Western Oregon University – B.S./B.A. Earth Science
2010 Follow-up Review of a New Academic Program (August 13, 2010)

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(A program approved by the Oregon State Board of Higher Education as a new program within the last 5 years)

Summary: *(The summary should be a brief statement of the conclusion and recommended disposition following the review – program is on track and should continue; program has not met expectations but problems are being addressed, with follow up review recommended for [date]; program will be eliminated; etc.)*

1. General Information

The Earth Science program at Western Oregon University offers B.S. and B.A. degrees in Earth Science with minors in Earth Resources, Earth System Science, and Geology and History of the Earth and Biosphere. WOU is distinctive in that it offers the only undergraduate multi-disciplinary Earth Science degree of its kind at any of the regional OUS institutions or private liberal arts colleges in the State of Oregon. Three tenured faculty members and five fixed-term adjunct faculty members support the program. Focus areas include Earth system science education, volcanology-igneous petrology-geochemistry, sedimentology-paleobiology, and geomorphology-environmental geology-geographic information systems. Supporting curricula includes meteorology, oceanography, geochemistry, and astronomy.

a. What was the program originally approved by the Board? When was it last reviewed?

During spring term 2000, faculty in the Earth and Physical Science Department at Western Oregon University (WOU) proposed to reorganize the former (pre-existing) B.S./B.A. Natural Science Major (Geology / Earth Science Options) into a unified B.S./B.A. Earth Science degree, better aligning the curriculum with parallel division programs in Biology, Chemistry, and Mathematics. At that time, course additions, modifications, and updated catalog descriptions were approved by the campus curriculum committee, faculty senate and WOU administration. Later that year, the proposal was subsequently carried forward by then Provost John Minahan to the Oregon State Board of Higher Education (State Board) for system-wide approval. The program reorganization was unanimously approved, and the B.S./B.A. Earth Science degree program was formally integrated into the WOU academic catalog during the 2001-2002 year.

A request for a follow-up review by the State Board was issued to WOU administration in spring 2010. This document addresses that request. The Earth Science program was last reviewed and accredited in winter-spring 2007, as part of the WOU institutional review process conducted by the Northwest Commission on Colleges and Universities (NWCCU). In addition, formalized strategic planning activities were conducted in the 2005-2006 academic year, as part of an university-wide process.

b. Explain any major modifications in the program from the original proposal. Do you foresee modifications of this program in the future?

The program prefixes were modified in academic year 2003-2004 from the previous “G” (Geology) and “GS” (General Science) designations to a uniformly-applied “ES” (Earth Science) course prefix. This was primarily a book-keeping change to improve the alignment between the program name (Earth Science), the reorganized degree designation (B.S./B.A. Earth Science), and the faculty areas of expertise in which courses are taught. In addition to the above realignment of prefix designations, several new courses were selectively added over

the years to increase program efficiency and improve training opportunities for post-baccalaureate employment of graduates. In academic year 2008-2009, the degree program math requirement was expanded in scope to provide more flexibility for student scheduling, and to better align the curriculum with existing mathematics options in other degree programs offered by the Division of Natural Sciences and Mathematics at WOU.

No further curriculum modifications to the WOU Earth Science program are planned for the foreseeable future.

c. Have new locations or delivery models been implemented since the program was first approved?

No new locations or delivery models have been implemented since the reorganized Earth Science program was first approved.

d. Please describe any new related degrees, certificates, or concentrations that are now offered in areas related to this program. Are there collaborations with other institutions (community college, OUS institution, and/private college/university)?

As a result of the initial program reorganization, four minors are now currently active as part of the Liberal Arts curriculum at Western Oregon University: (1) Earth System Science Minor, (2) Earth Resources Minor, (3) Geology Minor, and (4) History of the Earth and Biosphere Minor. The Earth System Science Minor has attracted a significant amount of attention from students in a wide variety of Liberal Arts and Sciences (LAS) majors across campus. The Earth Resources Minor is growing in popularity with ecologically-minded Biology majors, and the Geology Minor also attracts several students each year. .

The 100-level Earth System Science sequence at WOU (ES104-105-106) is currently the focus of a major curriculum development proposal submitted to the National Science Foundation. The proposed project entitled “Transforming Undergraduate Earth System Science Curricula through Inquiry-Based Learning-for-Use Modules” was crafted in direct partnership with the Division of Science, Engineering, and Technology at Linn-Benton Community College. The focus of the proposed project outcome is on use of an Earth System Science curriculum to enhance workforce-development skills and provide WOU connections to regional community college instruction. The proposal is currently pending review under the NSF Transforming Undergraduate Education in Science, Technology, Engineering and Mathematics (TUES) program (formerly Course, Curriculum, and Laboratory Improvement - CCLI).

e. How does the program support the mission and strategic plan of the institution, spires of excellence, and signature programs?

The Earth Science program provides a liberal arts core education in geoscience with an emphasis on the scientific method, problem solving, and interdisciplinary science education. A key objective of the program is to prepare undergraduates for careers as professional geoscientists and educators. The program also promotes the development of an informed citizenry for wise decision-making on issues related to natural resources, environmental quality, and sustainability in Oregon and beyond. WOU Earth Science is distinctive in that it is the only undergraduate-focused degree program of its kind at any of the comprehensive, regional institutions or private liberal arts colleges in the State of Oregon.

The strengths of the Earth Science program are summarized as follows:

- The Earth Science program has a faculty:student ratio that is conducive to one-on-one contact, personalized instruction, and promotion of undergraduate research.
- The Earth Science program is one of the campus leaders with respect to service contributions to the Liberal Arts Core Curriculum and pre-education programs. The ES100 sequence (ES 104-105-106) serves approximately 1400 students per year, and is a common first destination for entering freshman. In addition, ES100 encourages real-world problem solving, is appealing to non-science majors, and has a notably high retention rate amongst the science disciplines.
- Earth Science faculty members embrace a technology-based curriculum and are working to implement standardized program assessment tools.
- Earth Science faculty members actively serve as leaders on a number of campus-wide committees and serve in a variety of professional capacities.
- Earth Science faculty members are enthusiastically engaged in a wide spectrum of peer-reviewed research, publications, and related professional development.

By design, the program mission and demonstrated strengths are in direct alignment with the stated university mission and learning aspirations.

f. How does the program meet the needs of Oregon and enhance the state's capacity to respond effectively to social, economic, and environmental challenges and opportunities?

The WOU Earth Science Program supports the state higher education needs in three primary ways:

(1) Provides career training for natural resources, environmental, and geoscience professionals,
(2) Provides interdisciplinary physical science training for K-12 teachers, and
(3) Provides liberals arts education for Oregonians in the areas of natural hazards mitigation, natural resources management (water, minerals, energy, ecological services), geospatial technology and environmental sustainability.

For nearly two decades, there has been a persistent call to improve standards and learning outcomes in undergraduate Science, Technology, Engineering, and Mathematics (STEM) education in the United States. As the global economy shifts to one requiring workers to increasingly develop proficiencies in computer-based technology and problem-solving skills, the U.S. has consistently lagged behind other developed nations in STEM learning performance. Results from a recent survey of 302 employers by the American Association of Colleges and Universities suggest that two- and four-year colleges are not fully preparing students for success in the global marketplace (AACU, 2010). In fact, the majority of respondents suggested that general education programs require significant improvements for competitive job placement of college. Concomitantly, society is under constant pressure with increasing demands for improved natural resource management in the areas of energy development, water resource utilization, environmental planning, and hazards mitigation. A survey of some of the most noteworthy news events over the past several years demonstrates the strategic importance of the Earth Science discipline in the state and nation, examples include: global warming, unstable petroleum markets, water wars in the Klamath Basin, Hurricane Katrina, Haitian earthquake disaster, Indonesian tsunami catastrophe, Gulf oil spill, Chilean earthquake episode, landslide damage in Lake Oswego, coastal erosion and land

development in Newport; the list goes on. Earth Science is the quintessential study of "social, economic, and environmental challenges" and stands squarely at the crossroads of interdisciplinary science, technology, global economics, and natural resource management.

In the State of Oregon, Earth Science degrees lead directly to student career tracks in science education, natural resource management, and environmental restoration. The WOU program directly supports the advancement of geoscience education, conservation planning, environmental management, and natural hazards mitigation (refer to Appendix A – Supporting Letters). The problem-solving and technical skills acquired via training in the Earth Sciences are highly valuable and marketable, regardless of career track. Students are expected to actively participate in the learning process and make a significant contribution to the academic integrity of the Earth Science program at WOU. The ultimate goal of the program is to provide graduates with the academic skills that will enable them to be highly competitive in graduate school or the 21st century career marketplace. Through the professional geologist licensing process, and the Oregon State Board of Geologist Examiners, the WOU Earth Science degree has a clear outcome leading students directly to career pathways as one of over 1200 licensed geoscience professionals in the state.

g. How does the program address student and faculty diversity in the context of its discipline?

WOU Earth Science is committed to providing educational opportunities to students from all backgrounds, and particularly under-represented groups in the science professions, including women, economically-disadvantaged youths, and first-generation college enrollees. Consistently over 60% of graduates from Western Oregon University are female, and that trend is equally reflected in the Earth Science student community. While great strides have been made nationally in terms of fostering the development of women scientists, female participation in the Physical Sciences, including Earth Science, still lag behind that of other disciplines (e.g. Biology and allied health professions). Earth Science faculty work directly with diverse populations in lower-division LACC electives, and actively foster a culture of acceptance and mentoring to all.

2. Faculty Resources

a. Please identify the program faculty by name, FTE, rank/title, and expertise/ specialization.

Tenured Faculty:

Dr. Jeffrey Myers (PhD Geology), 1.0 FTE, Professor of Geology, Specialties: historical geology, sedimentology, paleontology, geology of the Pacific Northwest, Earth system science.

Dr. Stephen Taylor (PhD Geology), 1.0 FTE, Professor of Geology, Specialties: geomorphology, environmental geology, hydrology, geographic information systems. Earth system science, industry background in hydrogeology.

Dr. Jeffrey Templeton (PhD Geology), 1.0 FTE, Associate Professor of Geology, Specialties: mineralogy, petrology, geochemistry, volcanology, Earth system science.

Adjunct/Non-Tenure Track Faculty:

Karen Brown (M.S. Geology), 1.0 FTE, Instructor, Specialties: Earth system science, mathematics, industry background in mining geology.

Don Ellingson (M.S. Science Education), 1.0 FTE, Instructor, Specialties: Earth system science, meteorology, military background in weather analysis.

Jeremiah Oxford (M.S. Geology), 1.0 FTE, Instructor, Specialties: Earth system science, research background in igneous petrology.

Grant Smith (M.S. Geology), 0.6 FTE, Instructor, Specialties: Earth system science, research background in soils geology and geoarcheology.

Phil Wade (M.S. Geology, science teaching credential), 1.0 FTE, Instructor, Specialties: Earth system science, science education, teaching methods, research background in active tectonics and curriculum development

(Note: In addition to above faculty, the Earth Science program also employs a 0.5 FTE Staff Laboratory Preparator, Ms. Julie Grammer)

b. Describe how the institution has maintained adequate qualified faculty members and staff members in relation to the program's growth since first approved.

Three full-time tenured faculty members and five fixed-term adjuncts support the Earth Science program. The core curriculum in the Earth Science degree track is based on the discipline specialties of the three tenured faculty members: (1) surface processes – environmental – applied geographic information systems (Dr. Taylor), (2) volcanology - petrology – geochemistry (Dr. Templeton), and (3) stratigraphy - sedimentology – paleobiology (Dr. Myers). The LACC Earth system science sequence (ES 104-105-106) uses a pedagogy in which concepts of chemistry, physics, and geology are presented in a real-world context of the Earth as an integrated system. As such, the fixed-term adjuncts that teach these courses possess degrees and/or extensive background in Earth Science. The Earth Science program also receives ancillary faculty support in the form of elective courses from physics, biology, and chemistry.

The Earth Science program has experienced a steady number of graduates (range: 4-8) since reorganization and a stable enrollment in upper division major-minor courses (range: 6-18, average: 11). Recent growth has occurred mainly in the 100-level Liberal Arts Core Curriculum (ES100 sequence) and upper division courses related to the Earth System Science minor. The growth rate in these areas is around 10% annually, approximately paralleling overall university trends. Ten-year average annual student credit hour production (SCH) in the program is ~8200, second in magnitude to Biology in the WOU Division of Natural Sciences and Mathematics (average annual ~9100 SCH over the same time period).

Adjunct instructors work part-time to full-time, dependent upon course enrollments and staffing needs. A full course-load equivalency for tenured faculty is 12 contact hours per term, while that of the adjuncts is 15. The sole duty of adjunct faculty is that of teaching and course management. Tenured faculty duties include teaching, discipline-specific scholarly activity, and service to the university, community, and profession. Of the three task areas, teaching occupies approximately 70% of the work load, followed by service and scholarship in decreasing order of time commitment. Regardless of the high teaching load, Earth Science faculty members, both tenured and adjunct, are actively engaged in research, professional development, and outreach.

The Earth Science program is adequately staffed to conduct the necessary business associated with the major and 100-200 level liberal arts service courses (average total annual

SCH ~8200), however there is an anomalously high over-dependence on adjunct faculty compared to other programs in the Division of Natural Sciences and Mathematics. The percent adjunct usage for the WOU Earth Science averages ~61%, while that for the Biology, Chemistry, and Mathematics programs averages ~30%. For the past five years, the Earth Science program has doggedly requested the addition of a new tenure line to rectify this imbalance, but budget limitations and other need areas have impelled the WOU administration to either freeze hiring or make alternative decisions for other programs. As in past years, the Earth Science leadership currently has a request to administration for a new tenure line to rectify the above imbalance, we are hopeful that the program will be able to advance forward in this regard at the next available opportunity.

3. Enrollment/Degree Production

a. How many student majors are currently in the program? To what extent have enrollment limitations been imposed?

The program supports 25 to 30 majors and 15 to 20 minors per year.

By necessity, some enrollment limitations have been imposed on select upper division classes that require specialized laboratory equipment, computer resources, and/or field trips that are limited by infrastructure capacity. For example ES301 Petrographic Microscopy is limited by access to 14 polarizing microscopes, ES341 Geographic Information Systems is limited by access to18 seats in the NS216 computer lab, ES302 Quantitative Methods is limited by access to two surveying instruments and 10 seats in the NS218A GeoData Processing Laboratory, and numerous field-based courses are limited by logistical access to one 12-passenger van per field trip.

Access to lower level ES100 and ES200 LACC introductory sections is limited to the 60-seat lecture room in NS101 and 24-seat lab space, or combinations thereof.

b. How many degrees have been awarded, per year, since program implementation? How do these figures correspond to the numbers projected in the program's original proposal?

Since program reorganization and major curriculum changes were implemented, WOU Earth Science has awarded a total of 42 degrees, averaging 5 to 6 per year, and ranging up to 10 if Integrated Science Education students are included in the analysis (Note: Integrated Science is a B.S. degree in Teacher Education, and contains a significant Earth Science content component in the first three years of the curriculum).

The following is a summary table comparing WOU Earth Science to other degree-granting programs in the Division of Natural Science and Mathematics during the review period:

Program	No. of Degrees	Range Per Year	Average Per Year	Standard Deviation
Biology	172	11 - 28	21.5	+/- 6.0
Chemistry	45	4 – 8	5.6	+/- 1.6
Earth Science	42	3 – 8	5.3	+/- 1.7
Mathematics	55	4 – 9	6.8	+/- 1.8

Analysis of Variance (ANOVA, F-test, T-test):

No significant difference exists at the 95% confidence level between average annual graduation rates of Chemistry, Earth Science, and Mathematics majors. A significant difference is detected at the 95% confidence level between Biology and the other three programs, collectively.

The Earth Science graduation rates have been consistent and stable since program reorganization, and are statistically comparable to those in other Physical Science and Mathematics programs at WOU. A modest 10 to 15% growth in annual graduation rates was predicted in the original proposal. The constancy reflected in the numbers of majors and graduates in the Earth Science program during the review period has been the subject of discussion in recent accreditation reports. The following is a summary dialogue of enrollment challenges facing the program.

Student enrollment and retention is an ongoing challenge at all levels of the University, including the Earth Science program. Overall, Earth Science 100-level course enrollments have increased, and the numbers of majors have been relatively steady. The 100-level enrollment trends in large part mirror that of the university as a whole. The most significant challenge to growth of the program is related to the general lack of geology/Earth Science content in high school curricula. In the state of Oregon, K-12 Students are only required (i.e. "tested") to take Earth Science in 8th grade. Geology-related course offerings at the high school level occur sporadically on a district-by-district (teacher to teacher) basis, and are not prominently required in the same way as chemistry, biology, or physics. This deficiency is notable given the prominent role that the geosciences are currently playing in the state and national dialogue about oil and gas resources, energy production, water supplies, sustainability, and global climate change. The lack of an advanced placement (AP) test in Earth Science and absence of an explicit Oregon teaching endorsement are exacerbating factors. The net result is that students receive comparatively minimal exposure to Earth Science or Geology in high school, with little understanding of career options or the importance of Earth Science to natural resources issues in the state of Oregon or nation. This deficiency propagates as students enter college, thus stagnating opportunities for freshman enrollment growth into the program (refer to Appendix B for supporting data on this topic). Through recruitment and professional outreach, WOU Earth Science faculty are working to rectify this deficiency at the state and national levels.

c. How has the program been made available for part-time, evening, weekend, and/or place-bound students?

The Earth Science program has a tradition connected to the long history of teacher preparation at Western Oregon University. As such, the program maintains late afternoon and evening course schedules designed to accommodate working education professionals, 500-level graduate students, and continuing-education needs of non-traditional students. Such scheduling patterns have existed for decades, back to the days of the Oregon College of Education (OCE), and this accommodation continues to the present. In addition to late afternoon and evening classes for working professionals, the program also consistently offers summer courses and workshops to accommodate varying student work schedules.

d. Is there evidence of regional or national need for additional qualified individuals such as the program is producing? Please specify.

The American Geological Institute (AGI, www.agiweb.org) is a nonprofit federation of 32 geoscientific and professional associations that represent geologists, geophysicists, and other Earth scientists. For the past five years, AGI has been working to collect data and conduct analysis of current trends in the national geoscience workforce. Their work culminated in a 2009 report entitled "Status of the Geoscience Workforce" in which they document the employment trends and training needs in the industry (AGI, 2009, http://www.agiweb.org/workforce/reports/2009-StatusReportSummary.pdf). AGI occupation fields include: (1) "Geoscientist" with subfields encompassing environmental science, hydrology, oceanography, atmospheric science, geology, geophysics, climate science, geochemistry, and paleontology; (2) "Geoengineering" with subfields including natural resource extraction, and geotechnical construction; and (3) "Geomanagement" that involves natural resource planning, management, analysis, and finance. The following excerpts from the AGI (2009) report summarize the current state of affairs and need for well-qualified Earth scientists at regional and national levels (refer to Appendix B for original AGI report figures and supporting data):

Present and Future Need:

"External threats from global competition and 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 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)."

"Because of economic cycles, more than 50% of the workforce needed in natural resource industries (including geoscience) in 10 years is currently not in the workforce. Additionally, because of the recent economic downturn, there are major constraints on immediate opportunities for new college graduates. However, the mid- to long-term issue remains unchanged, and in a new economy, may be even more exacerbated."

"Geoscientists will be expected to apply their skills from one field to the next as workforce demands change and society's needs shift… Across all fields, geoscientists will need to be equipped with a strong set of fundamental skills in science 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 professionals."

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 percent of geoscientists between 31 and 35 years of age is less than half of geoscientists between 51 to 55 years old."

"In petroleum companies, which typically offer the highest salaries of all geoscience industries, the supply of new graduates falls short of replacement needs. The number of young 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 over the next 20 years. By 2030, the unmet demand for geoscientists in the petroleum and energy industries is expected to be approximately 30,000 workers. Similar age demographics also exist for the mining industry and academia."

Salary Trends:

"Geoscience starting salaries are competitive with other science and engineering fields. Bachelor's geoscience graduates, generally employed in the environmental and hydrology industry, earn an average of $31,366 per year, compared to $31,258 for biologists and $32,500 for chemists. Master's recipients earn the highest starting salaries in the petroleum industry, with an average of $81,300 per year, compared to all other Master's graduates who average $46,873. Geoscience doctorates working in the private sector command an average salary of $72,600."

Other Evidence:

Other evidence of regional or national need for well-trained and qualified Earth Science graduates, such as those produced at Western Oregon University, is provided in Appendix A. – External Letters of Support and Appendix B. – Supporting Industry Data from the American Geological Institute (AGI, 2009) (attached at back of report).

4. Accreditation/Advisory Board

a. Is the program accredited? If so, by what agency? If not, will accreditation be sought?

The program is not accredited by an external agency, other than those services provided to the institution as a whole via the Northwest Commission on Colleges and Universities (NWCCU). Most of the program faculty are affiliated with the Geological Society of America (GSA), a professional academic organization that has been in existence since 1889. GSA has developed an exploratory working group to examine the viability of providing future external accreditation and certification to university geoscience programs, but to date, no formal accrediting body exists in the profession. If GSA, or a similar organization, develops an accreditation process, WOU Earth Science will actively investigate this procedure as an option.

b. Describe how the program curriculum stays current and responsive to changes within the related field.

The WOU Earth Science program remains current in the profession through dedicated professional service and scholarly engagement by the faculty. Earth Science faculty are in constant communication with industry professionals, potential employers, K-12 education leaders, and graduate school faculty across the nation. Through professional service, Earth Science faculty conduct continuous evaluation and quality assurance of program objectives to ensure that WOU students are adequately prepared for graduate school and the 21st century marketplace. In addition, this type of service work is a significant component of tenure and promotion incentives at WOU. Earth Science faculty energetically engage this work and are

making significant contributions in this regard. The following is a summary of faculty professionalism, service, and outreach conducted during the review period:

- Dr. Myers: President of the Oregon Academy of Sciences, regional co-director for science fair programming for the Junior Academy of Science (JAS), Junior Science and Humanities Symposium (JSHS), and Intel International Science and Engineering Fair (Intel ISEF), peer-reviewer for nationally-recognized grant programs and scientific publications.
- Dr. Taylor: Chair of the Oregon State Board of Geologist Examiners (OSBGE), Member of the Council of Examiners – Association of State Boards of Geology (ASBOG), Member Oregon State Department of Education K-12 Science Standards Review Panel, Member of the Academic and Applied Geoscience Relations Committee - Geological Society of America, peer-reviewer for nationally-recognized grant programs and scientific publications.
- Dr. Templeton: Director of the Program for Undergraduate Research (PURE) at Western Oregon University, WOU Faculty Liaison to the Council on Undergraduate Research (CUR), Campus Representative for Geological Society of America (GSA), peer-reviewer for nationally-recognized grant programs and scientific publications.

5. Other Resources

a. What is the current budget (present year) for this program?

Faculty-Staff Salaries and OPE = $561,900
Supplies and Services = $76,800

TOTAL = $638,700

Note: Assumes no step increases and frozen salaries from 2009, with no reduction in S&S this budget year.

b. To what extent were the anticipated annual program expenses and revenues realized since the program's initial approval?

The Earth Science program at Western Oregon University is efficient, cost effective, and consistently generates annual net positive revenues in the $300,000 to $500,000 range. The total cumulative revenues generated by the program since 2002 are estimated to total over $3M. Annual revenue and expense analyses for the review period are as follows:

YEAR	ACADEMIC YEAR STUDENT CR. HR[1]	TUITION PER CREDIT[2]	TUITION REVENUE[3]	LAB FEES[4]	TOTAL PROGRAM COST[5]	NET REVENUE[6] [Col 3+Col 4 – Col 5]
2002-03	8864	$83	$735,712	$10,100	$311,105	+ $434,707
2003-04	8794	$95	$835,430	$15,400	$347,155	+ $503,675
2004-05	8588	$96	$824,448	$25,900	$395,297	+ $455,051
2005-06	8032	$104	$835,328	$24,700	$406,037	+ $453,991
2006-07	7126	$104	$741,104	$29,300	$392,232	+ $378,172
2007-08	8034	$112	$899,808	$35,300	$473,440	+ $461,668
2008-09	8242	$117	$964,314	$35,800	$603,960	+ $396,154
2009-10	7819	$152	$1,188,488	$47,000	$638,700	+ $596,788
		EST. CUMULATIVE PROGRAM REVENUE 2002-2010 =				**+ $3,680,206**
		AVERAGE ANNUAL NET PROGRAM REVENUE =				**+ $ 460,025**

Explanation:

1 SCH = total annual student credit hour production = total course enrollment x credit hours per course. Enrollment information provided by College of Liberal Arts and Sciences and the WOU Office of Institutional Research, as derived directly from the Banner Database.

2 Average per credit tuition for each listed academic year is calculated from the published WOU catalogs assuming undergraduate rates, in-state residency, cumulative full-year tuition and incidental fees, and a full-time equivalency of 15-credits. The per-credit cost estimate is simplified for the given year, and does not factor in the sliding WOU "tuition promise" variable that was implemented in 2007. The published annual tuition rates used in the calculation are as follows: 2002-03 = $3720, 2003-04 = $4305, 2004-05 = $4332, 2005-06 = $4683, 2006-07 = $4683, 2007-08 = $5037, 2008-09 = $5283, 2009-10 = $6843.

3 Total tuition revenue is calculated by SCH x PER CREDIT TUITION COST. This item includes tuition and incidental fees, but not course-specific lab fees. Refer to column 4 for the latter.

4 Annual lab fee revenues are approximate and estimated from departmental budget records and cross-validation with published fee schedules and course enrollments in a given year.

5 Total program cost includes faculty salaries, OPE, and program-specific supplies and services expenditures for a given year. Annual salary and OPE information provided by WOU Business Office.

6 NET REVENUE = [(TUITION REVENUE + LAB FEES) – TOTAL PROGRAM COST]

Error Analysis:

The faculty-staff salary and OPE expenses account for the bulk of the program costs (~88%). These numbers are very well known and derived directly from institutional payroll records. The annual supplies and services costs are derived from departmental records and include time periods prior to 2004 in which the Chemistry, Earth Science, and Physics programs were combined into one budgetary unit. Also, some services are shared between departments in the Division of Natural Sciences and Mathematics, providing a gray margin in calculation. The S&S estimates have more uncertainty, but error variations are in the +/- $5000 range.

The bulk of the tuition revenue values are derived from high-enrollment ES100 LACC classes in which most students are freshman and sophomores. The annual per-credit tuition rates become less accurate after 2007, when the sliding "WOU Tuition Promise" was implemented. In this model, existing students are guaranteed locked tuition rates for the duration of their tenure at WOU, while incoming students may be subject to increased rates as warranted. As such, the Tuition Revenue estimates are generalized and simplified, but the total annual student credit hour production values are highly accurate (as derived directly from Banner archives). Error estimates for the tuition revenue values may range up to several 10's of thousands of dollars. As such, the overall Net Revenue error values are similarly in the 10's of thousands of dollars range. Given that the overall program revenues are estimated to range between +$300,000 to $500,000, the Earth Science program at WOU is clearly a profitable revenue generator, even if an unlikely worse-case error scenario of +/- $100,000 per year is considered. Since the salaries and OPE costs consume almost 90% of the budget, and their values are accurately known, the annual error bars associated with the net revenue calculation is most certainly less than +/- $50,000.

In sum, the cost-revenue analysis demonstrates that the WOU Earth Science program is economically viable and a solid return on institutional investments.

c. Have grants been generated through, or because of, this program? Please specify.

Over $1.09M in grant funds have been generated through the Earth Science program at Western Oregon University during the review period. The following is a bulleted summary of faculty-driven grant proposals and funding initiatives related therein (reverse chronological order; note: a significant percentage of these projects directly involve WOU undergraduate students as partners and research assistants):

- 2010, National Science Foundation; Transforming Undergraduate STEM Education (TUES) Grant: "Transforming Undergraduate Earth System Science Curricula through Inquiry-Based Learning-for-Use Modules" (Templeton PI, Taylor and Wade, Co-PI, $249,657, review pending)
- 2010, NASA Oregon Space Grant: "Comparative Hydrogeomorphic Analysis of Western Oregon Watersheds Using Airborne Laser Swath Altimetry (LIDAR)" (Taylor faculty supervisor for B. Snook, WOU Student, $5000, review pending)
- 2010, Meyer Memorial Trust and Oregon Watershed Enhancement Board (OWEB) Special Investments Partnership Program: "Hydrogeologic Assessment and Aquifer Characterization at the Luckiamute State Natural Area" (Taylor PI with WOU student assistants, $25,000, review pending)
- 2010, WOU Faculty Development Research Grant: "Description of an Articulated Fruiting Head of *Securidaca (Polygalaceae)* from the Latest Eocene Badger's Nose Flora of NE California" (Myers, PI, $2500)
- 2010, Contract Agreement Upper Nehalem Watershed Council: "GIS Analysis and Results from Rapid Bio-Assessment (RBA) and Limited Factors Analysis (LFA) in the Upper Nehalem Watershed, Tillamook County, Oregon" (Taylor PI with WOU student assistants, $17,000)
- 2010, Western Oregon University Faculty Development Fund: "Electron Microprobe Analysis of Pleistocene Ash-flow Tuffs at Newberry Volcano, Oregon: Fine-scale Compositional Constraints on the Evolution of a Continental Silicic Magma System" (Templeton PI, $2300)
- 2010, U.S. Environmental Protection Agency, Greater Research Opportunities (GRO) Fellowship for Undergraduate Environmental Study: "The Distribution and Occurrence of Nitrate in Groundwater Supplies of the Mid-Willamette Valley: Implications for Water Resource Management in the Monmouth-Independence Area, Oregon" (Taylor faculty supervisor for K. Dana, WOU Student, $45,100)
- 2010, NASA Oregon Space Grant: "Land Cover Analysis Utilizing Aerial Photography, Remote Sensing and Geographic Information Systems: Application to Riparian Zones in the Mid-Willamette Basin, Oregon" (Taylor faculty supervisor for R. Stanley, WOU Student, $5000)
- 2009, U.S. Department of Justice: "Application of Spatial Statistics to Latent Print Identifications: Towards Improved Forensic Science Methodologies" (Taylor Co-PI with E. Dutton and project team P. Aldrich, B. Dutton, $685,800)

- 2008, Cascades Volcano Association: “Geomorphic Analysis of Late Quaternary Cinder Cones at Newberry Volcano, Central Oregon: Landform Evolution and Eruptive History in a Back-Arc Setting” (Taylor PI, $500)
- 2007, Oregon Department of Geology and Mineral Industries Undergraduate Research Stipends: “Seismic Preparedness and Hazards Mitigation at Western Oregon University (Myers, PI, $1000).
- 2007, Western Oregon University Faculty Development Fund and Foundation: “Tertiary Paleobotany Studies in Western and Central Oregon” (Myers, PI, $2800)
- 2007, National Science Foundation-Research Opportunity Award: “The Influence of Geomorphic and Anthropogenic Processes on Decadal-Scale Sediment Yield in the Western Cascades, Oregon” (Taylor Co-PI with F. Swanson, $13,000)
- 2007, Western Oregon University Faculty Professional Development Grant: “The Influence of Forestry Practice on Geomorphic Processes in Oregon (Taylor PI, $2100)
- 2007, Western Oregon University Faculty Development Research Grant: “Detailed Geochemical Study of Pleistocene Ash-Flow Tuffs at Newberry Volcano, Oregon: Constraints on the Evolution of a Silicic Magma System” (Templeton PI, $2100)
- 2005-2006, Junior Science and Humanities Symposium Organizational Grant (Myers Co-PI with A. Schepige, and A. Courtney, $16,900)
- 2005-2006, Northwest Invasive Weed Management Partnership: “Reconnaissance Survey of Japanese Knotweed Distribution in the Luckiamute River Basin” (Taylor Co-PI with B. Dutton, $2000)
- 2005-2006, Oregon Community Foundation Grant: “Geomorphic and Anthropogenic Influences on the Distribution of Invasive Plant Species in the Luckiamute Watershed” (Taylor Co-PI with B. Dutton, Year 2 Supplemental, $5000)
- 2005, Western Oregon University Faculty Development Research Grant: “Petrologic Investigation of the Tepee Draw Tuff and Related Units at Newberry Volcano, Oregon: Constraints on Zoning and Configuration of the Pre-eruptive Magma Chamber” (Templeton PI, $3000)
- 2004-2006, Center for Water and Environmental Sustainability (OSU/U.S. Geological Survey): “Hydrogeomorphic Analysis of the Luckiamute Watershed, Central Coast Range, Oregon: Integrating Applied Watershed Science with Undergraduate Research and Community Outreach” (Taylor PI, $15,000)
- 2004-2005, Western Oregon University Foundation Grant: “Spatial Analysis of Cinder Cone Distribution at Newberry Volcano” (Taylor PI, Student Research Grant, $1000)
- 2004-2005, WOU Center for Teaching and Learning Research Grant: “Morphometric Analysis of Cinder Cones at Newberry Volcano” (Taylor Co-PI with J. Templeton, $800).
- 2004-2005, Western Oregon University Faculty Professional Development Grant: “Geomorphic and Anthropogenic Influences on the Distribution of Invasive Plant Species in the Luckiamute Watershed” (Taylor Co-PI with B. Dutton, $6000)
- 2004, Western Oregon University Faculty Development Fund and Foundation: “Tertiary Paleobotany Studies in Western and Central Oregon” (Myers, PI, $3000)

- 2003-2004, Junior Science and Humanities Symposium Organizational Grant (Myers Co-PI with A. Schepige, and A. Courtney, $33,800)
- 2003-2004, Oregon Community Foundation Grant: “Geomorphic and Anthropogenic Influences on the Distribution of Invasive Plant Species in the Luckiamute Watershed” (Taylor Co-PI with B. Dutton, $7000)
- 2003, Western Oregon University, PT3 (U.S. Dept. of Education) Student Technology Associate Program: “Development of an Earth System Science Digital Image Library” (Templeton PI with student assistant, $500)
- 2002-2005, National Science Foundation, Course, Curriculum, and Laboratory Improvement-Adaptation and Implementation (CCLI) Grant: “Actively Engaging Undergraduates in Geologic Problem Solving by Integrating Petrographic Microscopy and Digital Image Analysis into an Earth Systems Science Curriculum” (Templeton PI, $80,900)
- 2002-2003, Western Oregon University, PT3 (U.S. Dept. of Education) Faculty Grant: “Integrating Electronic Measurement Technologies into the General Science Laboratory Curriculum: Enhancing the Preparation of Pre-Education Majors at Western Oregon University” (Templeton and Taylor co-PIs, $5,000)
- 2002, DAAD German American Academic Exchange Service Fellowship: “Paleobotanical Research Exchange at the Senckenberg Museum, Germany” (Myers PI, $5000)
- 2002, Evolving Earth Foundation: “Systematics of Conifer Taxa in the Oligocene Willamette Flora, Western Oregon” (Myers faculty sponsor for student S. Burgett, $2100)
- 2002, Western University Faculty Development Grant: “Tertiary Paleobotany Studies in Western and Central Oregon” (Myers PI, $3000)
- 2002, Western Oregon University, Faculty Professional Development Grant: “Geomorphic Controls on Sediment Transport Efficiency in the Luckiamute Watershed, Polk and Benton Counties Oregon” (Taylor PI, $3000)
- 2002, Western Oregon University, PT3 (U.S. Dept. of Education) Faculty Grant: “A Practical and Uniform Microscope Technology Platform for K-12 Educators (Myers PI, $8000)
- 2002, Oregon Collaborative for Excellence in the Preparation of Teachers (NSF-funded initiative in state of Oregon): “Write ON! Retreat; Earth System Science – An Innovative Approach to Teaching Undergraduate General Science” (Templeton PI, $1000)
- 2002, Digital Library for Earth System Education (NSF-supported geoscience education project): “Invited Participant–Third Annual Meeting of DLESE at Cornell University, Ithaca, NY, June 29-July 2, 2002” (Templeton, $335)
- 2002, Western Oregon University Faculty Development Grant: “Digital Image Analysis of Macroscopic and Microscopic Textures in Ash-Flow Tuffs at Newberry Volcano, Oregon” (Templeton PI, $3000)

- 2001-2002, Western Oregon University, PT3 (U.S. Dept. of Education) Faculty Grant: “Integrating Digital-Based Pedagogy into the Earth and Physical Science Curriculum at Western Oregon University: Modeling Best Practices for Education Majors through Enhanced Classroom Technology” (Templeton, Taylor, and Myers co-PIs, $28,000)
- 2001-2002, Junior Science and Humanities Symposium Organizational Grant (Myers Co-PI with A. Schepige, and A. Courtney, $33,800)
- 2001, National Science Foundation / Oregon Collaborative for Excellence in the Preparation of Teachers (OCEPT): “Development of an Interdisciplinary Science Summer Institute for the Preparation of Elementary-Middle School Science Teachers (Co-PIs: J.A. Myers, S. Taylor, B. Dutton, P. Poston, $8000)
- 2001, Western Oregon University, PT3 (U.S. Dept. of Education) Faculty Grant: “Integrating Geospatial Technology into a Natural Science Summer Institute Course” (Co-PIs: J. Myers, S. Taylor, B. Dutton, and P. Poston, $4500)
- 2001, Western Oregon University, PT3 (U.S. Dept. of Education) Faculty Grant: “Development of a Virtual Integrated Science Field Trip Module (Myers Co-PI with A. Courtney, and A. Schepige, $5000)
- 2001, Western University Foundation Grant: “Tertiary Paleobotany Studies in Western and Central Oregon” (Myers faculty sponsor student J. Cameron, $1,000)
- 2001, Western Oregon University Faculty Development Major Project Grant: “Volcanology and Petrology of the Pleistocene Ash-Flow Tuffs at Newberry Volcano, Oregon” (Templeton PI, $2,600)
- 2000-2002, National Science Foundation / Oregon Collaborative for Excellence in the Preparation of Teachers (OCEPT): “Development of an Earth System Science Curriculum for Pre-Service Teachers at Western Oregon University” (Templeton, Schepige, Matson, Taylor, $9,000)
- 2000-2001, Murdock Trust Partners in Science Research Grant: “Geomorphic Hazards Assessment in West Central Oregon” (Taylor PI, $15,000)

d. Evaluate the adequacy of other resources necessary to support this program (e.g., library, computer equipment, other equipment, facilities, labs).

The technologic hub of the Earth Science program is the Geo-Data Processing Laboratory in rooms 218A and 216A of the Natural Sciences Building. The lab currently supports ten PC-workstations, color and laser print stations, a large-format (36 inch) color plotter, a set of digitizing tablets, digital image scanners, and a collection of advanced geoprocessing-GIS software and databases (e.g., ArcGIS, IDRISI image processing, surfer/grapher, rockware, groundwater-river modeling tools, state digital map and photo data). The lab is used for student support of upper-division courses, for faculty-student research, and for community development projects. Examples of the latter include compilation of spatial datasets for the Luckiamute Watershed Council, the Upper Nehalem Watershed Council, and the City of Independence (Ash Creek Recreation Project). The GIS software initiative in the Earth Science program also served as the catalyst for a campus-wide deployment involving University Computing Services, the Student Technology Fee Committee, and the College of Education. The NS218 geology laboratory is fully equipped with multimedia instructional technology.

The Earth Science program, along with the Division of Natural Sciences and Mathematics, has greatly expanded our technology capacity in the past 8-10 years. Technology-based resources that have resulted from these efforts include NS101 multi-media presentation technology, NS 017 electronic data instrumentation, updated PC workstations, software resources, remodeled NS017 laboratory space, surveying technology, petrographic / binocular microscopes, digital imaging systems, field laptops, digital cameras, and surveying equipment. Funds for this expansion were derived from internal supplies and services budgets, student lab and technology funds, administrative opportunity funds, and external grant funding (e.g., National Science Foundation, and U.S. Dept. of Education; refer above for grants-related accomplishments in this area). In addition to dedicated Earth Science space, students and faculty work collaboratively with colleagues in Chemistry and Biology, readily sharing facilities as needed. Through much hard work and persistence by faculty over the past decade, the facilities necessary to support this program are adequately scaled to achieve success.

The WOU Library has recently expanded electronic journal holdings, while the existing regional alliance and interlibrary loan system is excellent. Within 24 to 48 hours, Earth Science students and faculty have access to any journal article published in the world. The electronic library access and service at WOU is more than adequately scaled to serve the needs of the Earth Science program.

6. Student Outcomes

a. Describe the program's current student learning outcomes and the means by which these are assessed and used to improve the curriculum and instruction.

Key student learning outcomes include: (1) demonstrate knowledge of the physical, chemical and biological processes operating in the Earth system; (2) develop proficiency in using technology-enriched methods to solve geologic problems and communicate results; and (3) gain experience in conducting inquiry-based science in laboratory and field settings.

Formative assessment of Earth Science students is performed on a course-by-course basis with a range of methods including inquiry-based lab exercises, writing assignments (informal short essays and longer-form expose), short active-learning exercises, oral group presentation, multi-media work samples, and objective quizzes and exams (essays, multiple choice, true/false, lab practicum). The style and level of formative assessment tool varies according to instructor and course content. Some courses are based on quantitative problem solving and computer applications (e.g. ES 302 Quantitative Methods, ES 321 Structural Geology, ES 492 GIS Applications, ES 476 Hydrology), others focus on lab and field techniques (e.g. ES 301 Petrographic Microscopy, ES302 Quantitative Methods, ES 450 Petrology, ES392 Sedimentary Geology), still others on written/oral multi-media presentation (e.g. ES407 Senior Seminar, ES 473 Environmental Geology, ES 453 Geology of the Pacific Northwest, ES 454 Volcanology).

Hard skill development in our program focuses on proficiency in quantitative techniques, technology applications, multi-media communication, and problem solving through application of the scientific method. Geoscience curriculum by its very nature is activity-based and involves outdoor adventure, field trips, hands-on lab exercises, geological conundrums, and problem-solving sets. All of these active learning strategies are employed as formative assessment tools to varying levels on a course-by-course basis in our program.

b. Briefly describe any employment related experiences required in this program (e.g., internship, student teaching, practicum, clinical experience) that document students' learning outcomes. What have the faculty learned from reviewing these results that has improved the program?

There are currently no required employment-related experiences related to this program, however, service learning, professional placement, and research experiences are extensively encouraged on a case-by-case basis depending on student skills and availability. As documented in section 5c above, Earth Science faculty have generated numerous grant-funded projects since 2001, the majority of which have actively engaged WOU undergraduates as research assistants and collaborative partners. One of the advantages of supporting an undergraduate-focused, bachelor's level program, is that students receive close one-on-one attention and direct mentoring from their faculty. This type of mentoring occurs with a depth and focus that is simply not possible at larger-scale Research-I Institutions.

c. Describe any senior projects, capstones, or exit requirements in the program that document students' learning outcomes. How have the results been used to improve the program?

Senior Seminar (ES 407) serves as the degree-program assessment tool and capstone evaluation for majors preparing to graduate from the Earth Science program. Students are required to complete ES 407 during the final term of their senior year. The objective of the course is for students to conduct in-depth study and research on relevant topics in the Earth Sciences, by requiring students to draw on information from the full range of major courses they have completed during their time as an undergraduate. A campus-wide seminar session is conducted at the end of the term, providing students with an opportunity to demonstrate proficiency in the Earth Science content areas. Seminar sessions are modeled after theme sessions at professional meetings, and each student is required to give an oral presentation. Senior Seminar employs inquiry-based, work sample techniques to demonstrate student proficiency in Earth Science content areas. Students are required to satisfactorily complete the capstone course to graduate from the program. Since 2006, senior seminar has been integrated into the university-wide Academic Excellence Showcase event sponsored by the Phi Kappa Phi honor society and the Program for Undergraduate Research Experience (PURE). The Showcase provides a robust platform for students to present the results of their Senior Seminar projects and has been well received by students, faculty, administrators, and parents.

In conjunction with seminar work-sample method described above, a capstone standardized exit exam was initially conceived and implemented during Spring Term 2005. It is a work in progress and is actively being developed at the time of this writing. The exit exam is based on national standards established by the Educational Testing Service and was formerly part of the Geology Graduate Record Exam used to evaluate entrance qualifications into graduate school. While ETS no longer offers the GRE Geology exam, Earth Science faculty have adapted the question sets from two editions of the ETS Geology Preparation Manuals (1st ed. 1988, 2nd ed. 1996). Exam questions were captured in digital format and imported into the Moodle class management system for online testing and automated scoring. Exit exam procedures are modeled after those of the GRE. Students are provided practice exams and instructional materials to prepare for the test. Exam results are scored and ranked in comparison to national standardized results from Geology/Earth Science graduates in the U.S. during the late 1980's and mid 1990's.

In addition to GRE-style procedure above, Earth Science faculty are also exploring other standard exit exam tools. One is the education-based PRAXIS exam for teaching candidates with an emphasis in Earth and physical science content. Several recent Earth Science graduates completed this exam for entrance into the Masters of Art in Teaching program at WOU. The other summative assessment tool that is currently being evaluated is the Fundamental Geology Exam that forms part of the Oregon State Board of Geologist Examiners (OSBGE) professional licensing process. The state of Oregon utilizes a nationally standardized process for professional licensure of engineers, geologists, engineering geologists, landscape architects, and land surveyors. Several graduates have taken the exam on a case-by-case basis, but the primary limitation to wholesale adoption is the cost required of students to apply for the initial OSBGE GIT license and fundamentals exam (currently ~$300).

Results of formative and summative assessment strategies described above have been used to guide curriculum changes both at the course and program levels. Example of assessment-driven course changes include: (1) development of applied microscopic problem solving exercises in ES301, (2) development of field-based research modules in ES392, (3) development of software-based problem solving in ES302, (4) inclusion of a themed-based group research projects in ES473. Programmatic changes during the review period resulting from assessment include expanding options in the mathematics requirement, compacting a three-term ES301-302-303 geotechniques sequence into a more efficient ES301-302 combination, and development of new courses in geographic information systems, volcanology and seismology, and paleobiology.

d. Are there professional licensure exams for this degree? If so, how have students performed (e.g., how many students took the exam; what percentage passed)?

As stated above, completion of the Earth Science degree qualifies graduates to begin the process of professional licensure as registered geologists (RG) in the state of Oregon. Oregon has laws that govern the public practice of geology to “safeguard the health, welfare, and saftety of it’s citizens and environment”. These are modeled after similar laws governing the practice of Professional Engineering. The steps in the RG licensing process involves: (1) completion of a minimum of 45 quarter-hours in university Geology/Earth Science course work, (2) a passing score on the nationally-standardized Fundamental Geology (FG) exam, (3) five years work experience as a Geologist-in-Training (GIT), under the supervision of licensed RG, and (4) a passing score on the nationally-standardized Professional Geology (PG) exam. With additional training and experience, licensed RG’s may also apply for a specialty license as a Certified Engineering Geologist (CEG). The exams are compiled and managed nationally by the Association of State Boards of Geology (ASBOG), a confederated association of 30 states that promulgate geology licensing laws.

WOU Earth Science graduates who enter the professional workforce are encouraged to start the registration process upon graduation. Starting in 2006, WOU Earth Science faculty actively engaged this process through outreach partnership with the Oregon State Board of Geologist Examiners (OSBGE). Since this initiative began, a total of 6 WOU Earth Science alumni have taken the Fundamental Geology (FG) exam and all have met the passing requirements.

e. What evidence does the program have about employment and/or further professional or graduate level activities of program completers?

Western Oregon University currently does not have a systematic post-baccalaureate assessment methodology or centralized alumni tracking system, but it is part of the university accreditation plan. Until a systematic institutional procedure is in place, the Earth Science program engages an *ad hoc* alumni-survey approach based on informal correspondence and networking between graduates and faculty (e.g., emails, phone calls, requests for recommendation, campus visits, etc.).

A total of 63 WOU Earth Science graduates were informally tracked for the period extending from 1999-2010. The following is a breakdown of post-baccalaureate employment outcomes: No Information Available = 22.2%, Science Education = 11.1%, Geotechnical-Environmental-Water Resources-Mining-Construction = 27.0%, GIS-Geospatial Technology = 6.3%, Other-Retail-Miscellaneous = 33.3%. Based on the above data, approximately 45% of Earth Science graduates are confirmed to have engaged gainful employment as a professional geoscientists or science educator's, 33% are working in other sectors of the economy, and no information is available for 22% of the population. In addition, approximately 10% of WOU Earth Science graduates continue on to graduate school in science or education, in direct alignment with standard student achievement measures and grade distribution curves (i.e. most of the top academic achievers, "A+" students" are motivated to continue on to graduate school).

7. Other Information

a. What else would you like to tell us about your program that was not addressed in this review?

Concluding Statement: The WOU Earth Science program is on track, meets the original proposed expectations, and should continue on its current trajectory of academic success. The strengths and institutional contributions of the program include:

(1) A faculty dedicated to high quality teaching, scholarship, and service;

(2) Stable course enrollments and consistent production of program graduates, comparable to other Physical Science and Mathematics programs at WOU;

(3) A program dedicated to the Liberal Arts science curriculum and service to a growing LACC university population;

(4) An efficient, cost-effective and profitable program that consistently generates average net tuition revenues totaling $450,000 per year and a combined sum of $1.09M in grant funding since 2001; and

(5) A program that produces well-trained graduates with fundamental skills in science and mathematics that can be transferred across industrial sectors and applied to state and national needs in the areas of science education, natural hazards mitigation, resources management (water, minerals, energy, ecological services), geospatial technology, geotechnical/construction and environmental sustainability.

Please refer to Appendix A and Appendix B (attached at back) for further supporting evidence. For more information or follow-up review, contact Dr. Steve Taylor, Professor of Geology, Chair – Division of Natural Sciences and Mathematics, Western Oregon University, email: taylors@wou.edu, web: www.wou.edu/taylor, work phone: 503-838-8398, cell: 541-760-9216.

APPENDIX A. – EXTERNAL LETTERS OF SUPPORT

College of Liberal Arts and Sciences
Department of Geology Scott F. Burns

Post Office Box 751 503-725-3389 tel

Portland, Oregon 97207-0751 503-725-3025 fax

burnss@pdx.edu

July 15, 2010

Oregon University System

Provost, Western Oregon University

Chair, Division of Natural Sciences and Math, WOU

Dear Evaluation Committee:

It gives me great pleasure to write a letter of support and evaluation for the Earth Science Program at WOU for their 5 year review. Dr. Steve Taylor asked me to do the review because of my background. I know the program well and know all three tenured faculty members well. I have interacted with the program for 20 years. I have had the pleasure of doing program reviews before, first as an Associate Dean at PSU in the College of Liberal Arts and Sciences and then as an outside reviewer for the California State University System for their geology programs. I have been teaching 40 years at the university level and have been the department chair of departments at three different universities.

The program plays a very important role in Oregon in many ways. We have three geology and earth science programs at the large universities, but this program at WOU is the only remaining earth science program at any of the regional universities. Students need to have a choice of a regional university to study earth sciences. It has a strong program with over 35 majors per year with 13 minors per year and graduating 6-12 per year. Those numbers match many of the Big Ten University programs! This program at a regional university is very important.

The program also is intimately involved with the other programs at WOU in the sciences: environmental sciences, geography, chemistry, physics, science education, and more. The program provides crucial classes to support those programs. The SCH levels for the earth science faculty are huge – over 400 SCH/faculty/year. A lot of those hours are involved in interdisciplinary work. The earth science component of those programs is crucial to excellence.

I do not know how the faculty do it, but they all carry on research programs in addition to heavy teaching loads. This affords the students chances to do undergraduate research – a sign of a quality program. Hats off to the faculty for doing this. This is a real strength of the program. The quality of the research of the faculty is really good, too. The faculty at WOU also interact with faculty at other OUS institutions which is important.

Another important factor in the program is the faculty to student ratio in the upper division courses. It is low so the students get really quality teaching and direction in research.

I love that the program is so involved in teaching about environmental problems, natural resources, environmental quality, sustainability, and real world applications of earth science. This really is important, especially in interdisciplinary courses for creating an informed citizenry.

Another strength of the faculty is their outreach into the community, especially the professional community. With their huge teaching loads, Steve Taylor finds time to be a very important member of the State Board of Geologist Examiners. He also gets his students out to professional meetings each year of the Association of Engineering Geologists in Portland in the spring. Jeff Myers has been president of the Oregon Academy of Sciences and has done an awesome job there. He even put on the annual meeting of the group (a large undertaking) either once or twice.

They also have a program that is very technology based. Keeping their students up with the latest in technology is so important. One strength of the program is their GIS (Geographic Information System) work which is becoming a very important part of working professionally in the earth sciences.

I got a chance to review their earth science BA and BS program and it looks very strong. We have a similar program at PSU in addition to our geology BA and BS.

If there is any way to decrease the teaching load of the faculty, it would be great. It is incredibly high for a faculty that is also involved in research. A 36 FTE load per year is really high.

I also got a chance to review the self evaluation of the program which was well constructed and stressed many important things. This is a strong program with great leadership and a strong faculty. It is doing a great job at WOU. It is serving OUS well as well at the state of Oregon. Congratulations to the faculty and staff of the program for a job well done.

If you have any questions, please contact me at 503-725-3389 or burnss@pdx.edu.

Sincerely,

Scott F. Burns,

Professor of Geology,

Dept. of Geology, PSU

Oregon
Theodore R. Kulongoski, Governor

Department of Geology & Mineral Industries
Administrative Office
800 NE Oregon Street #28, Suite 965
Portland, OR 97232
PHONE 971-673-1555
FAX 971-673-1562

July 20, 2010

Dr. Kent Neely, Provost
Western Oregon University
Monmouth, OR 97361

Re: WOU Earth Science Program

To whom it may concern:

As the State Geologist of Oregon and the Director of Oregon Department of Geology and Mineral Industries, I am writing in support of the Western Oregon University Earth Science Program. I applaud the goal of the program to produce B.S and B.A. degreed students with academic credentials sufficient to follow a path to professional geoscientists. Oregon's geology is complex, beautiful, and hazardous and we need practical geoscientists working in the industry to protect our citizens and develop our resources in a safe manner. The WOU Earth Science Program has recognized this academic need and evolved their program to answer it.

Further, having an undergraduate degree in earth sciences can prepare a student for a variety of higher degree directions. Students need a firm background in scientific inquiry, empirical observational skills, and a comfort with integrating multiple sciences into problem solving if they are considering careers in environmental sciences, natural resource law, water quality and quantity and human health.

Please do not hesitate to contact me if you have any questions.

Many regards,

Vicki S. McConnell, Ph.D., R.G.
Oregon State Geologist

cc: File

Oregon
Theodore R. Kulongoski, Governor

State Board of Geologist Examiners
707 13th Street SE, #260
Salem, OR 97301
Phone: 503.566.2837
Fax: 503.485.2947
Website: www.oregon.gov/osbge

July 28, 2010

Dr. Kent Neely, Provost
Western Oregon University
Monmouth, Oregon 97361

Subject: WOU Earth Science Program Five-Year Review

Dear Dr. Neely:

The Oregon State Board of Geologist Examiners (Board) is charged with regulating the public practice of geology in Oregon. The Board understands that the Earth Science program at Western Oregon University (WOU) is scheduled for a five-year review by the Oregon University System. The Board would like to take this opportunity to express its ongoing support for WOU's Earth Science program and the greater geologic profession in the State of Oregon.

Oregon provides unique natural and geologic environments which are enjoyed by its residents and visitors alike. However, these environments can pose risks to the public that must be understood and appreciated so that enjoyment of Oregon's natural resources can be done in relative safety. In addition, as our population grows, there is increasing pressure to develop in hazardous areas, such as those that can be impacted by earthquakes, landslides, volcanoes, flooding and erosion. Changes that result from ongoing global warming can also increase hazards in areas that were previously at lesser risk. Our reliance on natural resources, including renewable and non-renewable resources, also grows as our population expands.

For these reasons, it is essential that our residents have a good understanding of the natural and geologic processes that impact our State. Strong undergraduate Earth Science programs, such as that provided at WOU, are needed to ensure that Oregon has an adequately educated population to deal with future environmental issues. Whether students pursue a professional career in Earth Science, or simply use their liberal arts education for personal growth, having a population well educated in geology will benefit Oregon through better public policy development.

The Board strongly supports WOU's Earth Science program, encourages the university to continue investing in this area, and provide further opportunities for students to learn about Oregon's natural environments. The Board licenses over 1200 geoscience professionals in the state, WOU Earth Science is making valuable contributions to our industry.

Sincerely,

Chris Humphrey, RG, CEG
Vice Chair, Oregon State Board of Geologist Examiners

APPENDIX B. – SUPPORTING INDUSTRY DATA FROM THE AMERICAN GEOLOGICAL INSTITUTE (AGI, 2009)

American Geological Institute
GEOSCIENCE CURRENTS
No. 19
11 May 2009

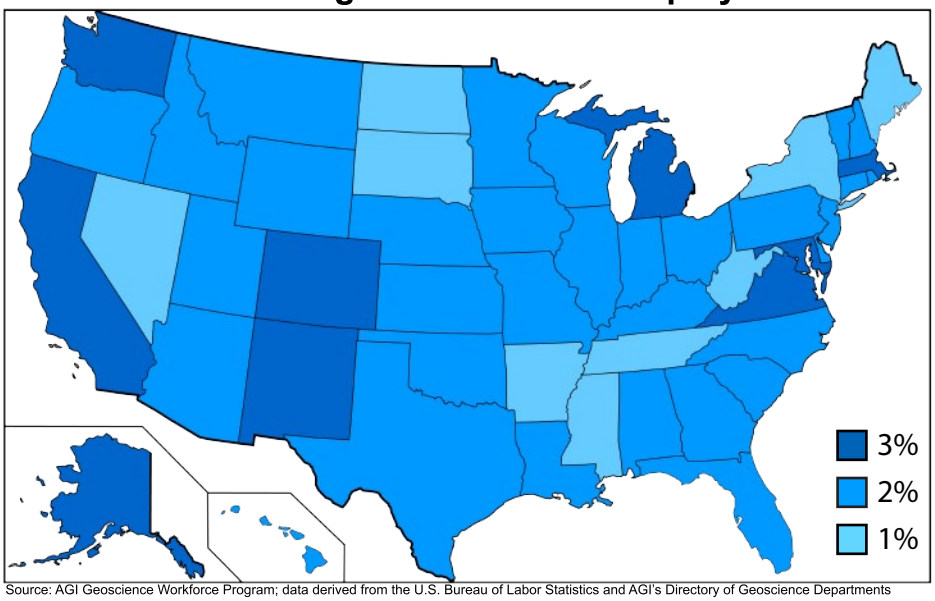
Geoscience and Science & Engineering Employment by State

Science and engineering employment comprises 1 to 3 percent of total state employment. On average, geoscience employment comprises 12 percent of science and engineering employment. States with the highest geoscience employment (as a percentage of total state science and engineering employment) are: Wyoming, Alaska, New York, Montana, South Dakota and Nevada.

States with the highest science and engineering employment as a percentage of total state employment:

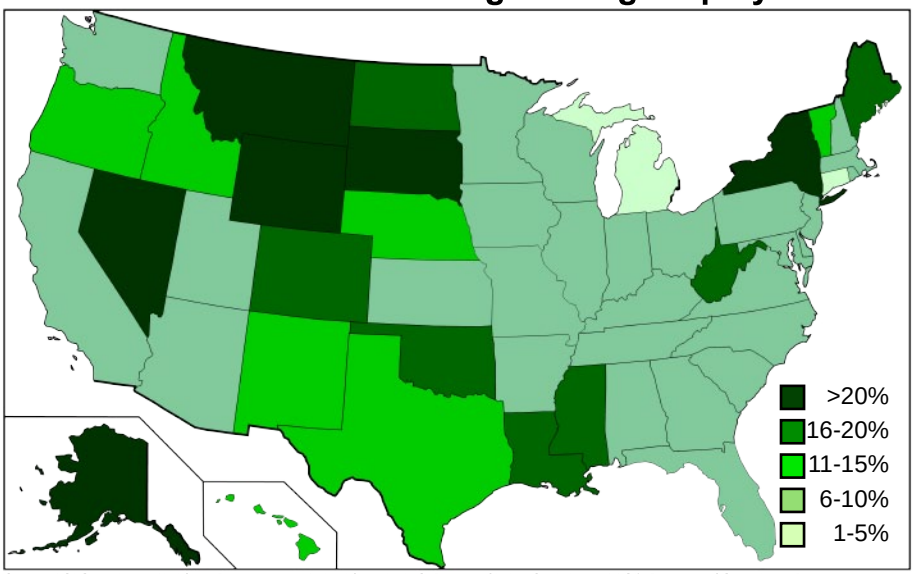
District of Columbia	5%
Arkansas	3%
California	3%
Colorado	3%
Massachusetts	3%
Maryland	3%
Michigan	3%
New Mexico	3%
Virginia	3%
Washington	3%

Science and Engineering Employment as a Percentage of Total State Employment



Source: AGI Geoscience Workforce Program; data derived from the U.S. Bureau of Labor Statistics and AGI's Directory of Geoscience Departments

Geoscience Employment as a Percentage of Total State Science and Engineering Employment



Source: AGI Geoscience Workforce Program; data derived from the U.S. Bureau of Labor Statistics and AGI's Directory of Geoscience Departments

States with the highest geoscience employment as a percentage of total state science and engineering employment:

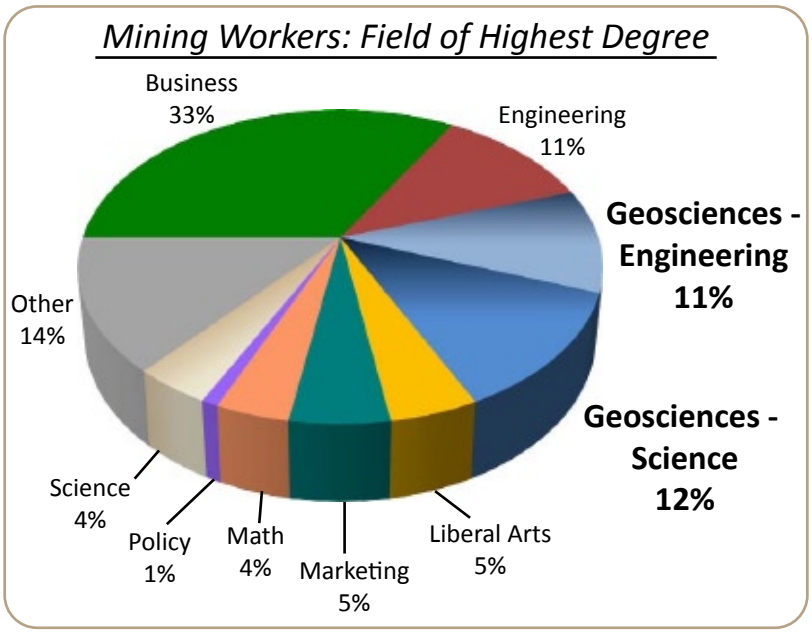
Wyoming	41%
Alaska	32%
New York	28%
Montana	25%
South Dakota	24%
Nevada	21%

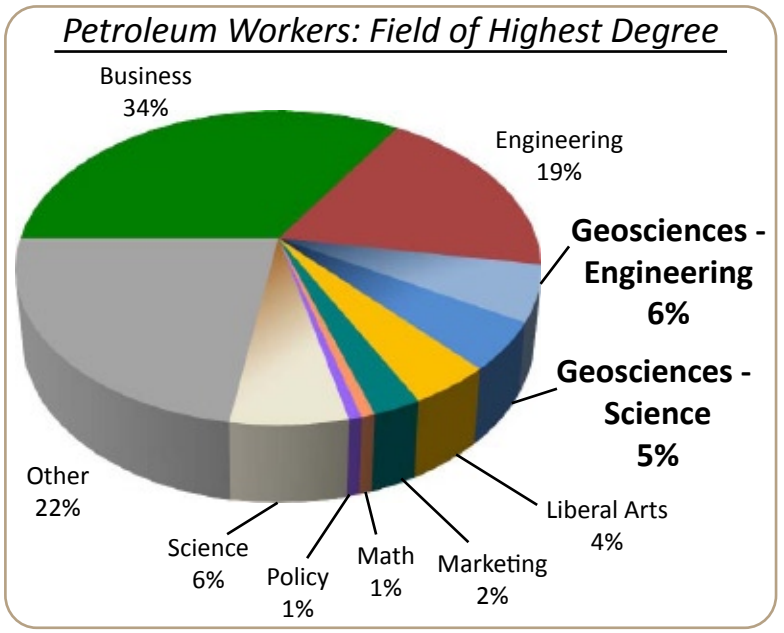
- Leila Gonzales

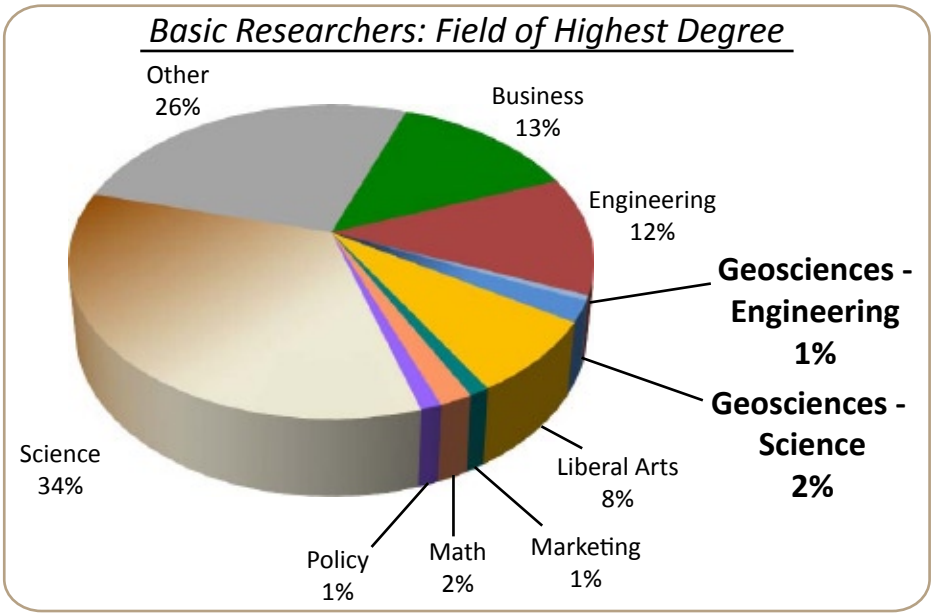
American Geological Institute
GEOSCIENCE CURRENTS
No. 10
17 June 2008

College Graduate Workers in the Mining, Petroleum, and Research Industries

College graduate workers with their ***highest*** degree in the geosciences comprise 23% of the mining industry, 11% of the petroleum industry, and 3% of the basic research industry. If a worker has multiple degrees, only their highest degree (bachelor's, master's, doctorate, or professional) is represented in these charts.







- Leila Gonzales

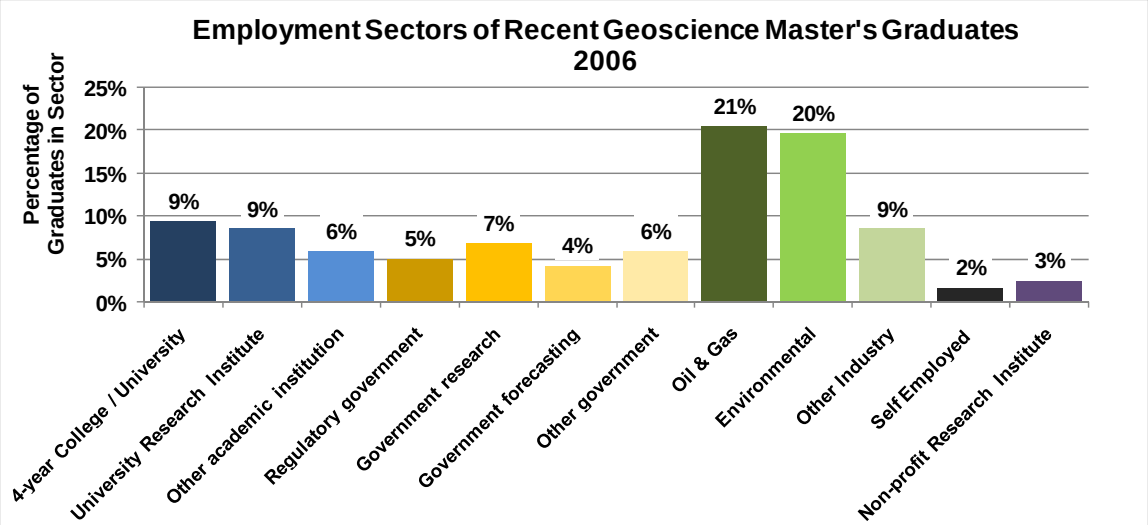
Source: National Survey of College Graduates, 2003

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).*

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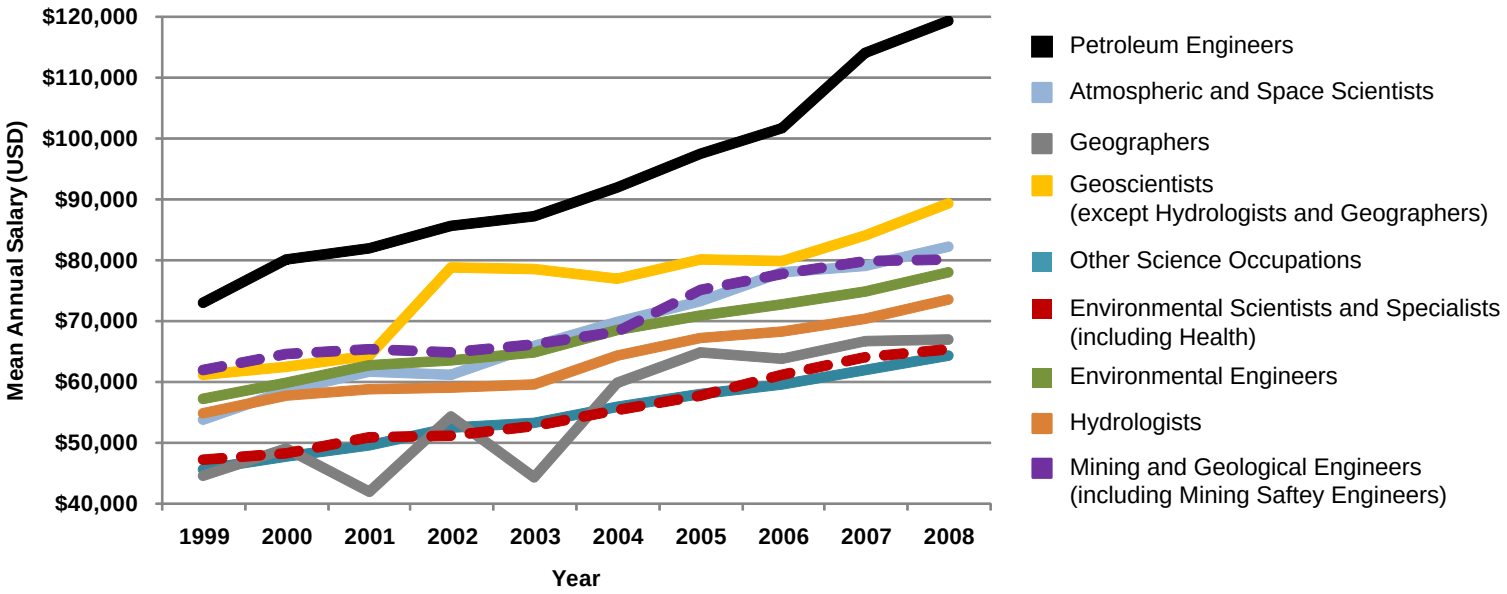
U.S. Geoscience Salaries Continue Upward Climb

Salaries for all geoscience-related professions continue to exceed the national mean salary for all other science occupations in 2008. Petroleum engineering salaries averaged $119,400, and salaries for geoscientists (except hydrologists and geographers) averaged $89,300. Salaries for environmental scientists and specialists averaged $65,280, just $1,000 over the national average for other science occupations.

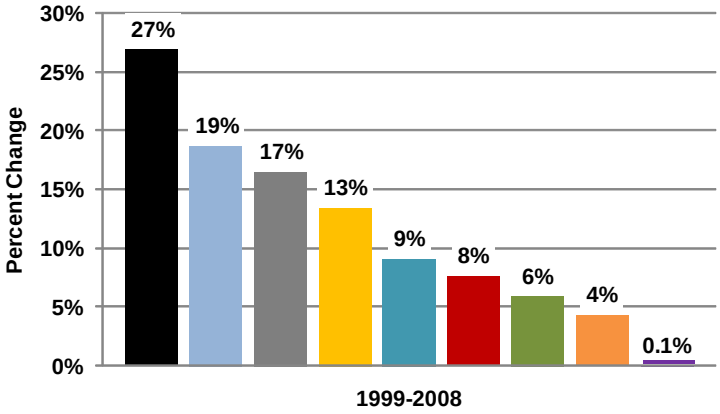
Mean Annual Salaries of Geoscience Professions (1999-2008)



Source: AGI Geoscience Workforce Program, data derived from the U.S. Bureau of Labor Statistics, National Occupational Employment and Wage Estimates, 1999-2008.

Petroleum engineering salaries, along with geoscientist salaries are strongly driven by the oil and gas industry. The growth in atmospheric and space science salaries tracks the increase in federal funding of atmospheric research. The increase in geographer salaries can be traced to the increased use of GIS technology in the private sector over the past five years.

Percent Change in Mean Annual Salary (1999-2008)



Note: Salaries were adjusted for inflation and normalized to 2008 dollars.
Source: AGI Geoscience Workforce Program, data derived from the U.S. Bureau of Labor Statistics, National Occupational Employment and Wage Estimates, 1999-2008.

- Leila Gonzales

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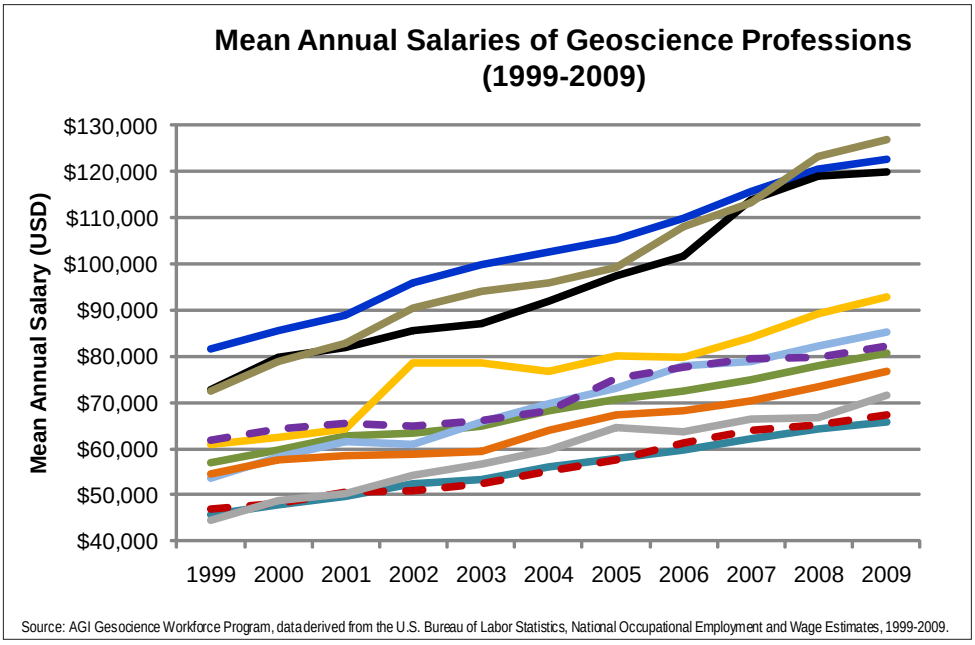
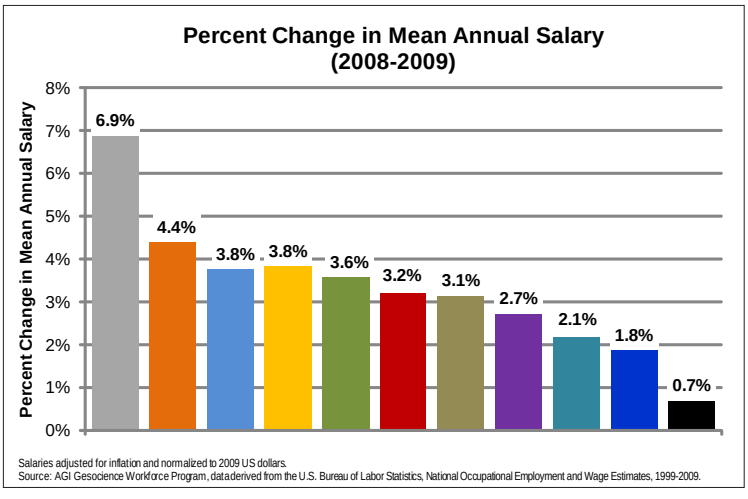
Geoscience Salaries Increase by 3.1% between 2008 and 2009

Despite the U.S. economy's downturn, geoscience salaries increased by 3.1 percent between 2008 and 2009, which is slightly more than the salary growth for other science occupations (2.1%) and for all U.S. occupations (2.8%). In 2009, the top geoscience salaries were for management positions (Natural Science Managers: $127,000, Engineering Managers: $122,810), petroleum engineers ($119,960), and geoscientists (excluding hydrologists and geographers) ($92,710). Mean annual salaries for environmentals scientists ($67,360) were $1,700 greater than national average for other science occupations.

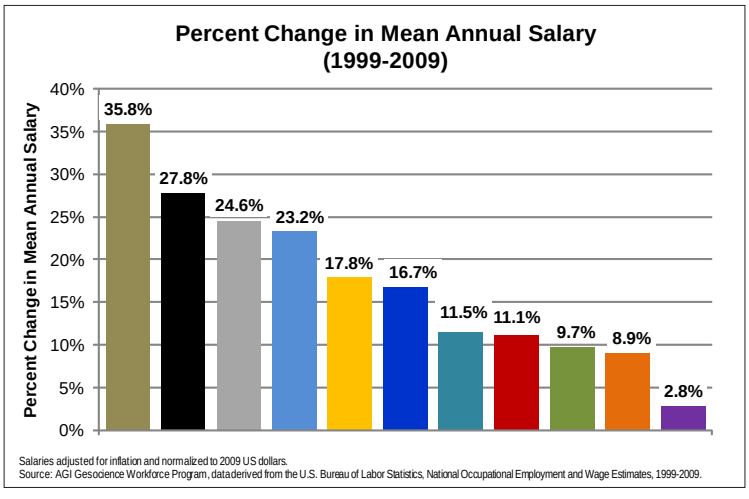
Salary growth between 1999 and 2009 for environmental scientists, environmental engineers, hydrologists, and mining and geological engineers lagged the national average salary growth for other science occupations. However, mean annual salaries for the majority of geoscience occupations increased more than the national average for other science occupations between 2008 and 2009.



Source: AGI Geoscience Workforce Program, data derived from the U.S. Bureau of Labor Statistics, National Occupational Employment and Wage Estimates, 1999-2009.



Salaries adjusted for inflation and normalized to 2009 US dollars.
Source: AGI Geoscience Workforce Program, data derived from the U.S. Bureau of Labor Statistics, National Occupational Employment and Wage Estimates, 1999-2009.



Salaries adjusted for inflation and normalized to 2009 US dollars.
Source: AGI Geoscience Workforce Program, data derived from the U.S. Bureau of Labor Statistics, National Occupational Employment and Wage Estimates, 1999-2009.

- Leila Gonzales

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14 December 2007

Competitive Starting Salaries for Geoscience Graduates

Geoscience starting salaries were competitive with other science and engineering fields in 2007. Bachelors 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 Masters recipients saw the highest starting salaries in the Oil and 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 Masters degree recipients, who earned an average of $46,873 p.a.

New doctorate recipients in all fields of science earned an average of $62,059 p.a. in the private sector, while new geosciences doctorates commanded an average of $72,600.

- Cindy Martinez

Starting Salaries for New Geoscience Masters, 2007

	Average Salary	Median Salary
Oil and Gas	81,300	82,500
Environmental Firm	47,500	45,500
Any Government	46,200	45,000

Starting Salaries for New Geoscience PhDs, 2007

	Average Salary	Median Salary
Postdoc – Academe	43,100	42,000
Postdoc - Government	55,200	53,000
Potentially Perm. Academe	51,900	52,500
Private Sector	72,600	71,000

Source: AGI/AGU study on Recent PhD and Masters Degree Recipients, 2007

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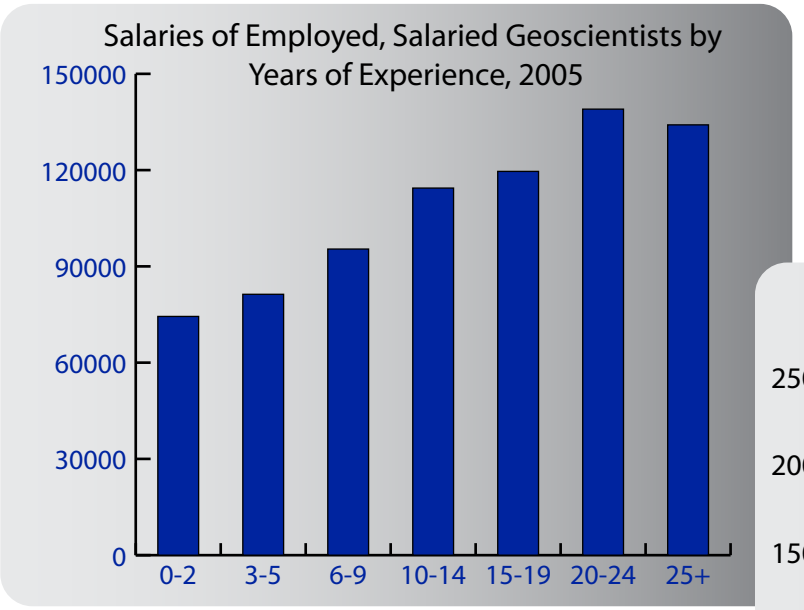
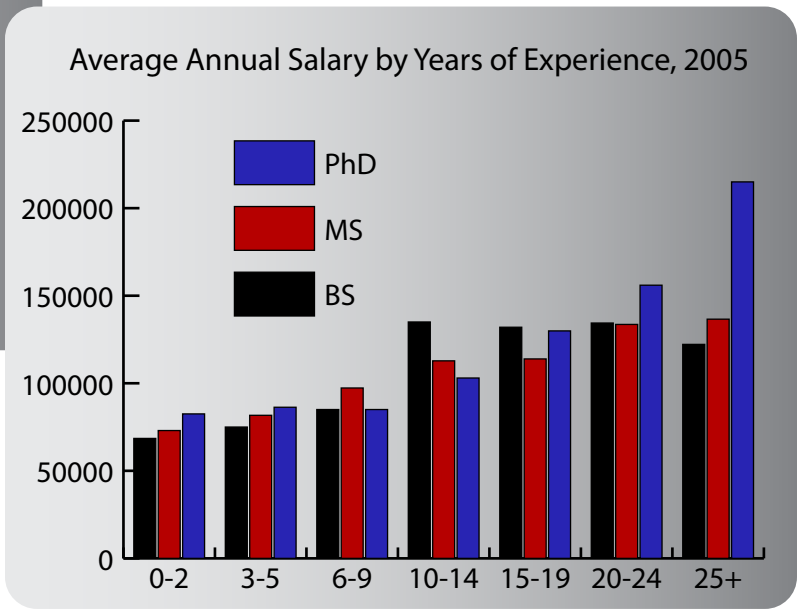
Geoscientist Salaries, by years of experience

The average salaries for geoscientists in 2005 varied by years of experience. For geoscientists employed for 0-2 years, the average salary was $74,000, a 9.7% increase over 2004's average. Geoscientists employed for 20-24 years earned an average of $139,000, which was more than a 23% increase over 2004 salaries. After 25 years of employment, average salaries dip slightly, to $138,100.

As expected, the greater the education, then generally the higher the compensation. However, given the premium on experience and small population of mid-career geoscientists in the US, even Bachelors' degree recipients can out-earn PhD and Masters degreed scientists. Geoscientists with their highest degree as the Bachelors earned an average of $135,000 with 10-14 years of experience, compared to only $103,000 for doctoral geoscientists with the same experience.

-Cindy Martinez and Chris Keane





Source: CPST 2007, Salaries of Scientists, Engineers, and Technicians: A summary of Salary Surveys (data derived from MLA Resources, Inc., Geological Salary Surveys, 2004 and 2005.)

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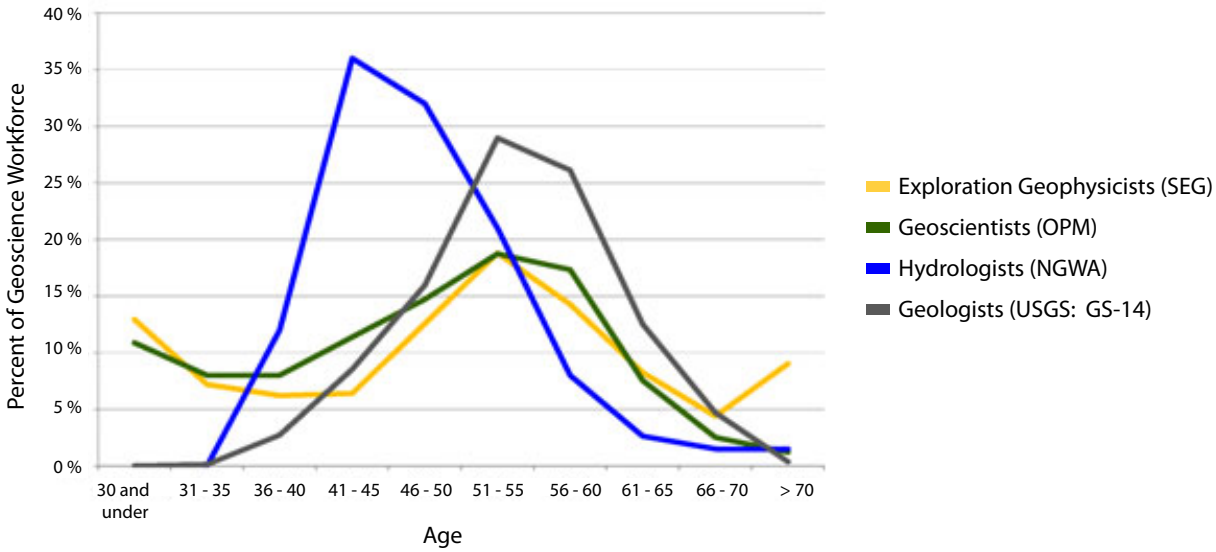
Geoscience Workforce Age Distribution

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 51-55 years old.

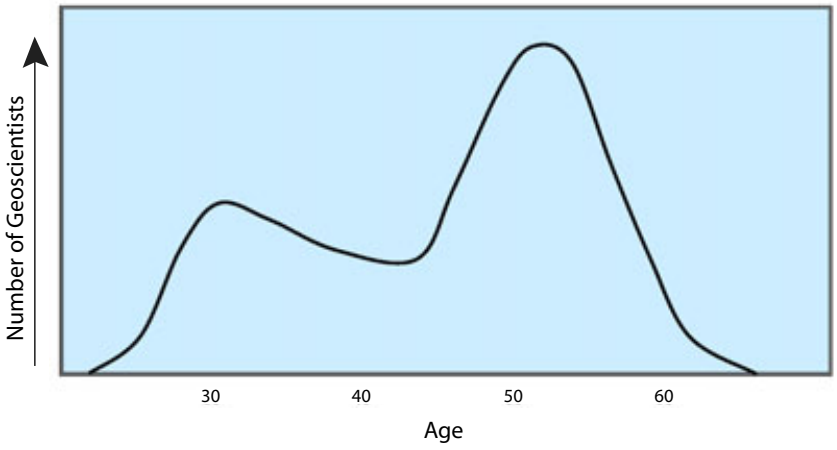
Age Distribution of Geoscientists in Industy



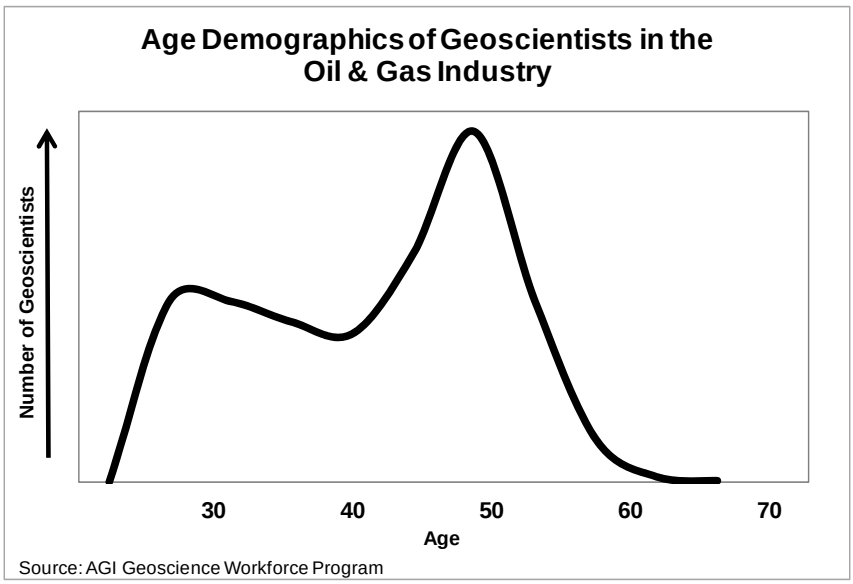
Data Sources: Society of Exploration Geophysicists (SEG), US Office of Personnel Management (OPM), National Groundwater Association (NGWA); *USGS Workforce Demographics and Trends*, Peter T. Lyttle 33rd IGC, Oslo, Norway, August 10, 2008 (USGS)

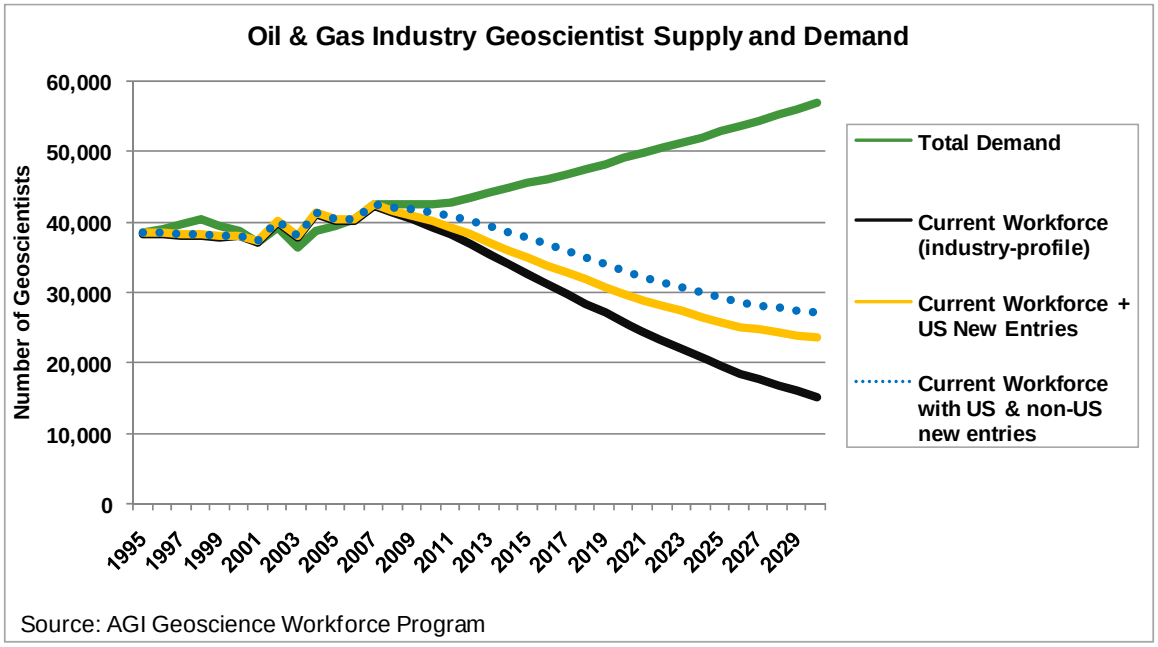
Even in oil & gas companies, which typically offer the highest salaries of all geoscience employing industries, the supply of new geoscientists is short of replacement needs. The number of younger geoscientists in their early 30's is approximately half the number of those nearing retirement age. This number is more than the data reported from federal agencies and professional societies.

Typical Age Distribution for an Oil & Gas Company



- Leila Gonzales

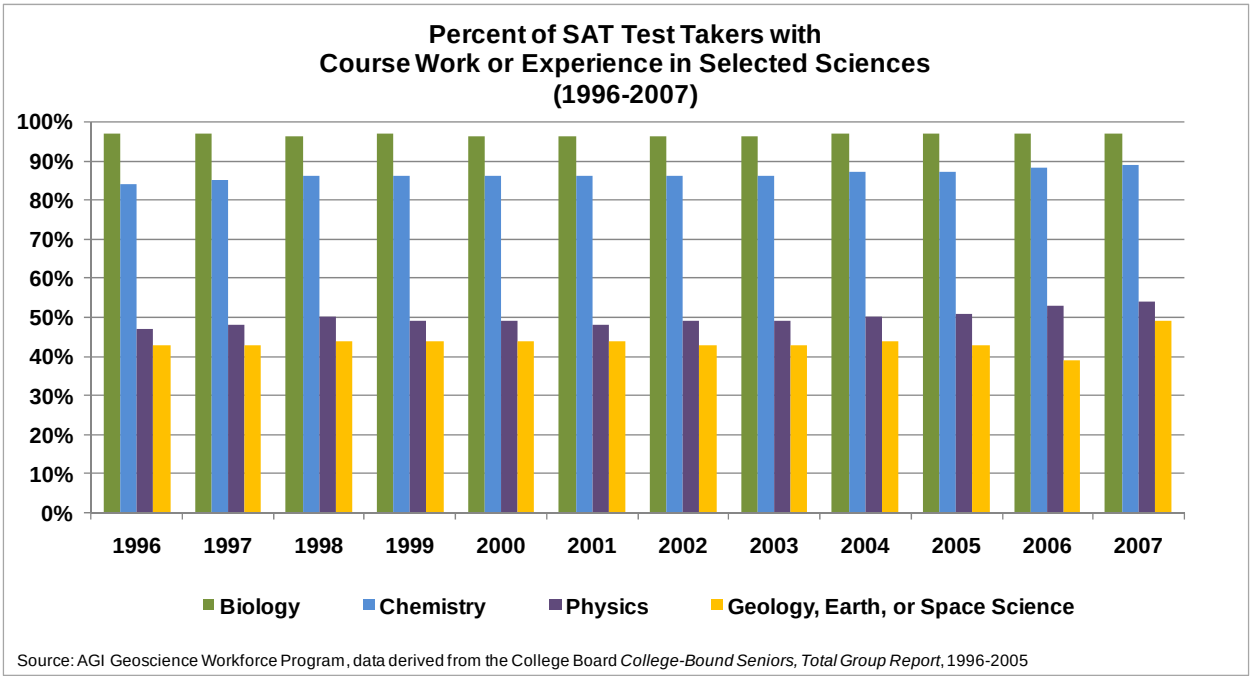




Support activities for mining and oil & gas is the only geoscience employment category with demographics that will provide for the replacement of the older generation of geoscientists who will retire within the next 15 years.

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.



Source: AGI Geoscience Workforce Program, data derived from the College Board *College-Bound Seniors, Total Group Report*, 1996-2005

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