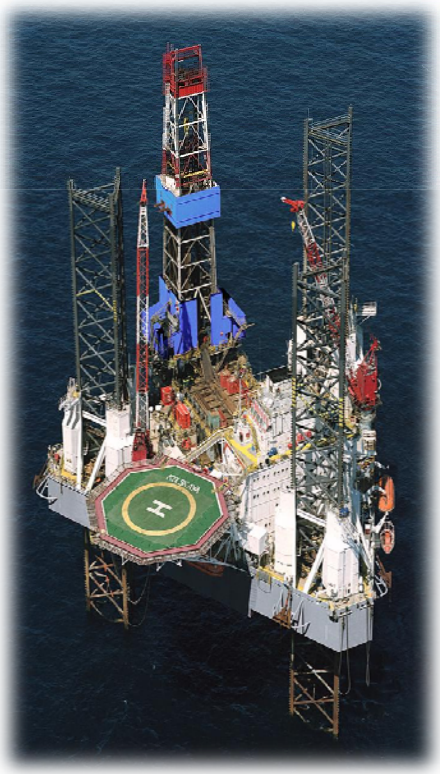
2009

Status of the Geoscience Workforce

Report Summary



American Geological Institute

February 2009

SERVING THE GEOSCIENCES WORLDWIDE
AGI
THE AMERICAN GEOLOGICAL INSTITUTE

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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

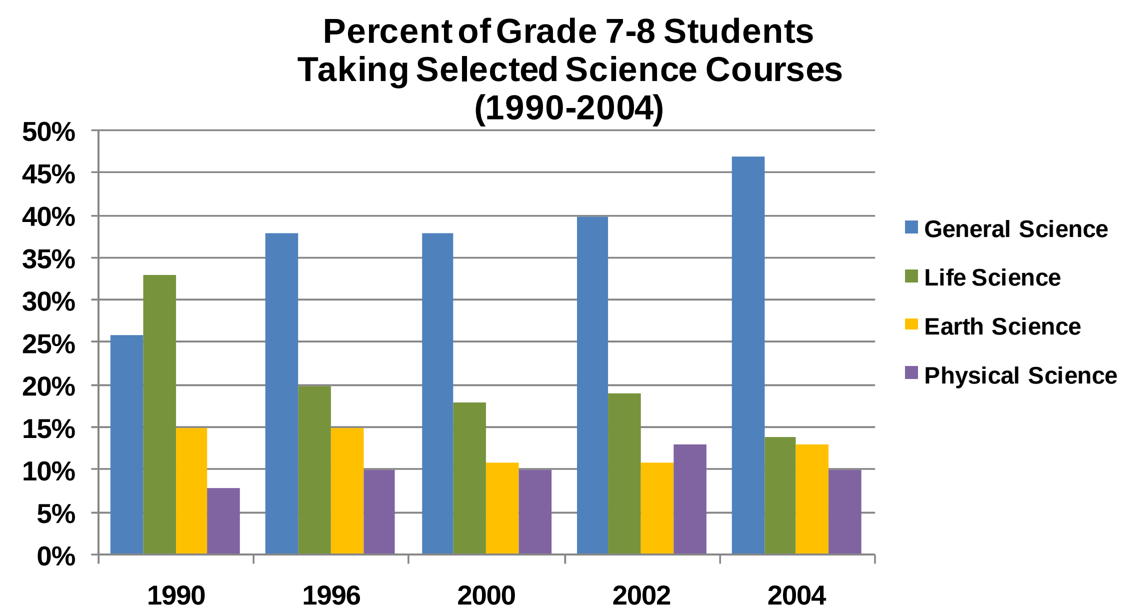
Studies the structural behavior of soil and rocks, perform soil investigations, design structure foundations, and provides field observations of foundation investigation and foundation construction.

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

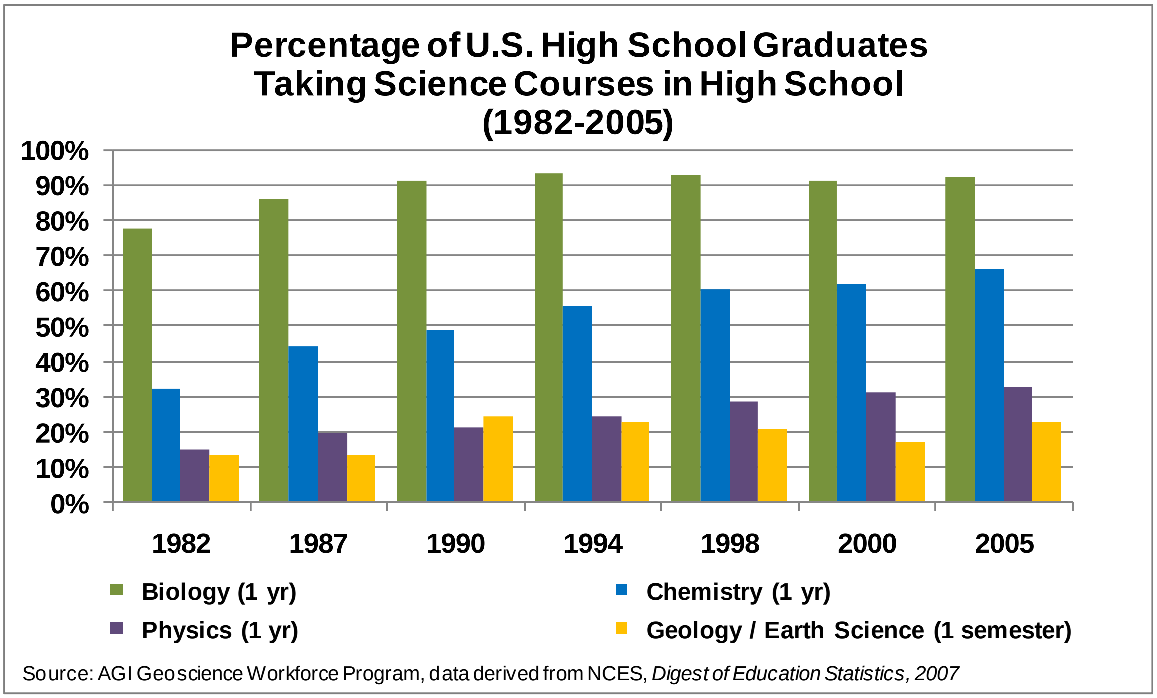
In the U.S., earth science education at the K-12 level is usually most intensive in grades 6 through 8 when national and state science standards mandate that students should learn about energy in the Earth system, geochemical cycles, and the origin and evolution of the universe and Earth. However, earth 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.



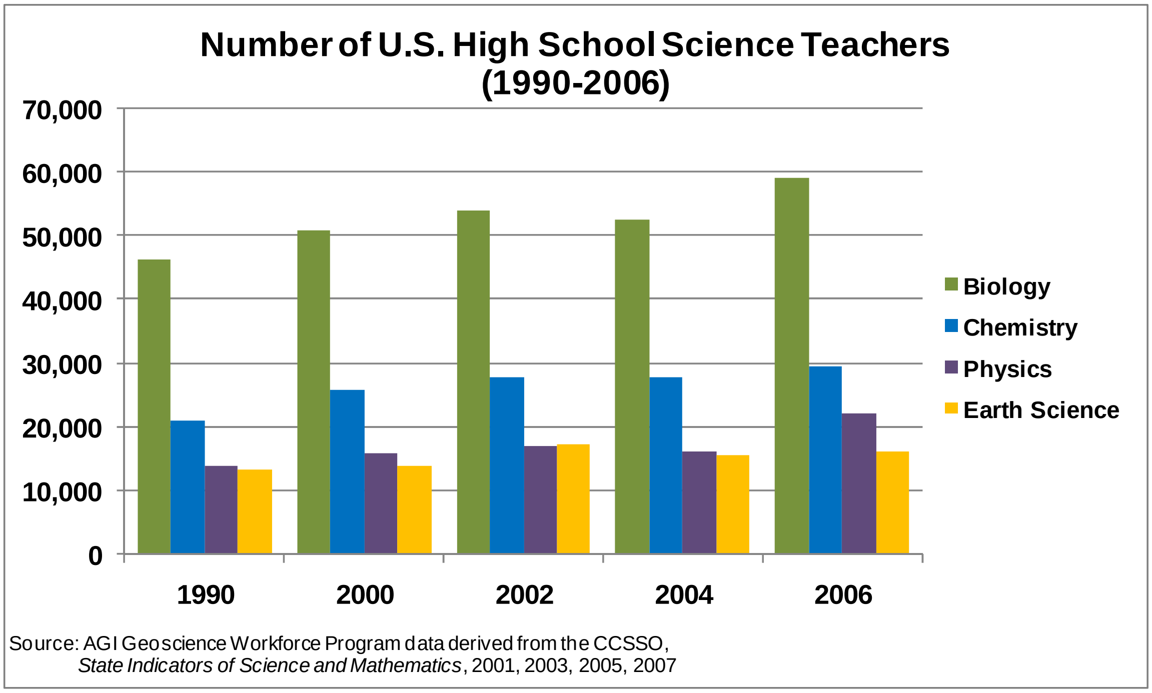
Source: AGI Geoscience Workforce Program, data derived from the CCSSO, *State Indicators of Science and Mathematics*, 2001, 2003, 2005, 2007

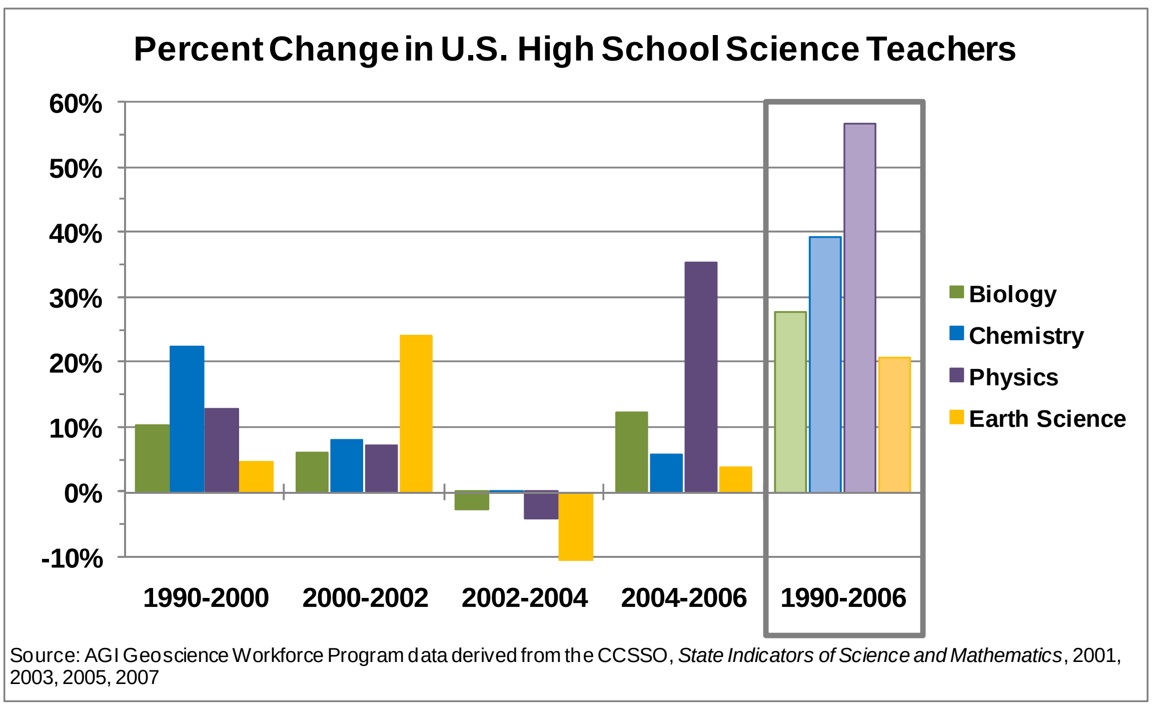
In high school, earth science was required for graduation by slightly more states in 2007 (7 states) than in 2002 (5 states). Although 3 states dropped their state-wide graduation requirement of earth science, 12 states that did not require earth science for graduation in 2002 now leave the decision 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%).

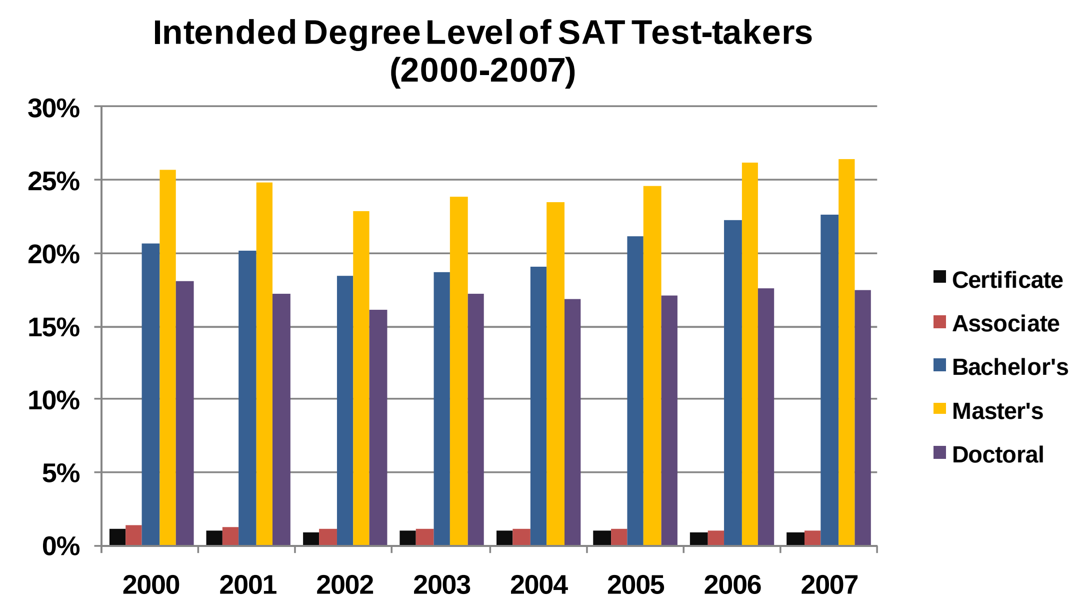




With less than a quarter of all graduating high school students taking courses in earth science/geology, it is no surprise that college-bound students have consistently indicated a low interest in pursuing either physical science or interdisciplinary science as a college major. For the past 22 years, 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.



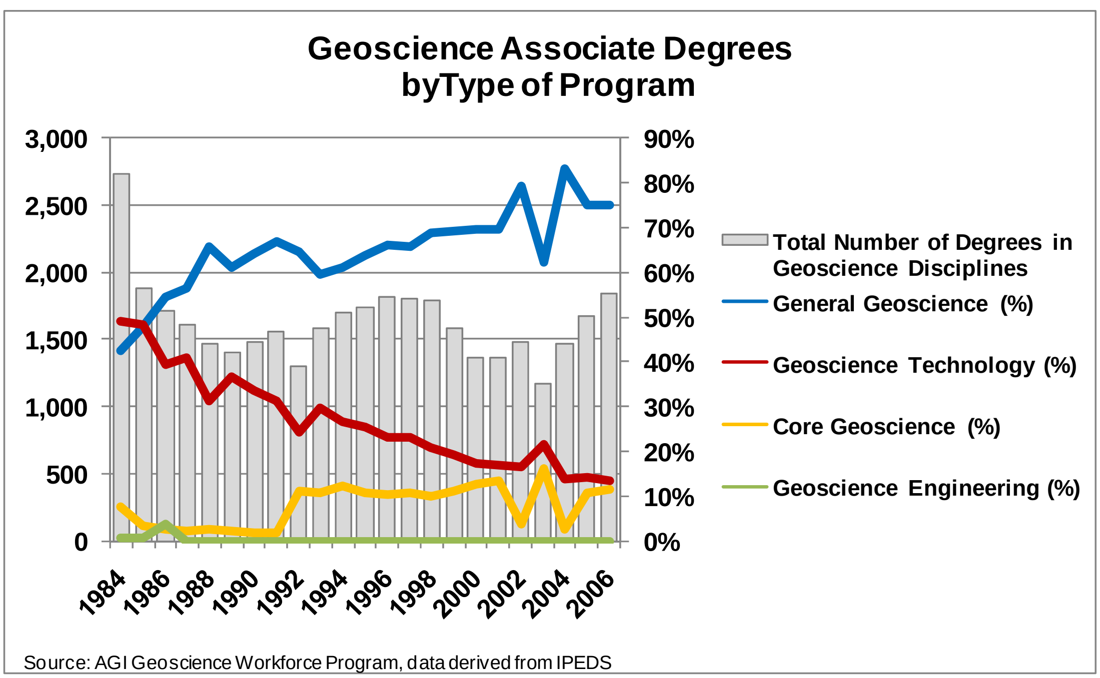
Source: AGI Geoscience Workforce Program, data derived from the College Board *College-Bound Seniors, Total Group Report*, 2000-2007

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.

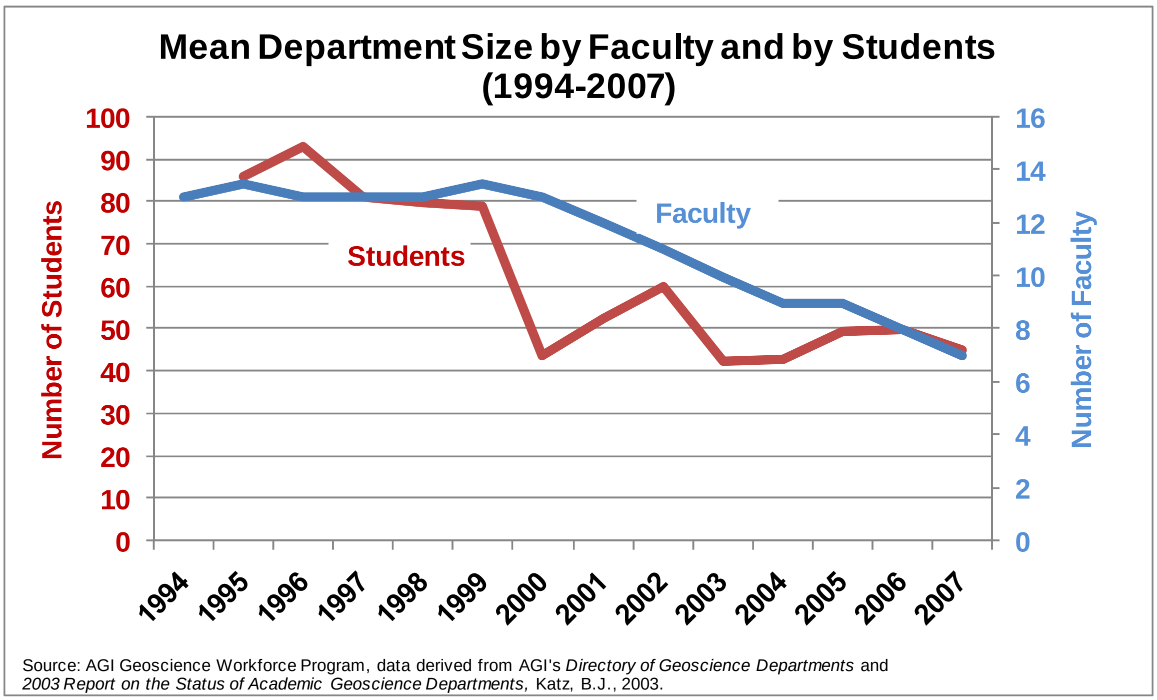
Since 1985, the number of Associate degrees conferred in geoscience disciplines has varied between 1,200 and 1,800 with an increasing percentage of these degrees from general geoscience programs (physical science, environmental science, and natural science). Core geoscience programs (earth science/geology, 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.



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.



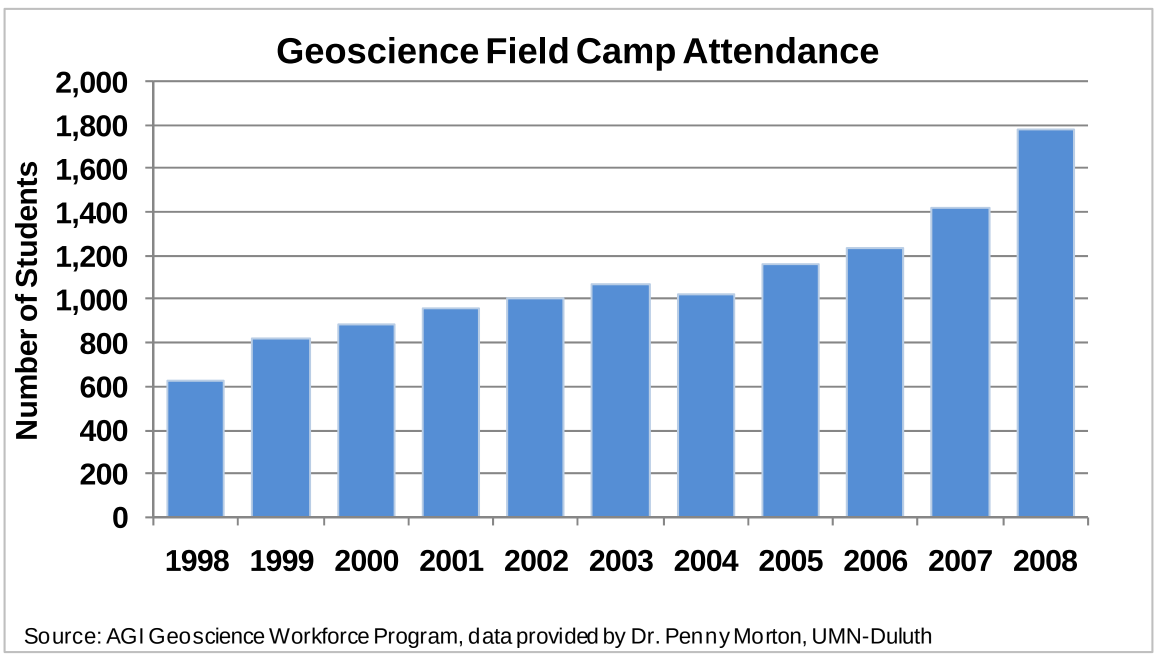
Currently, 56% of all faculty are tenured and 19% are untenured, but in tenure-track positions. Women comprise 14% of tenure-track faculty and 19% of non-tenure-track faculty in geosciences departments compared to 28% in tenure-track positions in all science & engineering fields. The level of female 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

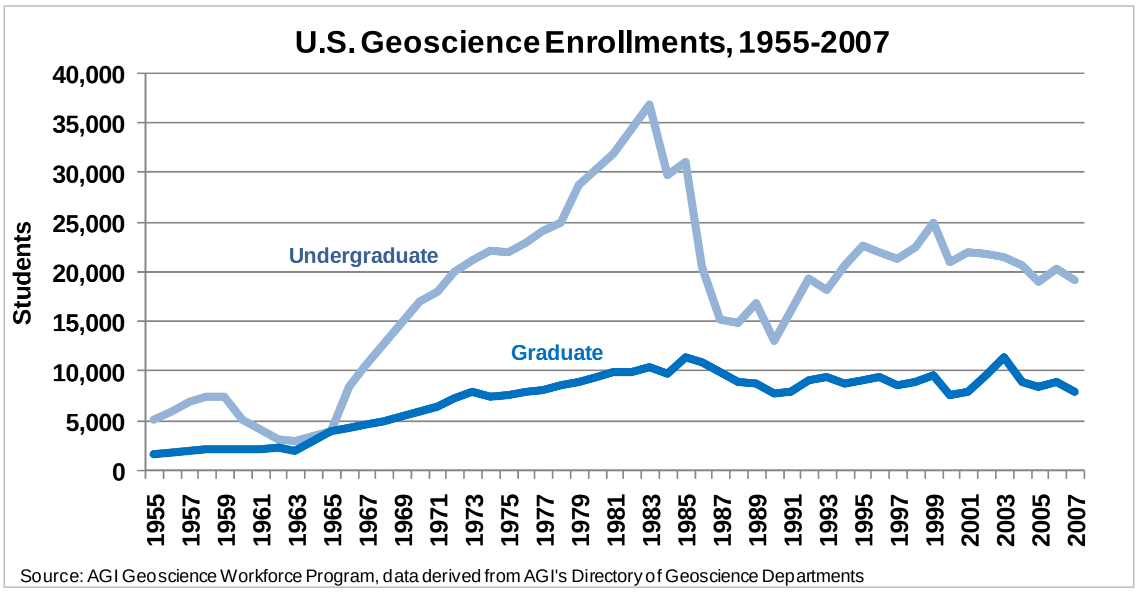
Over the past 10 years, there has been a decrease in the number of departments offering traditional summer field courses. These courses, or field camps, have traditionally served as a central part of undergraduate geoscience curricula. Employers across all sectors of the geosciences continue to either 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.

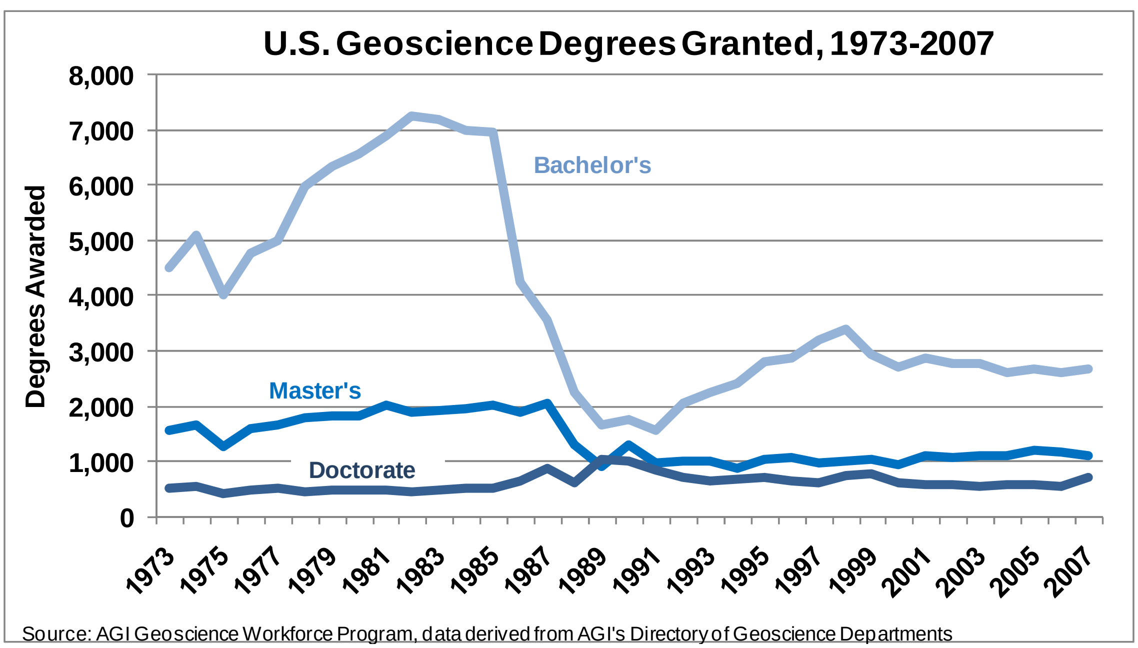
The current number of schools offering summer field camps represents less than 15% of the 695 schools listed in AGI's 2006 Directory of Geoscience Departments in the United States. In 1985 and 1995 close to 35% of schools offered summer field courses for geoscience students. There are several reasons 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.



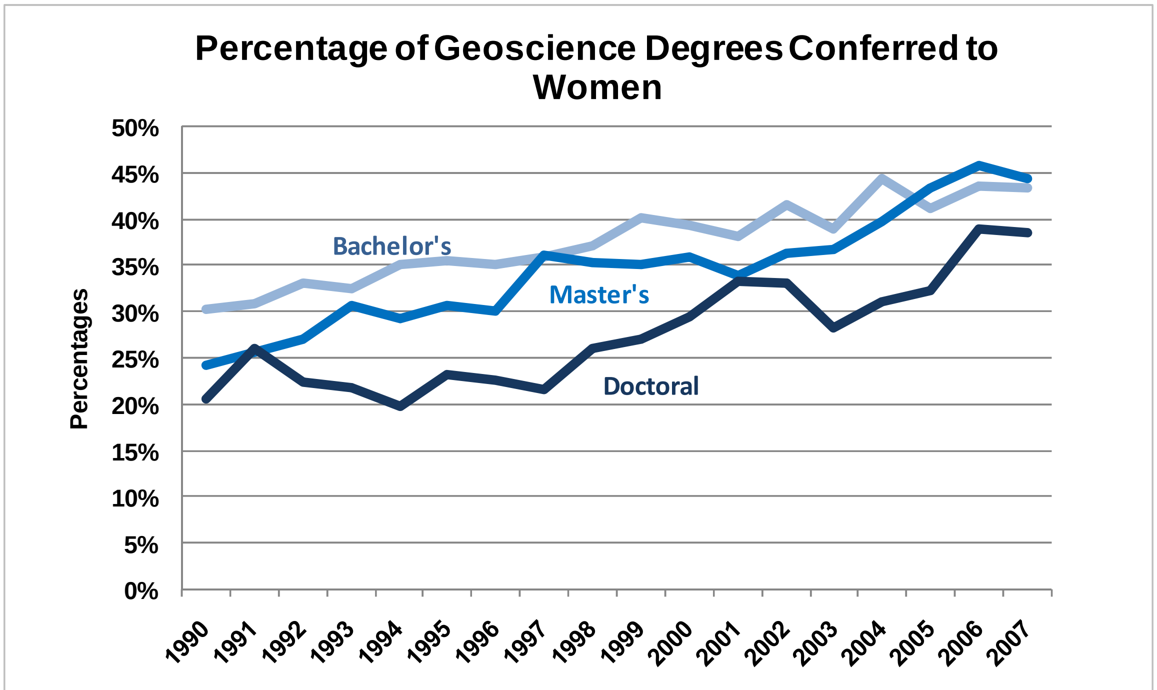
Enrollments and Degrees

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%).



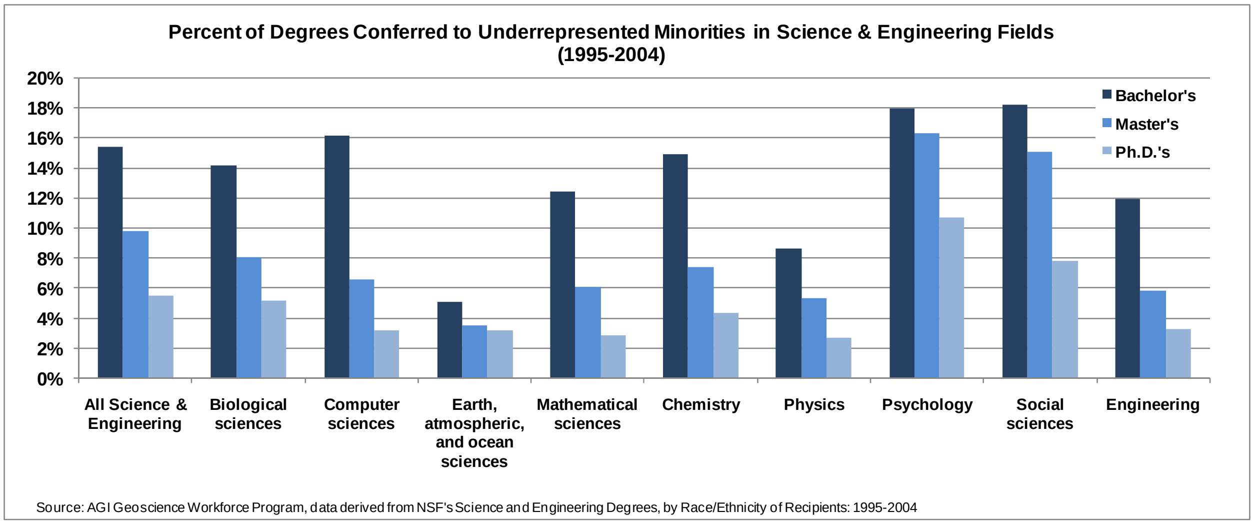


Although the trend in geoscience degrees granted has remained steady, the percentage of geoscience degrees conferred to women has increased over the past 20 years. In 2007, women earned 43% of all geoscience degrees.

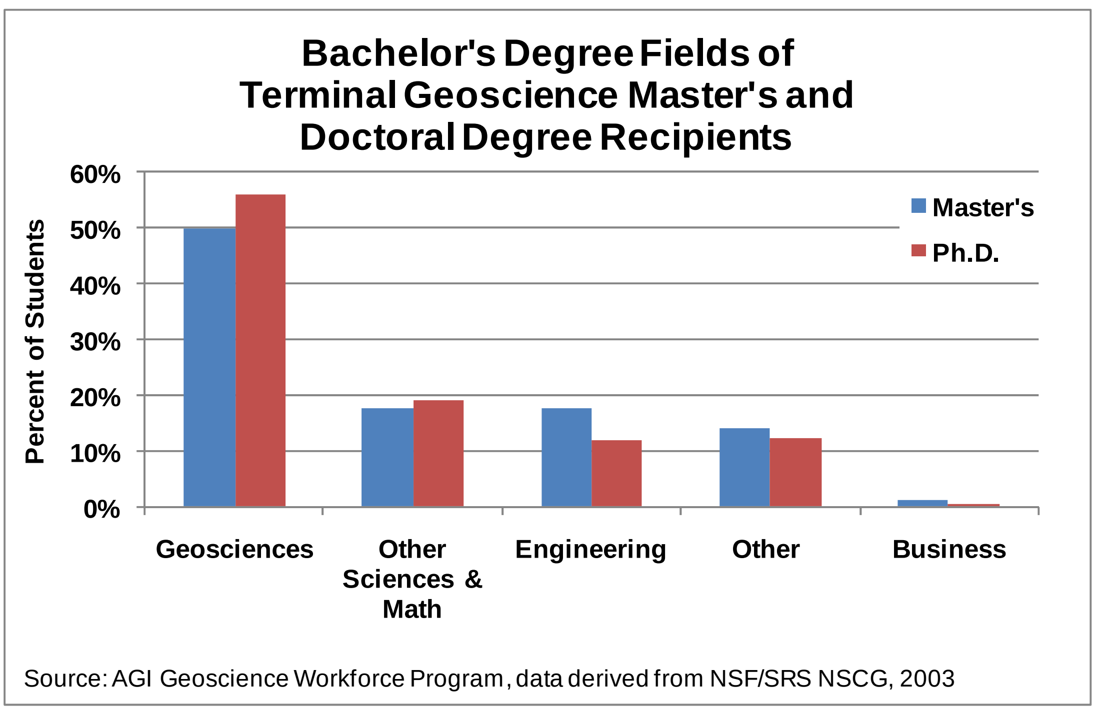


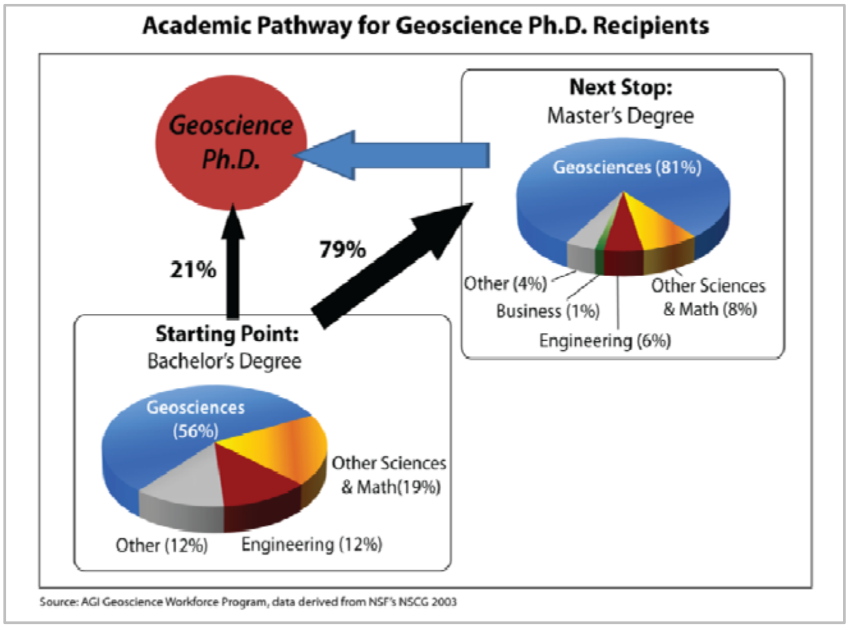
Source: AGI Geoscience Workfoce Program

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.



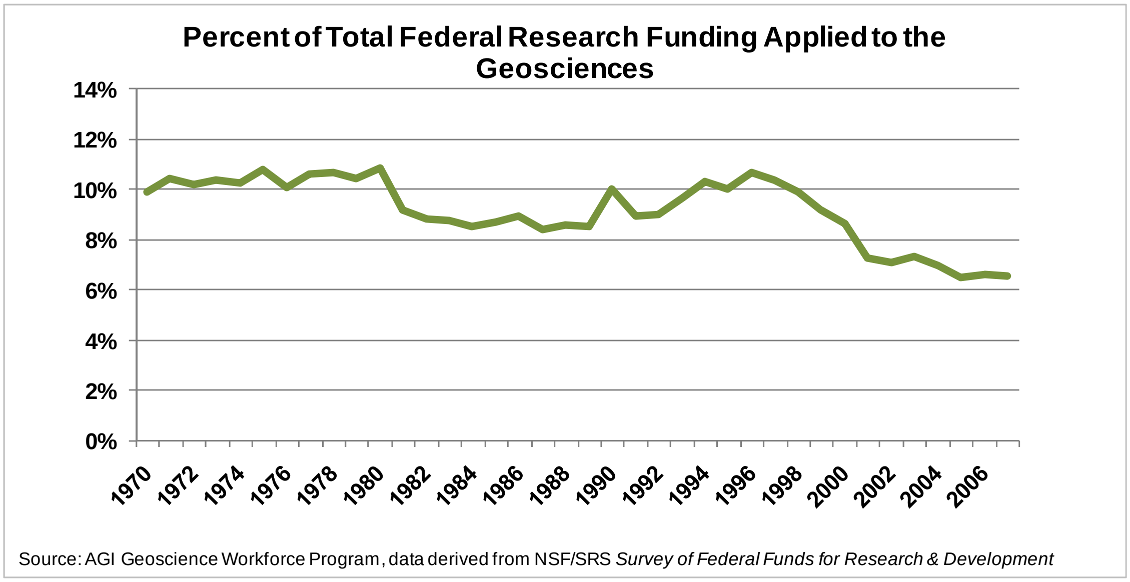
The academic backgrounds of individuals with geosciences master's or doctoral degrees are similar. Both groups have comparable percentages of Bachelor's degrees in business (~1%), engineering (12% to 17%), geosciences (50% to 56%), other science & mathematics (18% to 19%), and other degree fields (12% 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
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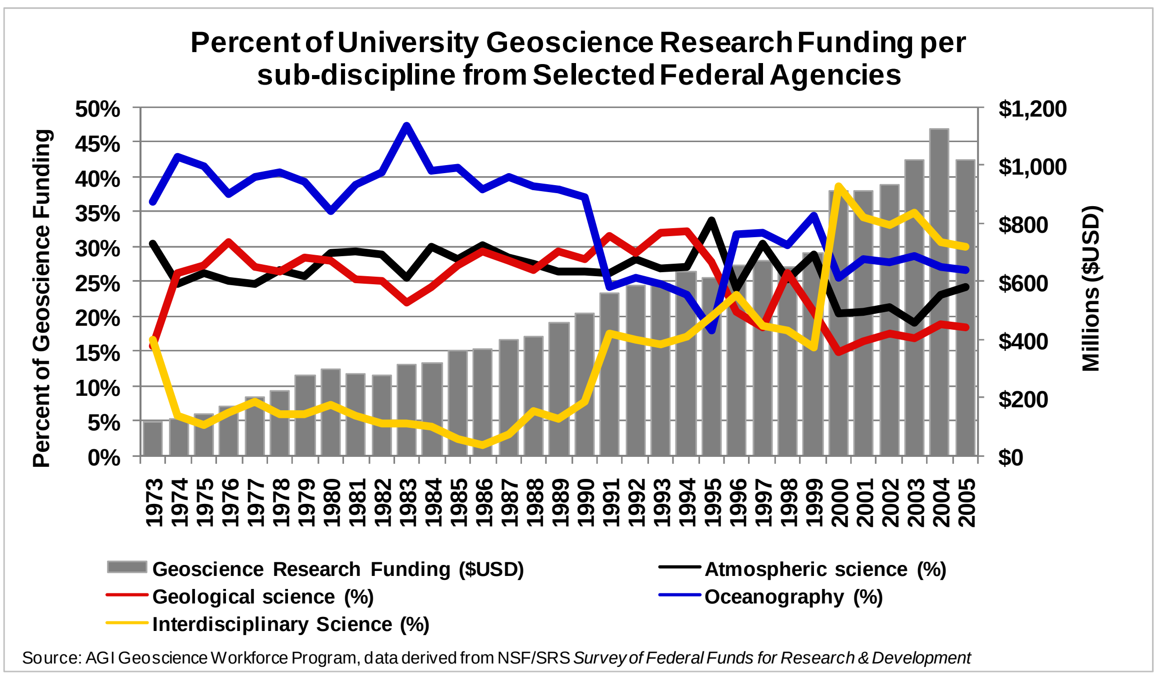
2004
2006
Source: AGI Geoscience Workforce Program, data derived from NSF/SRS Survey of Federal Funds for Research & Development


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
$0
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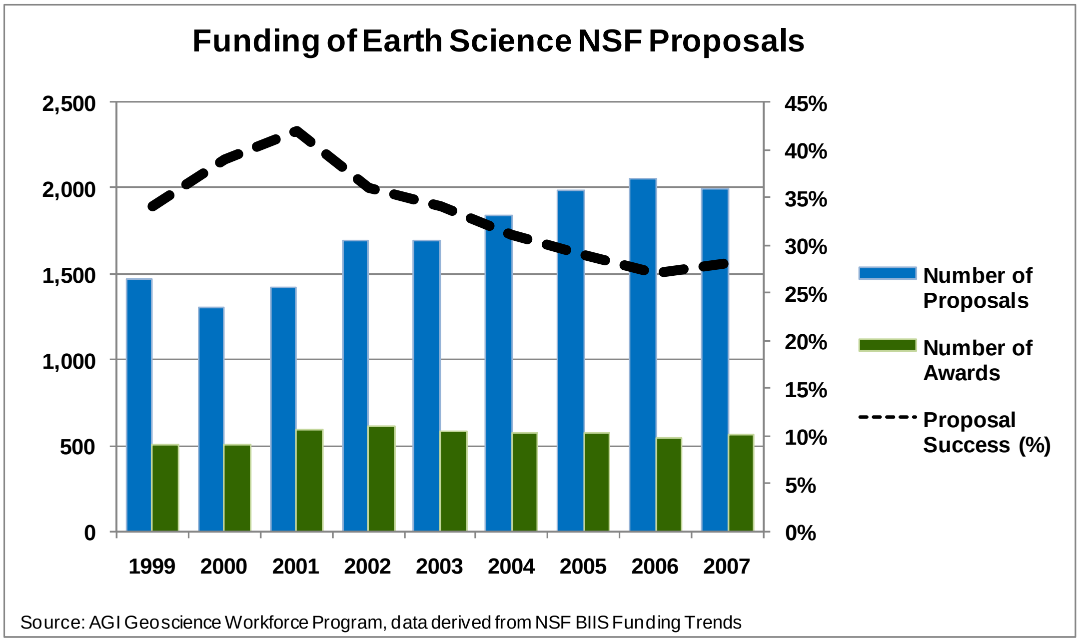
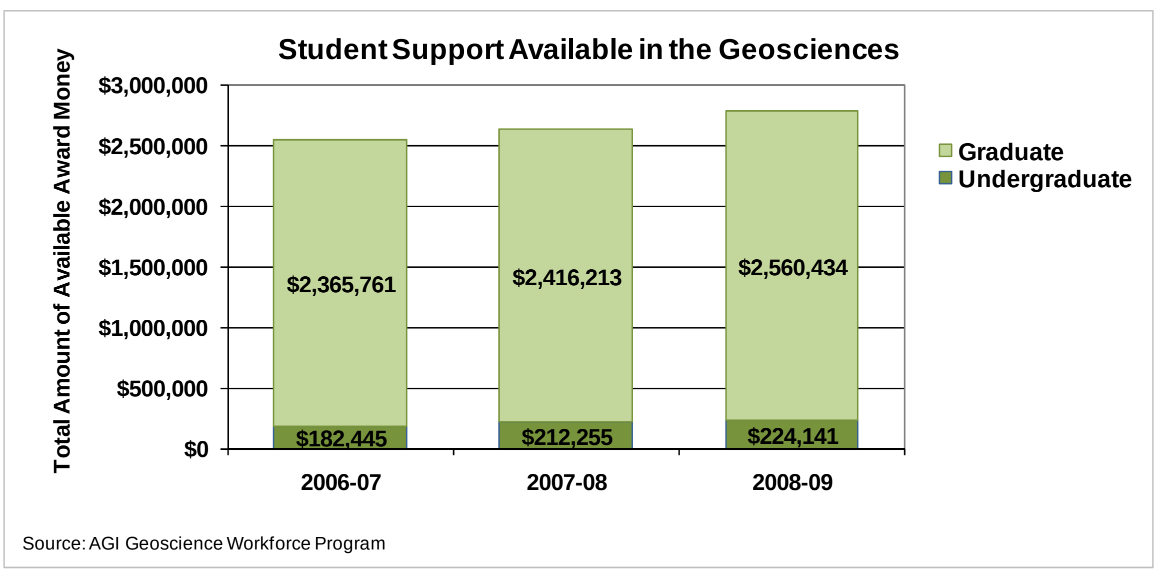
2004
2005
Geoscience Research Funding ($USD)
Atmospheric science (%)
Geological science (%)
Oceanography (%)
Interdisciplinary Science (%)
Source: AGI Geoscience Workforce Program, data derived from NSF/SRS Survey of Federal Funds for Research & Development



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.

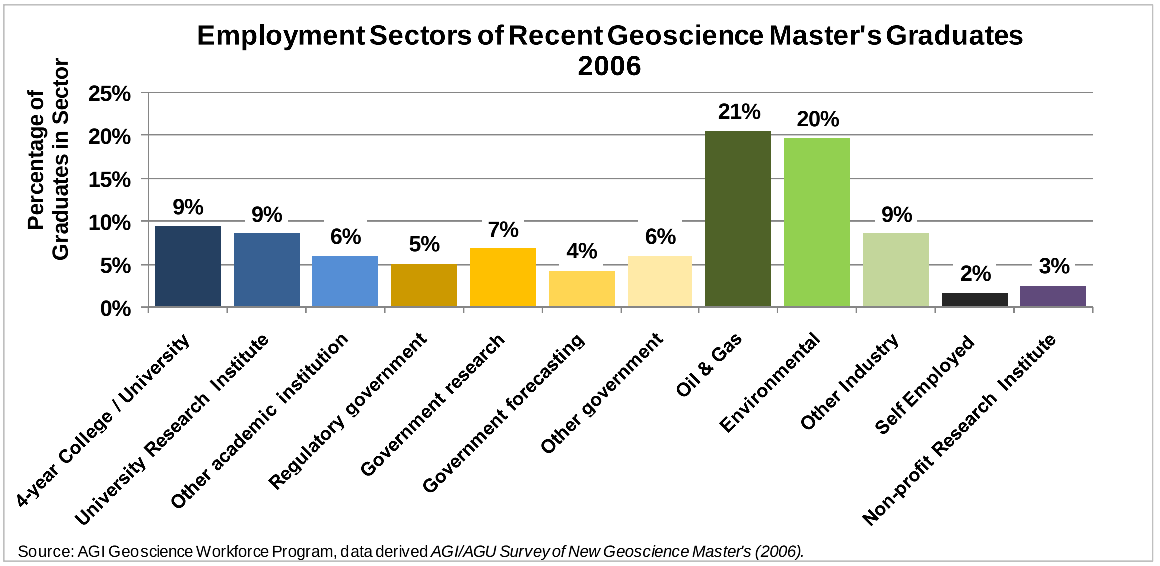


Trends in the Geoscience Workforce

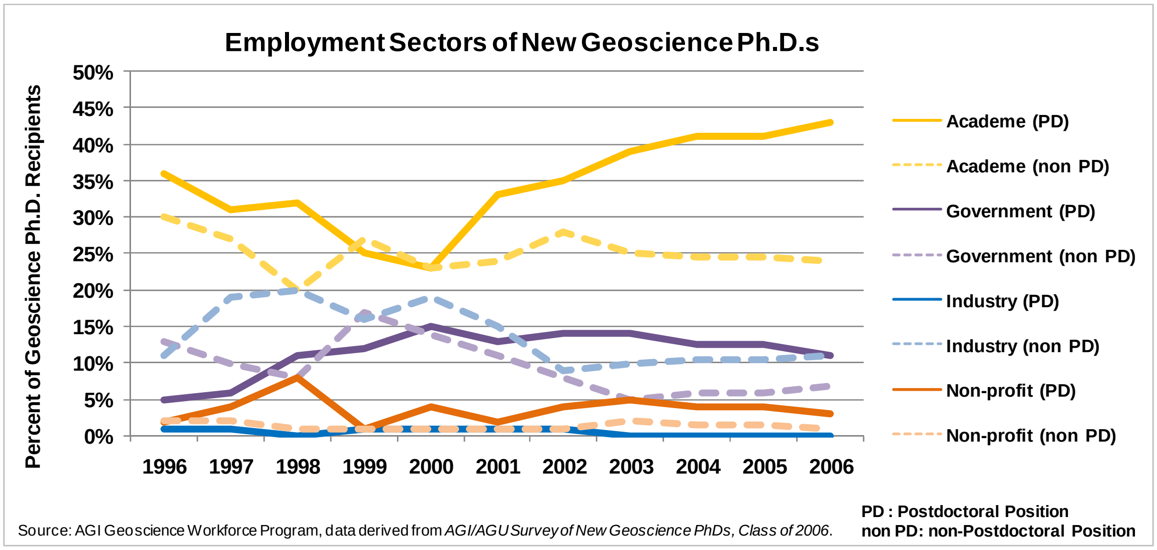
Student to Professional Transition

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%).

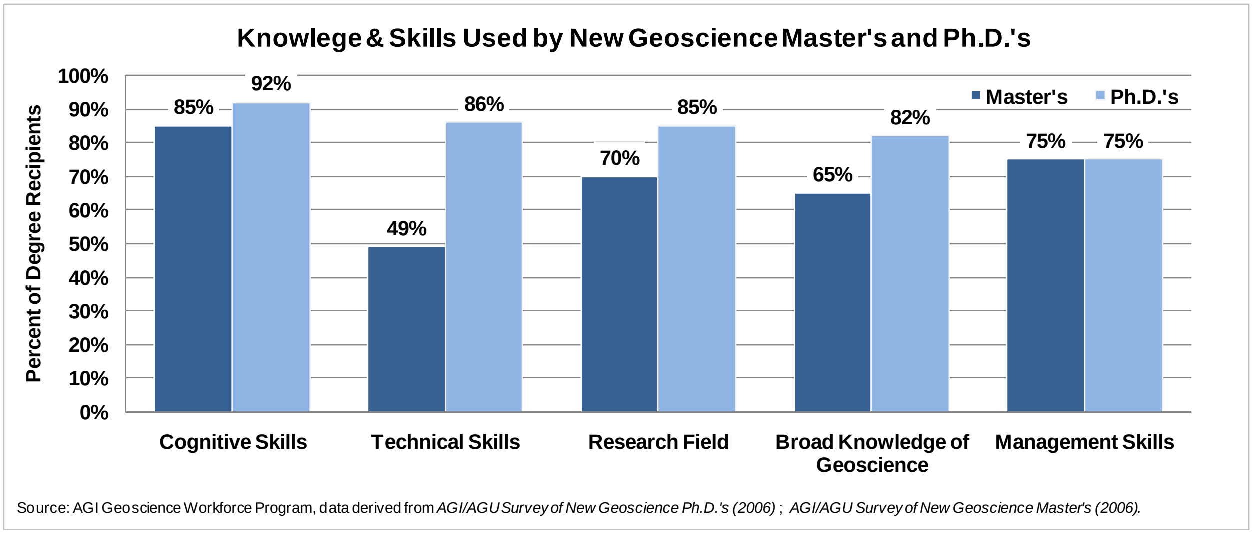


Source: AGI Geoscience Workforce Program, data derived *AGI/AGU Survey of New Geoscience Master's (2006).*



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.

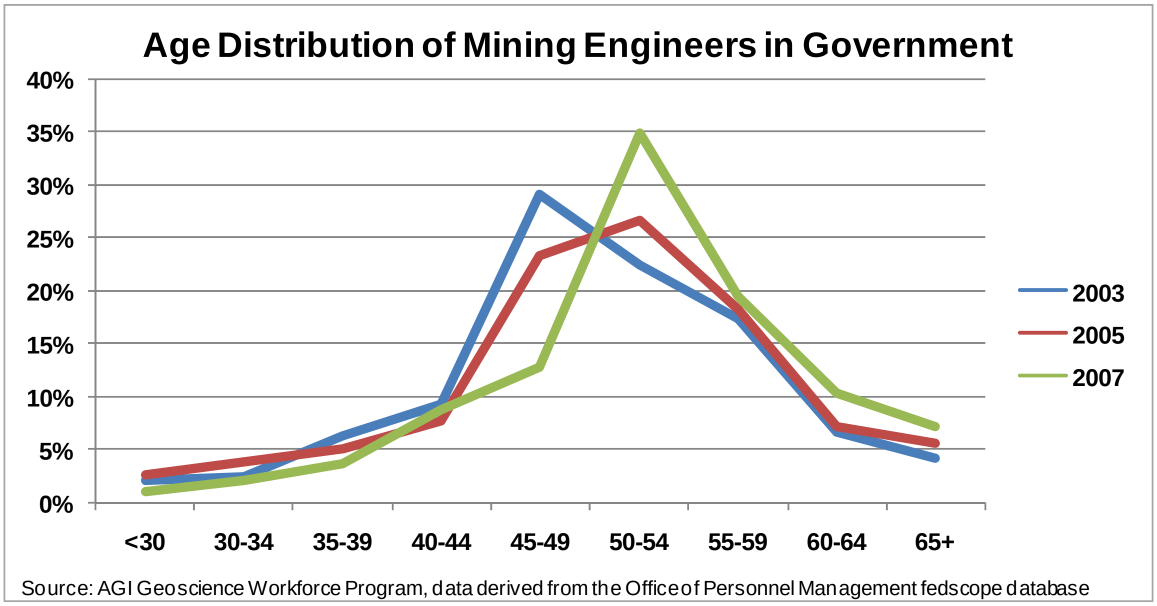


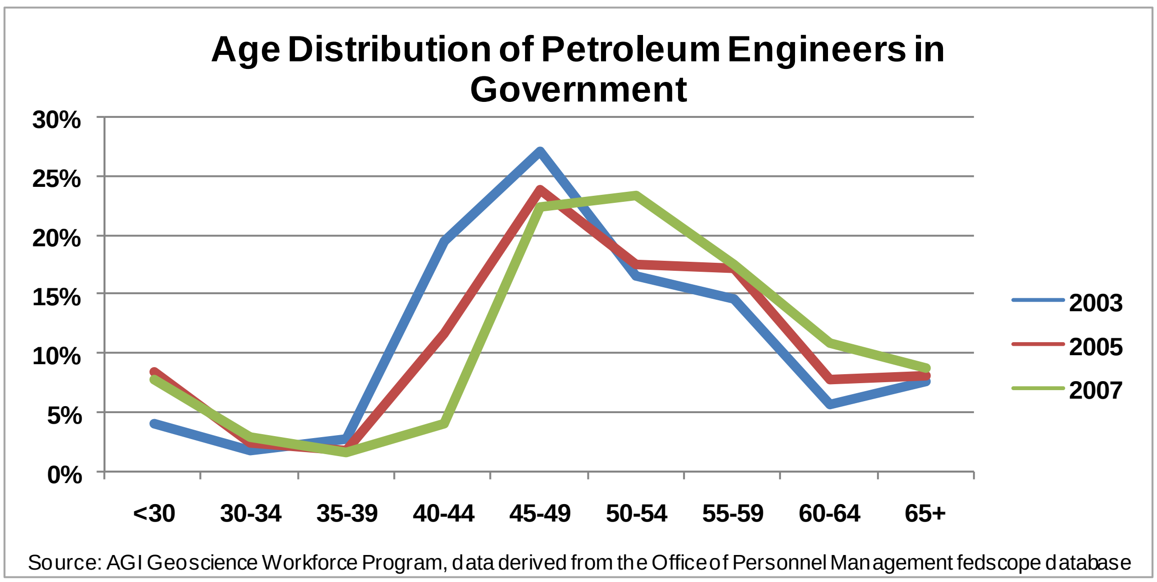
Geoscience Workforce Trends

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%).

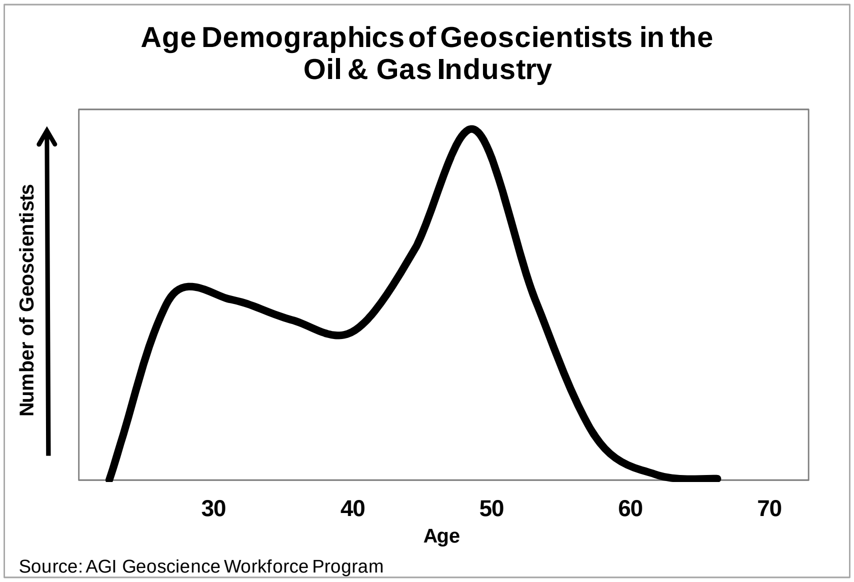
However, trends in the supply of new geoscience graduates have not increased over the past 10 years, and there is no indication that they will increase to meet the projected demand of geoscientists by 2016. Age demographic trends indicate that the majority of geoscientists in the workforce are within 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.

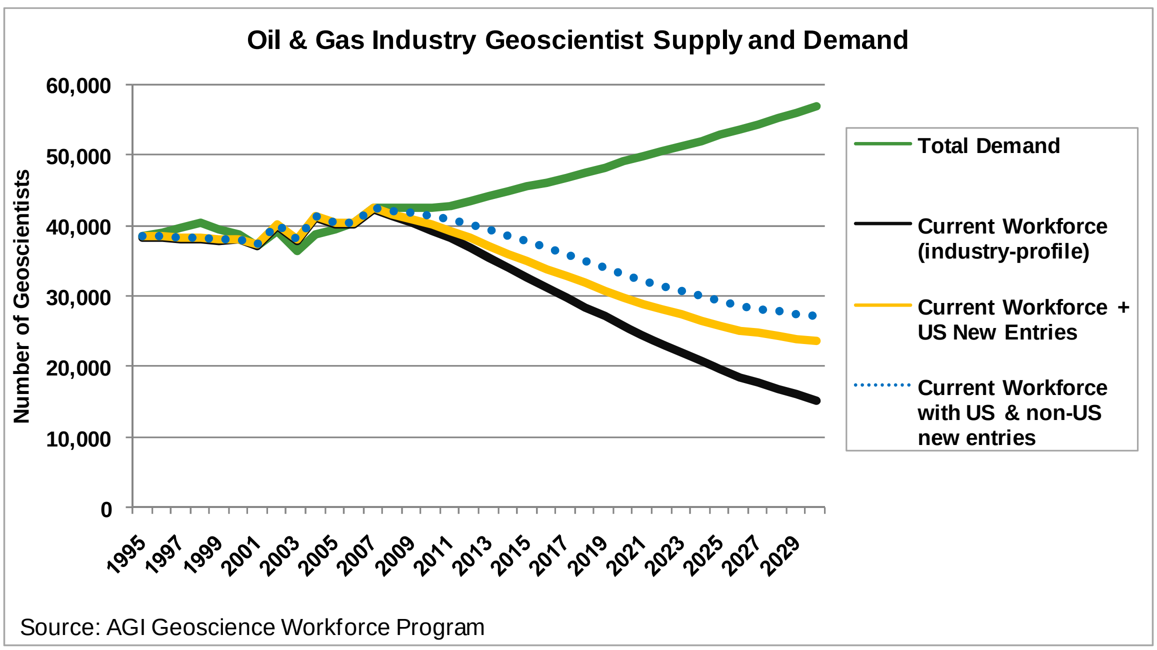
All geoscience occupations in the government, with the exception of meteorologists and oceanographers, experienced an age shift towards the 50 to 54 year old age group between 2003 and 2007. This shift is most pronounced in the age demographics of mining engineers and petroleum engineers.



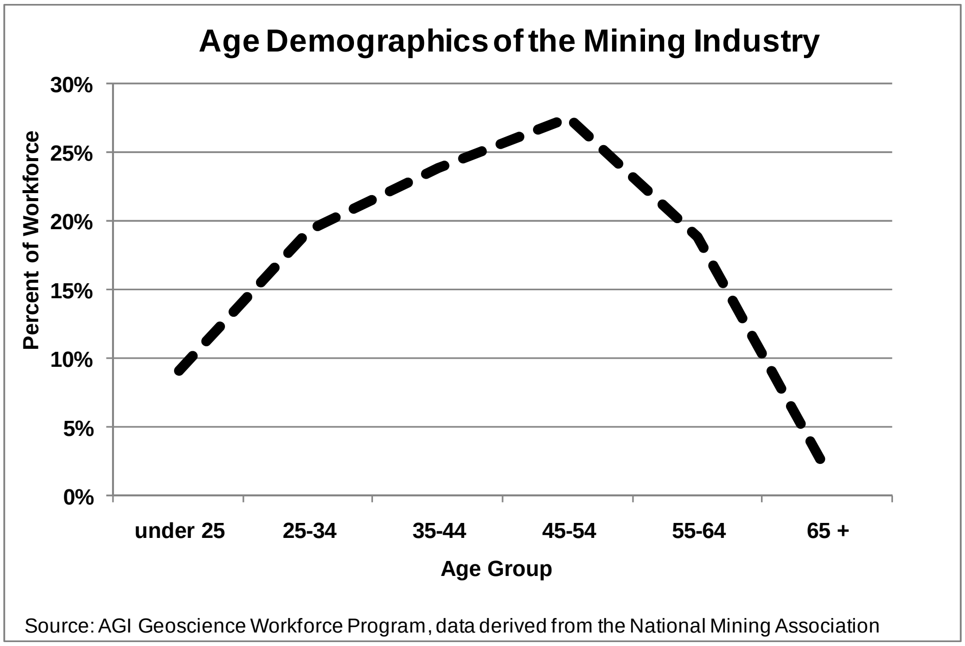


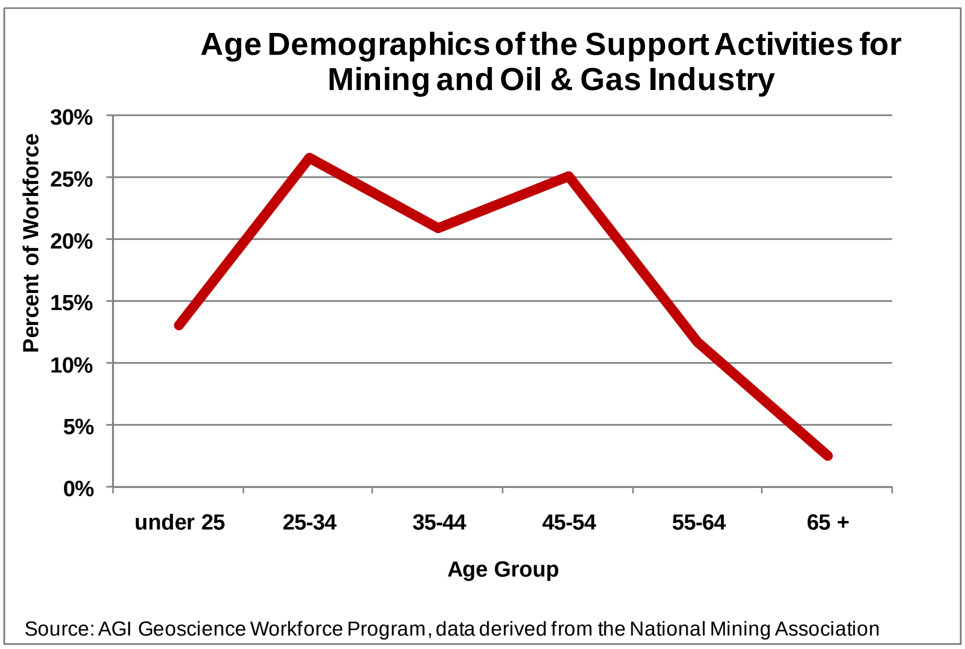
In oil & gas companies, which typically offer the highest salaries of all geoscience employing industries, the supply of new geoscientists falls short of replacement needs. The number of younger geoscientists in their early 30's is approximately half the number of those nearing retirement age. Additionally,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



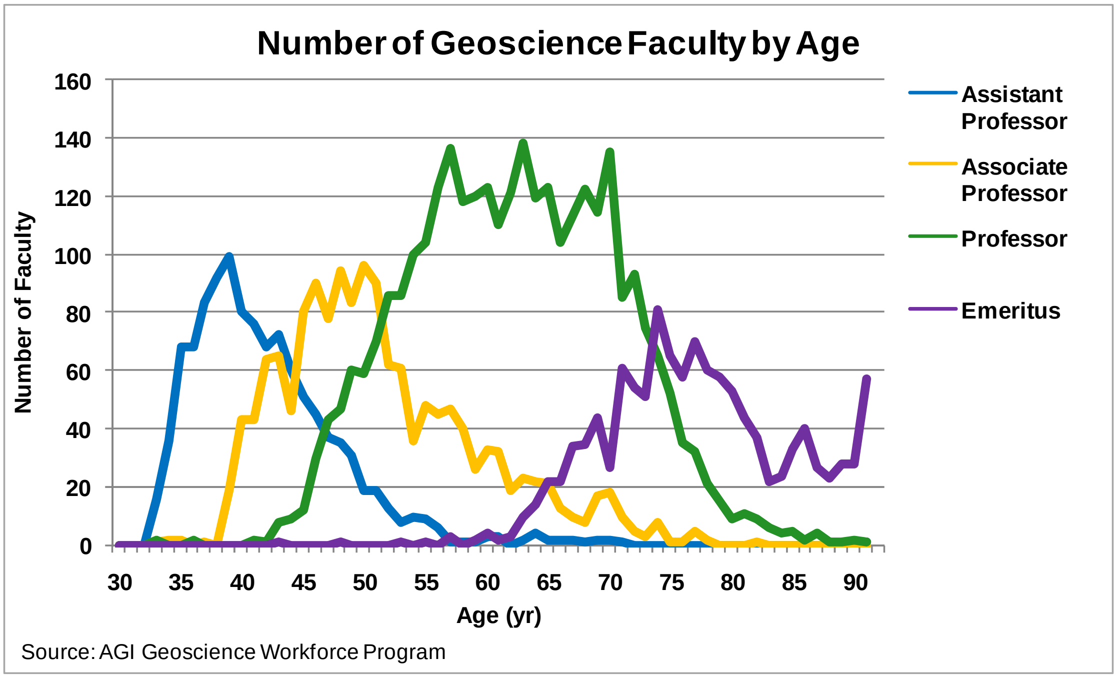


Support activities for mining and oil & gas is the only geoscience employment category with demographics that will provide for the replacement of the older generation of geoscientists who will retire within the next 15 years.





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.

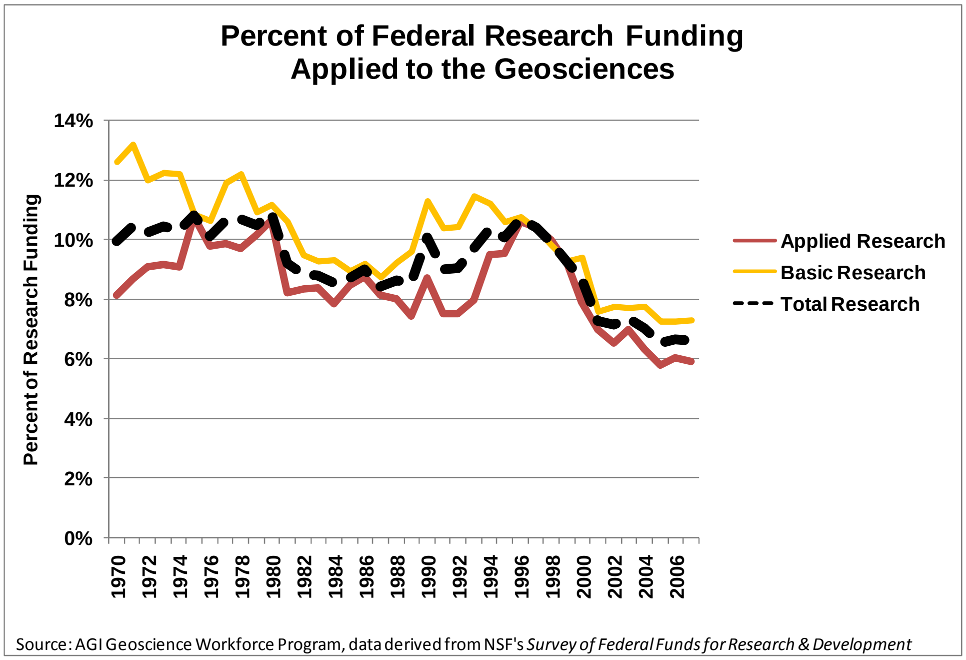


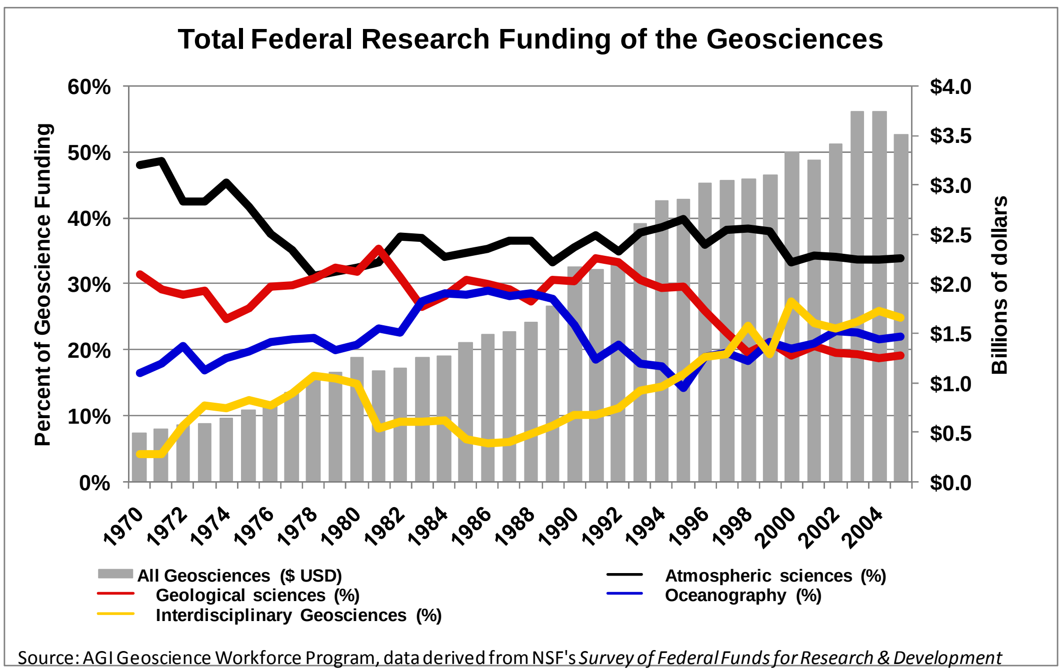
Geoscience Economic Metrics

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.

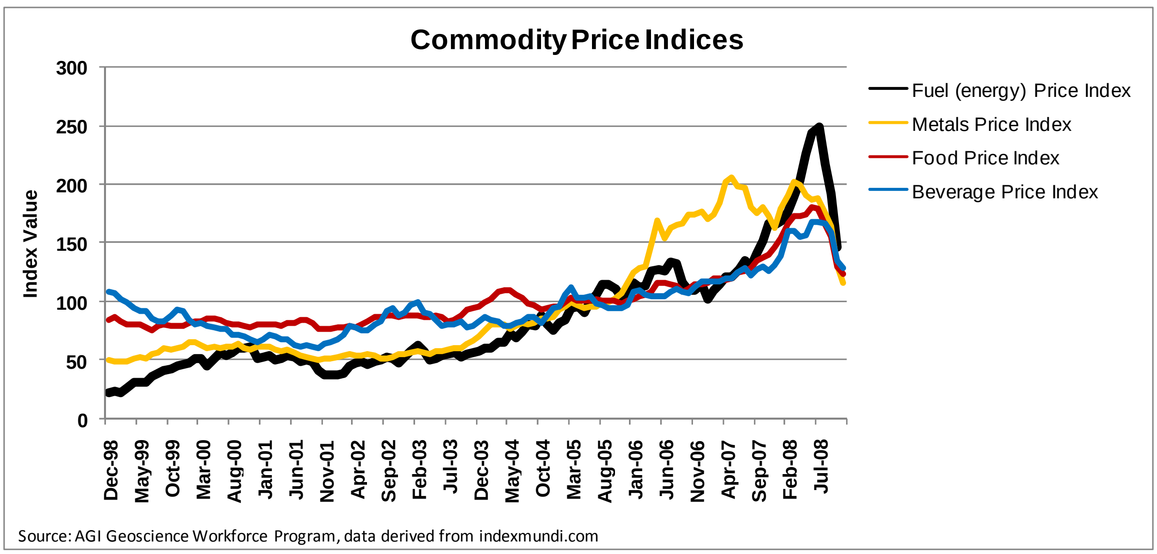




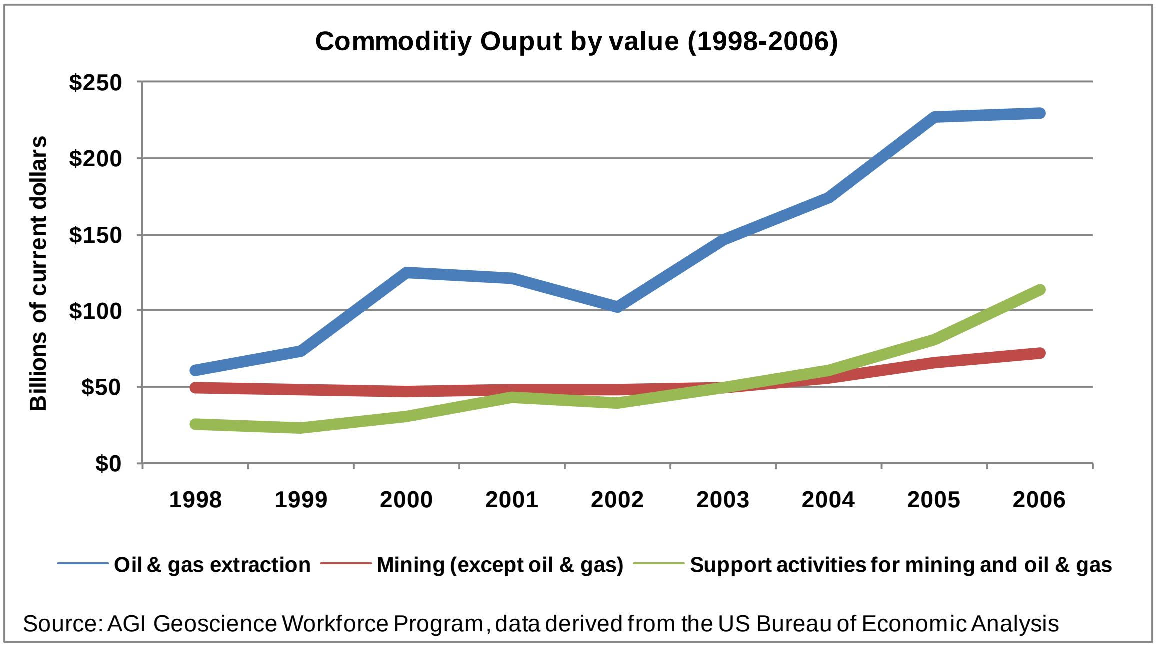
Information pertaining to industry funding of geoscience research is limited. Data pertaining to the trends in company research and development funds are available from the NSF / SRS Industry R&D Funding reports for the mining, extraction and support industries. Unfortunately, this data is aggregated 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.

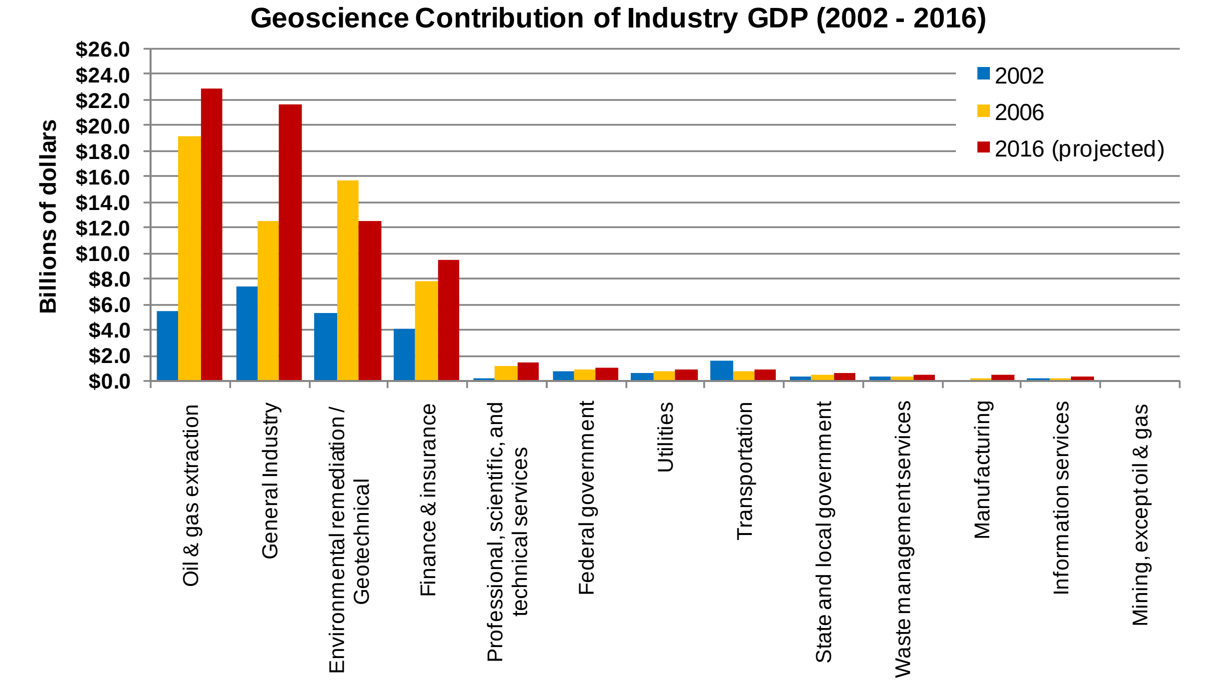


Total domestic commodity output data from 2002 through 2006 indicate a steady increase for both oil & gas extraction and for support activities for mining and oil & gas. Both industries show a drop in commodity output during the last recession between 2001 and 2002. Of note is the leveling off of commodity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

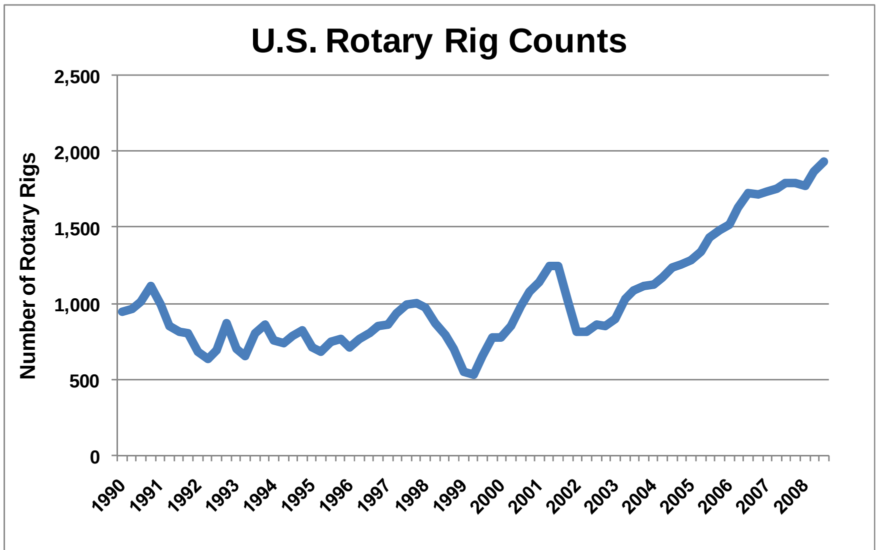


Source: AGI Geoscience Workforce Program, data derived from US Bureau of Economic Analysis, US Bureau of Labor Statistics, and AGI's Directory of Geoscience Departments

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%*

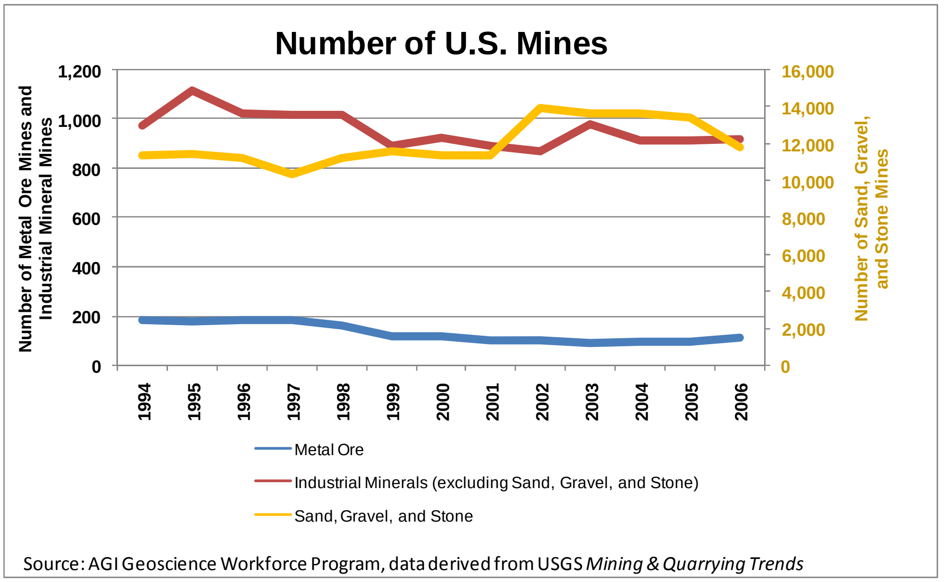
Productive Activity

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.



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

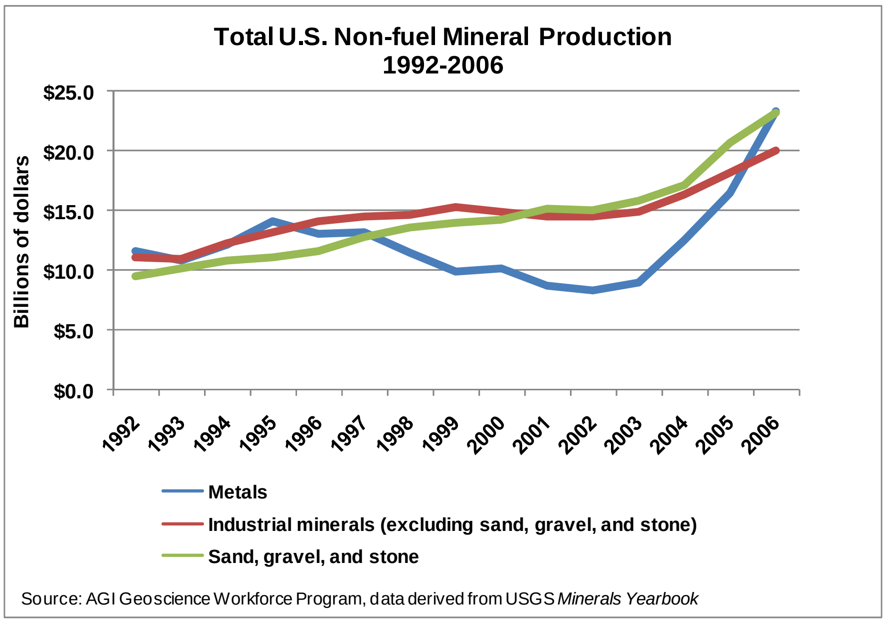
Unlike the oil & gas industry, the mining industry has not seen the same amount of productivity growth. The total growth in this industry was due solely to the increase of 2,000 U.S. sand, gravel, and stone mines. The number of U.S. mineral ore and industrial mineral mines (excluding sand, gravel, and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



Source: AGI Geoscience Workforce Program, data derived from USGS *Mining & Quarrying Trends*

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.

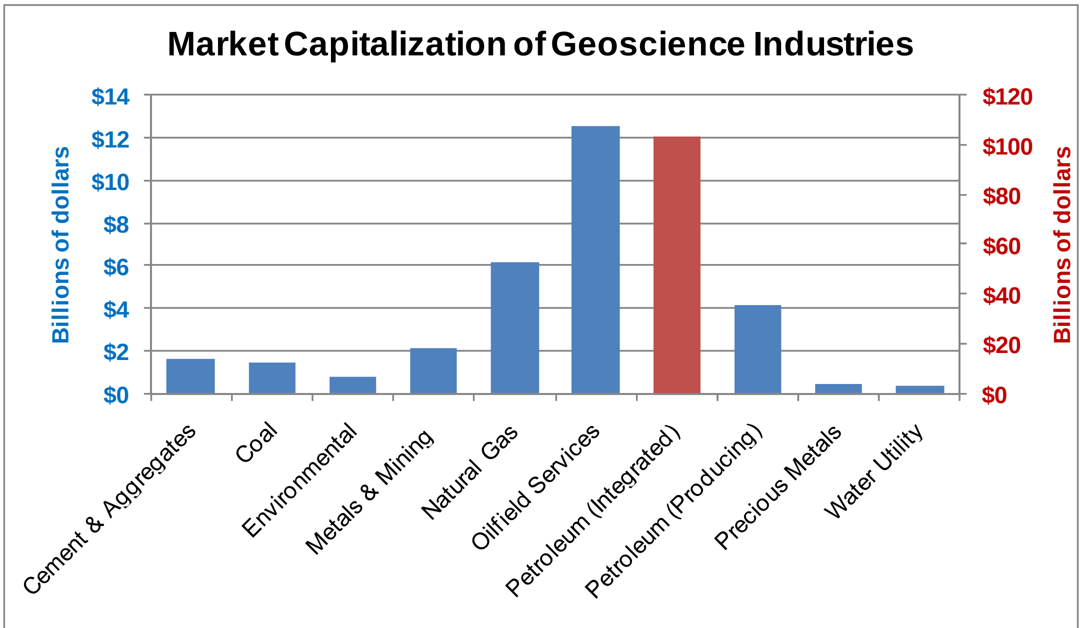


Market Capitalization

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.



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

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Questions and More Information

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