroleum Engineers	Devise methods to improve oil and gas well production and determine the need for new or modified tool designs. Oversee drilling and offer technical advice to achieve economical and satisfactory progress

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, 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 from fire and rodent damage. 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. Exclude "Zoologists and Wildlife Biologists" (19-1023) and "Foresters" (19-1032)
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 uses. Include weather analysts and forecasters whose functions require the detailed knowledge of a meteorologist
19-2041	Environmental Scientists and Specialists, Including Health	Conduct research or perform investigation for the purpose of identifying, abating, or eliminating sources of pollutants or hazards that affect either the environment or the health of the population. Utilizing knowledge of various scientific disciplines may collect, synthesize, study, report, and take action based on data derived from measurements or observations of air, food, soil, water, and other sources. Exclude "Zoologists and Wildlife Biologists" (19-1023), "Conservation Scientists" (19-1031), "Forest and Conservation Technicians" (19-4093), "Fish and Game Wardens" (33-3031), and "Forest and Conservation Workers" (45-4011)
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. Include mineralogists, crystallographers, paleontologists, stratigraphers, geodesists, and seismologists

SOC Code	SOC Title	Definition
19-2043	Hydrologists	Research the distribution, circulation, and physical properties of underground and surface waters; 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 nature and use of areas of 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
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. Include teachers of subjects, such as chemical, civil, electrical, industrial, mechanical, mineral, and petroleum engineering. Include both teachers primarily engaged in teaching and those who do a combination of both teaching and research. Exclude "Computer Science Teachers, Postsecondary" (25-1021)
25-1043	Forestry and Conservation Science Teachers, Postsecondary	Teach courses in environmental and conservation science. Include both teachers primarily engaged in teaching and those who do a combination of both teaching and research. Exclude "Agricultural Science Teachers" (25-1041)
25-1051	Atmospheric, Earth, Marine, and Space Sciences Teachers, Postsecondary	Teach courses in the physical sciences, except chemistry and physics. Include both teachers primarily engaged in teaching, and those who do a combination of both teaching and research
25-1053	Environmental Science Teachers, Postsecondary	Teach courses in environmental science. Include both teachers primarily engaged in teaching and those who do a combination of both teaching and research
25-1064	Geography Teachers, Postsecondary	Teach courses in geography. Include both teachers primarily engaged in teaching and those who do a combination of both teaching and research

Office of Personnel Management: *Handbook of Occupational Groups and Families*

The Office of Personnel Management's *Handbook of Occupational Groups and Families* defines geoscience occupations in the following manner:

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 that involve professional engineering work to protect or improve air, land, and water resources in order to provide a clean and healthful environment. Such work requires the application of: (1) professional knowledge of the principles, methods, and techniques of engineering concerned with facilities and systems for controlling pollution and protecting quality of resources and the environment; and (2) an understanding of and the ability to utilize pertinent aspects of chemistry, biological sciences, and public health that pertain to the control or elimination of pollutants.

Code-Title	Description
0880 – Mining Engineering Series	This series covers positions that require primarily the application of professional knowledge of mining engineering. The work requires the ability to apply the principles of mathematics, chemistry, geology, physics, and engineering to mining technology. It also requires general knowledge of construction and excavation methods, materials handling, and the processes involved in preparing mined materials for use. Mining engineer positions are concerned with the search for, efficient removal, and transportation of ore to the point of use; conservation and development of mineral lands, materials, and deposits; and the health and safety of mine workers.
0881 – Petroleum Engineering Series	This series covers positions that require primarily the application of a professional knowledge of petroleum engineering. The work is concerned with exploration and development of oil and natural gas fields; production, transportation, and storage of petroleum, natural gas, and helium; investigation, evaluation, and conservation of these resources; regulation of transportation and sale of natural gas; valuation of production and distribution facilities for tax, regulatory, and other purposes; and research on criteria, principles, methods, and equipment.
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 conditions of use.
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 or the improvement of existing meteorological theory; and the development

Code-Title	Description
	or improvement of meteorological methods, techniques, and instruments. Positions in this occupation require full professional knowledge and application of meteorological methods, techniques, and theory.
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, and mathematics and appropriate knowledge in the field of oceanography.

Industry Classifications

North American Industry Classification System (NAICS)

The NAICS (http://www.census.gov/epcd/www/naics.html) 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 1,170 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 as 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.

NAIC Code	NAICS Industry Title
11	Agriculture, Forestry, Fishing and Hunting
21	Mining
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
61	Educational Services
62	Health Care and Social Assistance
71	Arts, Entertainment, and Recreation
72	Accommodation and Food Services
81	Other Services (except Public Administration)
92	Public Administration

Energy Information Administration

The Energy Information Administration (EIA) is part of the U.S. Department of Energy. It collects and analyzes data related to energy issues, and publishes reports and relevant information on its website: http://www.eia.doe.gov/. EIA provides useful educational tools about the energy industry and maintains an online glossary of terms related to the energy industry.

AGI's Working Definition of Geoscience Occupations

In light of how existing federal data sources define the geosciences, AGI has worked with its stakeholders to establish a working definition for the geoscience profession in order to improve comparability 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:

AGI's Working Definition of Geoscience Occupations

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 atmosphere phenomenon, and study of 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 effect the environment, land reclamation, or management of natural resources.

Geoengineer

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 plan 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 determine the need for new or modified tool designs. Oversees drilling and offer technical advice to achieve economical and satisfactory progress.

Subfield: Geotechnical

Studies the structural behavior of soil and rocks, perform soil investigations, design structure foundations, and provides field observations of foundation investigation and foundation construction.

Geomanager

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

The "Status of the Geoscience Workforce" Report

The "Status of the Geoscience Workforce" report provides a comprehensive benchmark of the geoscience profession. The report is based on original data collected by the American Geological Institute as well as from existing data from federal data sources, professional membership organizations, and industry data sources. The report synthesizes all available data for the geosciences, from the supply and training of new students, to workforce demographics and employment projections, to trends in geoscience research funding and economic indicators. The report is available as a complete document, as well as on a per chapter basis. It will be available for download from AGI's website: http://www.agiweb.org/.

Report Summary

This 32 page summary provides an in-depth summary of each chapter of the report.

Chapter 1: Trends in Geoscience Education from K-12 through Community College

This chapter examines the student participation in geoscience education at the K-12 level and includes data on state requirements for earth science education in middle and high school, and data pertaining to the number of earth science high school teachers. The chapter also examines trends in college bound students including SAT scores, aspirations for higher education, and choice of college major. Additionally, this chapter examines the availability of geoscience education at community colleges and examines the trends in Associate degrees conferred from geoscience programs at these institutions.

Chapter 2: Trends in Geoscience Education at Four-Year Institutions

This chapter summarizes all available data pertaining to geoscience enrollments, degrees conferred, field camp attendance, and funding of geoscience undergraduate and graduate students. The chapter also explores trends in department size, faculty numbers and research specialties, and funding of geoscience research at the university level.

Chapter 3: Geoscience Employment Sectors

This chapter explores the transition of geoscience graduates into the workforce, age demographics of the industries where geoscientists work, and projected workforce demand. Data pertaining to the current number of jobs and projected number of jobs in 2016 is also provided, as is current salary information for each profession.

Chapter 4: Economic Metrics and Drivers of the Geoscience Pipeline

This chapter provides data on productive activity (number of oil rigs, mines, etc.), commodity pricing and output, gross domestic product, and market capitalization of the industries where geoscientists work.

Appendix A: Defining the Geosciences

This appendix outlines how geoscience occupations and industries are defined in federal data sources. Additionally, the appendix details the working definition proposed by AGI for tracking the geoscience occupation.

Acknowledgements

The AGI Geoscience Workforce program would like to thank the AGI Foundation for funding of the program and this report. The AGI Geoscience Workforce Program would also like to thank the following people, organizations, companies, and industries that provided data for this report, including:

Dr. Penny Morton, University of Minnesota-Duluth, who provided all field camp attendance data; Barry Jay Katz, ChevronTexaco for the "*2003 Report on the Status of Academic Geoscience Departments*"; American Association of Petroleum Geologists (AAPG); American Geophysical Union; Baker Hughes; College Board; Council of Chief State School Officers (CCSSO); Econostats.com; Energy Information Administration; Google Finance; Indexmundi.com; InflationData.com; Industry and corporate data collaborators; Integrated Postsecondary Education Data System (IPEDS); Kitco.com; National Center for Education Statistics (NCES); National Ground Water Association (NGWA); National Mining Association; National Science Foundation Division of Science Resources Statistics; National Science Foundation Award Database; OANDA.com; Office of Personnel Management; Society of Economic Geologists (SEG); Society of Exploration Geophysicists (SEG); U.S. Bureau of Economic Analysis; U.S. Bureau of Labor Statistics; U.S. Department of Education; U.S. Geological Survey.

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Questions and More Information

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