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November 2003

Earth & Space Science PhDs, Class of 2002

This study documents employment patterns and demographic characteristics of recent PhDs. It summarizes the latest annual survey of recent Earth and space science PhDs conducted by the American Geological Institute (AGI), American Geophysical Union (AGU), and the Statistical Research Center of the American Institute of Physics (AIP). Highlights of the results include the following:

- Feedback about initial employment of the PhD class of 2002 was generally positive. Most graduates (88%) found work in the Earth and space sciences. Virtually all agreed that their work was challenging, relevant, and appropriate for someone with a PhD.
- There was a slight increase in the proportion of PhD graduates taking postdoctorate appointments this year. In 2001, 49% took postdocs. This year, 54% did.
- The time new PhDs spent looking for work did not appear to increase compared to last year's PhD class. Those taking postdoctorate appointments generally spent less time finding employment than those seeking permanent positions. The median amount of time postdocs spent looking for work was two months; for non-postdocs it was four months.
- We found a marked decrease in the general perception of the market in 2002 for geoscientists compared to the past two years. While about half perceived the job market neutrally, almost one-third said that it was bad or hopeless.
- Data from the National Science Foundation show that Earth and space science PhDs are generally older than PhD recipients in other disciplines. The average age of individuals receiving PhDs in the Earth and space sciences in 2000 was just over 33 years. This may be attributable to delays in starting graduate school, as many of these PhDs worked for several years prior to beginning a graduate program.

Introduction

The American Geophysical Union (AGU) and the American Geological Institute (AGI) have been collecting data on recent PhDs in the geosciences for seven years. Geoscience, or Earth and space science, covers a broad range of disciplines (see **Appendix Table A2**). Each year, letters are sent to Earth and space science departments requesting contact information for their recent PhD graduates. The graduates are then contacted directly and asked to answer questions about their education and employment, information on efforts to find their first job, experiences in graduate school, as well as demographic information.

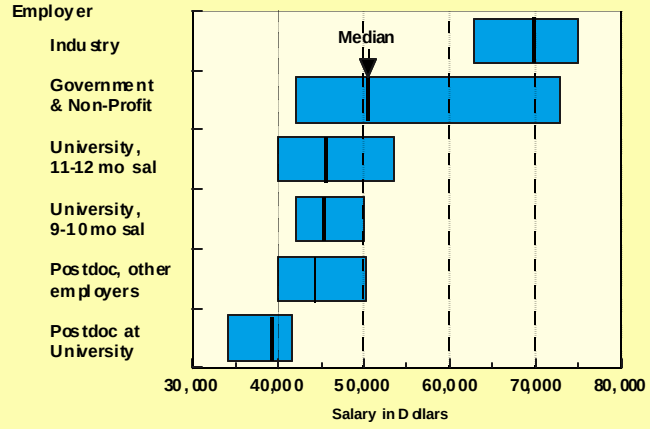
The National Science Foundation (NSF) Survey of Earned Doctorates reported a total of 797 PhDs in the Earth, atmospheric, and marine sciences in 2002. We obtained valid mailing addresses for 358 doctorates, of whom 198 responded. This report does not include new PhDs who left the US or those who earned their degrees from departments that do not have a geoscience term in their name.

In 1996 and 1997, this survey was conducted as part of a multidisciplinary effort coordinated by the Commission on Professionals in Science and Technology (CPST) and sponsored by the Alfred P. Sloan Foundation and the National Science Foundation. Since 1998, AGU and AGI have continued the effort with their own funds and included additional questions to provide a more complete picture of the graduates. Data collection and analysis were performed by the American Institute of Physics Statistical Research Center. This report draws on the results of the surveys of the past seven PhD classes (1996 to 2002) in the Earth and space sciences as well as data from the NSF.

Initial Employment

New doctoral recipients in the Earth and space sciences find a range of job opportunities with an even broader range of salaries (see **Figure 1**). Industrial employers typically pay the highest. There is much variation in the starting salaries of government employees, because this group includes national labs, federal and local government agencies, as well as non-profit research institutes. Academic salaries range from the mid-thirties to the mid-fifties, depending on salary base (9 to 10 months versus 11 to 12 months) and status (permanent versus temporary postdoc).

Figure 1. Typical starting salaries for Earth & space science PhDs, classes of 2001 & 2002



Note: Typical salary range includes the middle half of reported salaries.

Figure 2. Percent of Earth & space science PhDs working in postdoctoral positions, classes of 1996 to 2002

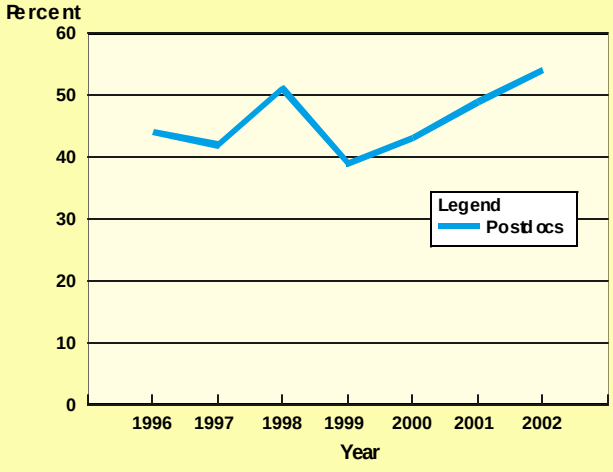


Table 1. Employment sector by postdoc status and year of graduation, 1996 to 2002

Postdocs	2002 %	2001 %	2000 %	1999 %	1998 %	1997 %	1996 %
Academe	35	33	23	25	32	31	36
Government	14	13	15	12	11	6	5
Industry	1	1	1	1	-	1	1
Non-Profit	4	2	4	1	8	4	2
Non-Postdocs							
Academe	28	24	23	27	20	27	30
Government	8	11	14	17	8	10	13
Industry	9	15	19	16	20	19	11
Non-Profit	1	1	1	1	1	2	2
Number of Respondents	204	211	150	157	144	327	123

There was a slight increase in the proportion of graduates taking postdoctorate appointments this year (54% compared to 49% of 2001 PhD recipients), sustaining a trend that began in 1999 (see **Figure 2**). More than half found postdocs rather than permanent employment in the Earth and space sciences.

Most postdocs were academic appointments, but one-quarter of all postdocs were in government (see **Table 1**). Sixty percent of those who found permanent employment were working in an academic setting. Most others were employed in government and industry.

Employment in Industry

The single largest reported industry hiring PhD geoscientists over the past four years was the petroleum industry, with about 39% of all industry new hires. Non-geoscience companies, ranging from Hewlett Packard to SAIC, hired 20% of new PhDs going into industry, with another 16% finding employment in the environmental consulting field. Weather and logistic companies represented 5% of the industry hires. The mining industry hired just 3% of the PhDs surveyed over the past four years. The balance of hiring occurred in a variety of companies, including finance and diversified corporations.

Working Before Degree Completion

An interesting characteristic of Earth and space science PhDs is that a significant number have been working full-time prior to earning their PhDs (see **Table 2**). Ten percent of geoscience graduates over the past seven years started their current jobs more than one year before formally receiving their degrees. By way of comparison, new physics PhDs are half as likely as geoscience PhDs to have done so. On average, these geoscience PhDs have been working for eight years by the time they finished their doctorates.

Table 2. Percent of those working at least one year prior to earning PhD by employment sector, 1996 to 2002

	Postdocs %	University, 9-mo salary %	University, 12-mo salary %	Govt. and non-profit %	Industry %	Overall %
Employed at least one year before earning PhD	-	8	13	15	37	10
Number of Respondents	612	181	127	214	171	1305

Table 3. Percent of PhDs agreeing with qualitative statements about their careers, by postdoc status, 2002			
	Postdocs %	Non-Postdocs %	Overall %
My current position is professionally challenging	98	94	96
My current position is commensurate with my education	100	88	95
My current position is related to my field	97	88	93
Number of Respondents	103	85	188

Respondents were asked to give their opinions on the extent to which they agreed with the above statements on a scale of 1 to 5 where 1=Strongly Agree, 3=Agree, and 5=Strongly Disagree. The above data reflect the percentage of respondents who chose 1, 2, or 3.

Comments on the questionnaire from some of the class of 2002 who were working a year or more before graduating suggest that students take these positions either due to financial hardship or because it is a job that they cannot count on being available after degree completion. As such, they accept the positions as they become available and complete their dissertations on the side. Still other students had their graduate degree sponsored by an employer they had worked for before beginning the program. These individuals had a large impact on the average number of years working before completing a PhD.

While these PhDs who were already employed at graduation had higher salaries by the time their degree was conferred, they spent an average of a year and a half longer in graduate school and delayed beginning a PhD degree program an average four years longer than their counterparts who found employment within a year of graduation.

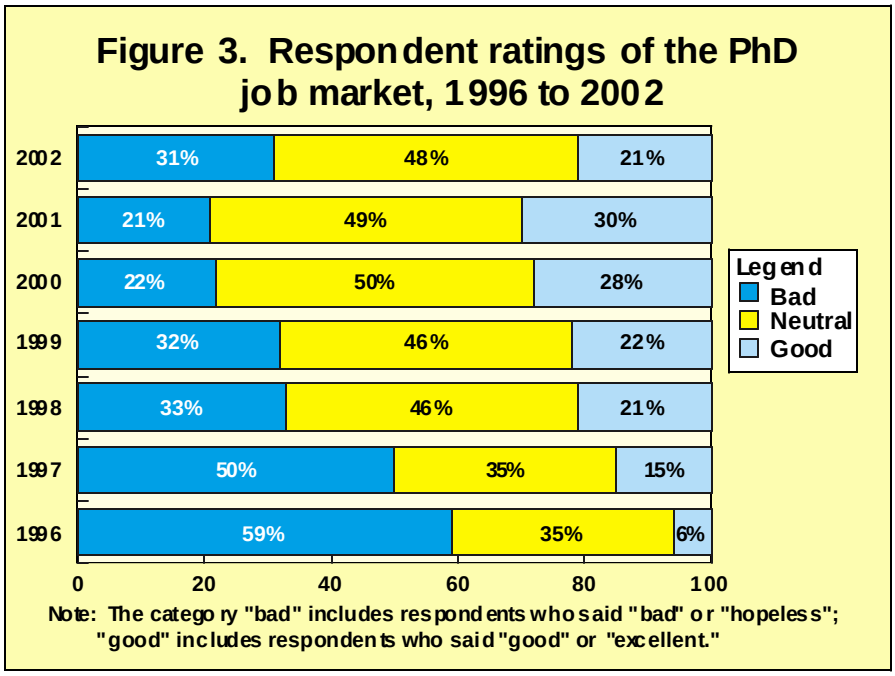
Initial Employment

Feedback about the initial employment of the PhD class of 2002 was generally positive. Virtually all agreed that their work was challenging, relevant, and appropriate for someone with a PhD (see **Table 3**).

Analytic thinking and problem-solving (cognitive) skills acquired in graduate school are being utilized on the job by a great majority (89%) of PhD recipients (see **Table 4**). Technical skills are more utilized in the industrial sector than others. Employment in the industrial sector appears to rely less on specialized knowledge such as one's dissertation field (27% often use these skills) compared to other types of employment.

Table 4. Degree to which new PhDs use the following skills on the job, 2002				
	PhDs who often use these skills			
	Academe %	Industry %	Govt. %	All %
Cognitive skills (analytical thinking, problem solving)	89	88	90	89
Technical skills (computer skills, modeling & simulation)	84	94	82	84
Knowledge of broad concepts in Earth & space science	82	75	68	78
Knowledge of dissertation field	75	27	68	69
Management skills	66	57	58	63

Respondents were asked to rate the degree to which they use the above skills and knowledge on a scale of 1 to 5, where 1=Extensively, 2=Often, 3=Regularly, 4=Occasionally, and 5=Not at all. Those who chose 1 or 2 are represented above.



This suggests that new PhDs are not being forced into these temporary positions as a last resort, but rather that a postdoctoral appointment is desirable as a first step into the typically academic arena and, eventually, tenure-track positions.

The amount of time spent looking for employment may be a good indicator of the shape of the job market. We found a marked decrease in the general perception of the market in 2002 for research-trained geoscientists compared to the past two years. While about half said that the job market was neutral, almost one-third said that it was bad or hopeless (see **Figure 3**).

Finding Employment

Time spent looking for work did not appear to increase for the most recent PhD graduates despite concern about the economy. Postdoctorates generally spent less time finding employment than those seeking permanent positions, though the data are unable to differentiate those postdocs who did not pursue permanent positions before accepting their postdoc. The median amount of time postdocs spent looking for work was two months; for non-postdocs it was four months.

The time spent looking for work does appear to be correlated with one's perception of the job market (see **Table 5**). For those PhDs who found work in less than 4 months, about half said that the job market was neutral or fair and about one-quarter said that it was good or excellent.

Table 5. PhD rating of job market by time spent looking for employment, 2002

	Months spent looking for employment				Overall
	Zero months	1 to 3 months	4 to 6 months	More than 6 months	
Bad	23%	24%	38%	44%	31%
Neutral	52	50	41	48	48
Good	25	26	21	8	21
Number of Respondents	61	34	56	25	176

Table 6. Most effective job search method by type of initial employment, PhD classes of 1998 to 2002					
	Non-Postdocs				
	Academic %	Government %	Industry %	Postdocs %	Overall %
Informal Channel	20	28	27	25	24
Advisor	8	15	8	26	18
Journal	36	6	1	17	18
Electronic Source	17	22	9	10	13
Former Job	5	9	11	8	8
Other	14	20	44	14	19
Number of Respondents	185	67	107	356	715

However, among those spending more than six months looking for work, only 8% reported positively about the job market. Forty-four percent rated it poorly and 48% gave it a neutral rating.

How PhD graduates find employment depends largely on the sector in which they wish to work and the type of position they want: postdoctoral or permanent (see **Table 6**).

Among PhD recipients from the past five years who gained academic employment, newsletter, magazine, and journal listings were the most effective job resource (36% of the academically-employed indicated that this was the most effective search method). Among all PhD recipients who used this method, the most popular resources in this category were Eos, GSA Today, Geotimes, and the Chronicle of Higher Education.

Those who went to work for a government or industrial employer most often cited informal channels, such as a colleague or friend, were the most helpful. This was the most effective job search method overall, indicating that ties made with faculty members and other students while in graduate school may be an important link to finding initial employment.

When asked to rate how helpful various resources were in their career planning, the majority of PhD graduates reported that their advisors were helpful (see **Table 7**). When responses were compared by type of employment found after graduation, we see that postdocs are much more likely to say that their advisor was helpful compared to those finding permanent employment. This suggests that PhD students who are on the track to academic employment rely on the faculty in their department to prepare them for these types of positions.

Table 7. PhDs who said that the following were helpful in their career planning, PhD classes of 1998 to 2002			
	Non-Postdocs %	Postdocs %	Overall %
Advisor	65	84	74
Scientific society	56	67	61
Department	49	52	50
University	39	36	38
Number of Respondents	419	376	795

Note: Respondents were asked to indicate how helpful the above were using a 5 point scale where 1=Extremely Helpful; 3=Helpful; and 5=Not at all Helpful. The above represent the percentage who answered 1, 2, or 3.

Table 8. Top reasons for considering dropping out of PhD program, PhD classes of 1998 to 2002

	Female %	Male %	Overall %
Financial concerns	30	35	33
Didn't feel intellectually capable	45	22	31
Poor job market	26	33	30
Poor relationship with advisor	35	25	29
Family concerns and responsibilities	19	23	21
Loneliness	25	16	20
Number of Respondents	170	270	440

Note: This table is based on the 47% of respondents who indicated that they had considered dropping out of graduate school at some point. Respondents were asked to choose all reasons that applied. The above list represents the five reasons cited most often.

Sixty-one percent of PhD recipients from the past five years said that a scientific society was helpful in planning their careers. Again there were small differences by type of employment, with postdocs reporting more favorably on the role of scientific societies. Only half of recent PhDs said that their department was helpful and even fewer (38%) said that their university was helpful. This may be the case either simply because these graduates felt that they did not need to utilize these resources, or possibly that consulting with departments and universities may not be appropriate means of preparing for a PhD-level career.

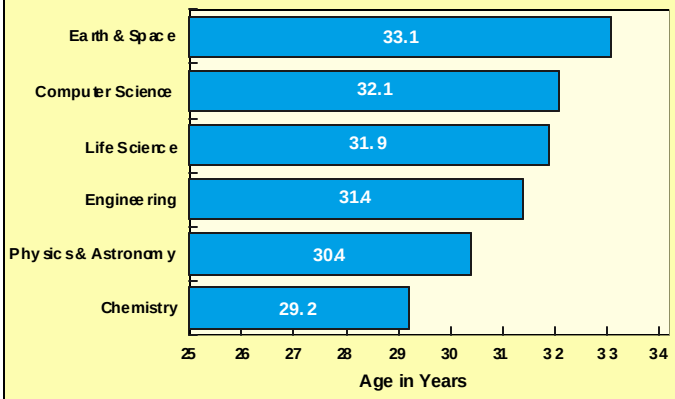
The Graduate School Experience

As we found in past years, the majority of PhD graduates (89%) reported that they either never or only occasionally considered dropping out of graduate school. Because this is a survey of individuals who completed their graduate program, it does not include the opinions of those who may have dropped out of school. As such, this result is likely biased towards the positive if one wishes to interpret it as the opinion of all graduate students in the geological sciences.

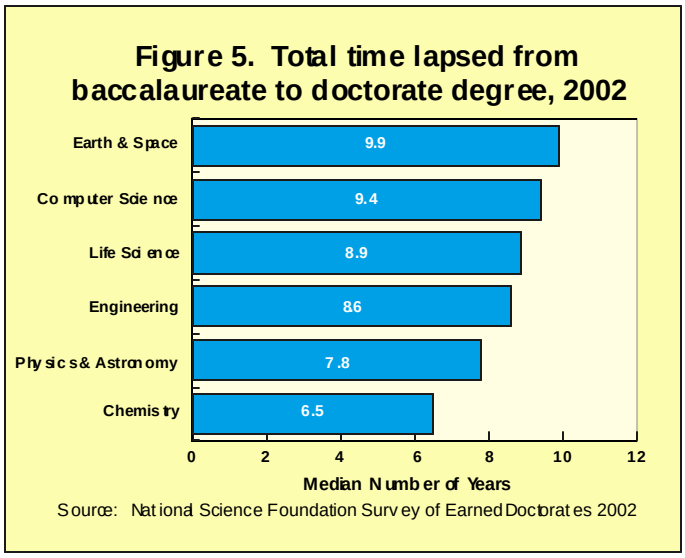
Over the past five years, about 8% of PhD recipients indicated that they did consider dropping out of their program either regularly or constantly. The most cited reasons why they thought about dropping out are listed in **Table 8**.

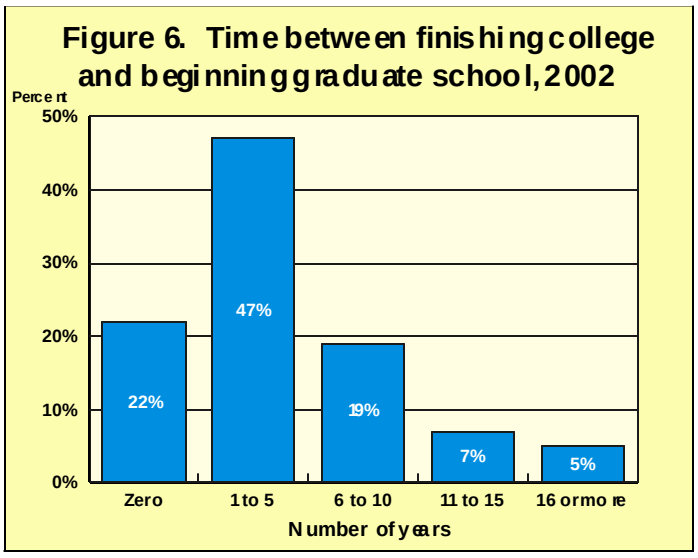
Financial concerns worry one-third of PhD recipients enough that they considered stopping graduate school in order to work. Because PhD recipients in this discipline are generally older and have a longer span between undergraduate and graduate degree completion compared to PhDs in other scientific disciplines (see **Figure 4** and **Figure 5**), these individuals are more likely to have spent a number of years in the workforce. Adjusting to a graduate student lifestyle may be more difficult for such people.

Figure 4. Median age of PhD recipients by discipline, 2002



Source: National Science Foundation Survey of Earned Doctorates 2002





Thirty-one percent of PhD recipients who considered dropping out of school did not feel up to par intellectually. There were large differences between men and women on this item. Women were also slightly more likely than men to say that loneliness and working with their advisor caused them to consider leaving graduate school.

The data suggest that men may be more likely to cite family responsibilities and financial or job market concerns compared to women. However, due to the small number of respondents, one is cautioned before making such generalizations. It appears as though problem areas for women include the climate of the work environment, whereas for men it is concerns of the world outside of graduate school.

As mentioned above, Earth and space science PhDs are generally older than other PhD recipients at the time of their degree. There is an almost ten-year delay between earning a bachelor's degree and a PhD in this field (see **Figure 5**). Other scientific disciplines show shorter average time spans.

This wide time span between undergraduate and graduate degrees in the geological sciences can partially be explained by the delay in beginning graduate school (see **Figure 6**). Almost half of the PhD class of 2002 had waited between one and five years after earning a bachelor's degree before beginning a graduate program. Almost one-third had waited six or more years before entering graduate school. This gap in education may help to explain why PhDs in this field are, on average, older than PhD recipients in other disciplines.

Gender

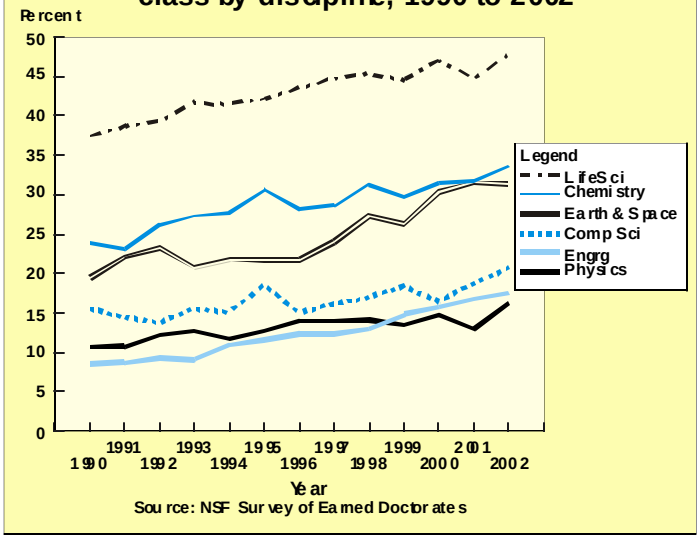
Women in Earth and space science are under-represented compared to the general population. However, the representation of women among geoscience PhDs is high compared to some other physical science fields (see **Figure 7**). Only the life sciences and chemistry produce a higher proportion of female science PhDs than the Earth and space sciences.

Table 9. Percentage of Earth and space science PhD graduates by employment field, class of 2002			
Field of Employment	Postdocs %	Non-Postdocs %	Overall %
Earth and space sciences	95	80	88
Other sciences	5	18	11
Non-science	-	2	1
Number of Respondents	113	99	212

The chart also shows that improvements have been made in making the field more representative of women at the PhD level. Just twelve years ago, fewer than 20% of PhDs awarded in the geosciences went to women. Now over 31% of PhDs are awarded to women. Of the fields shown here, only engineering has had a proportionately larger increase in the proportion of female PhDs granted in this time period, as it doubled from 9% to 18%.

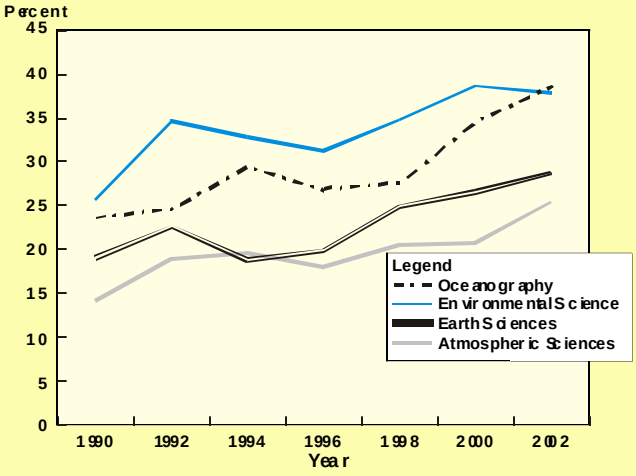
The percentage of PhDs who are female varies even within the Earth and space sciences. **Figure 8** shows the proportion of female PhD graduates by subdiscipline. Oceanography and environmental science have the highest representation of women at the PhD level, approaching 40%. About 29% of Earth science PhDs and one-quarter of atmospheric science PhDs are granted to women. While 25% female may sound comparatively low, it is useful to note that this is even higher representation of women than at the bachelor's level. The bachelor's classes of 1999 and 2000 (the most recent years for which data are available) show that 23% of atmospheric science and meteorology bachelor's were awarded to women (source: National Center for Education Statistics Integrated Postsecondary Education Database System). The fact that the representation of women is higher at the advanced degree level than at the undergraduate level is quite remarkable.

Figure 7. Proportion of women in PhD class by discipline, 1990 to 2002



Source: NSF Survey of Earned Doctorates

Figure 8. Proportion of women PhDs in Earth & space science disciplines, 1990 to 2002



Source: NSF Survey of Earned Doctorates
Note: Each data point is a two year average that includes the previous year's number

APPENDIX

Methodology

In January 2003, 199 PhD-granting Earth and space science departments received a request for the names and addresses of students who earned a PhD between July 2001 and June 2002. Those who did not respond received a second request in February 2003 and a third in May. By July, 140 departments replied, yielding a 70% response rate.

Questionnaires were sent to 379 recent PhDs between February and July. Of these, 21 were returned to us due to problems with the mailing address. PhDs who did not respond received a second request four to seven weeks after the first mailing. Of the 358 PhDs with valid addresses, 198 responded, for a cooperation rate of 55%.

Because PhDs in the Earth and space sciences are not all granted by departments in geology and similar fields, we amended our data with that collected by the American Institute of Physics (AIP) in their study of recent PhDs from physics departments. Twenty-six space science PhDs from their study were included in our analyses. The questionnaire used for AIP's study omitted several questions included on ours. Of the data taken from the AIP survey of physics departments, the questions used in ours were worded identically.

Because the date some students indicated as their degree date differed from that which their institutions stated, we had some discrepancies between school reports and self-reports. We relied upon the student's statement, but expanded our window to include degrees completed between April 2001 and October 2002. Seventeen students were excluded from the analysis because they received their degrees outside of this range. Sixteen respondents from last year's study have been included in the current analysis because they received their PhD after October 2001. They were not included in the analysis of the previous report, Earth & Space Science PhDs, Class of 2001 (Claudy, et al.) published November 2002.

A total of 223 PhD recipients for 2002 are included in the analysis of this report. Data are excluded only as a last resort when the information provided by the respondent either is not comparable to the aspect under study or does not make sense given other factors. Thirteen who have been working at their current job for more than one year were excluded from all salary analyses to restrict such results to starting salaries. Our focus is on initial employment in the US only.

Table A1. Types of employment included in each of the employment sectors

Category	Employment areas included
Industry	Multinational corporations
	Large companies
	Small consulting firms
	Self-employed workers
Academe	Four-year colleges or universities
	Two-year colleges
	Elementary or secondary schools
Government	Federal agencies
	National laboratories
	State and local governments

Note: People working at non-profit agencies are included with government employees unless otherwise specified.

Table A2. Breakdown of subfields by category	
Category	Subfields included
Atmospheric Sciences	Atmospheric Sciences Meteorology Climate Studies Global Earth System Science
Hydrology and Environmental Science	Hydrology Water Resources Soil Science Geomorphology
Oceanography	Physical, Chemical, & Biological Oceanography Geophysics Sea Floor Processes Marine Geology Ocean Engineering Coastal Science Fisheries
Solid Earth Geology	Paleontology Sedimentology Stratigraphy Structural Geology Tectonics Rock Mechanics Paleoscience Glaciology
Chemical Earth Science	Volcanology Petrology Mineralogy Geochemistry
Solid Earth Geophysics	Seismology Economic Geology Exploration Geophysics Other Solid Earth Geophysics
Space Science	Planetary Science Space Physics Aeronomy Astronomy
Other Science and Engineering	Engineering Computer Science Science Education Other Science Public Policy