American Geophysical Union (AGU)
2000 Florida Avenue N.W.
Washington, DC 20009-1277

American Geological Institute (AGI)
4220 King Street
Alexandria, VA 22302-1502

By Jennifer Giesler
Megan Henly
Nicholas Claudy

October 2001

Earth & Space Science PhDs, Class of 2000

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:

- Job market indicators for 2000 show that the market for recent PhDs in the geosciences is stronger than each of the previous four years. Starting salaries are up in almost every employment sector, including postdoctoral appointments.
- Time spent looking for work is down for the third year in a row. In 1998, graduates spent an average of 5.5 months looking for a job. In 1999, the average was 4.7 months; by 2000, it was only 3.4 months.
- Of the PhD class of 2000, 82% found work within the Earth and space sciences and 97% were employed in science or engineering.
- Ten percent of new PhDs over the past three years had been employed for more than one year by the time they received their doctorates. Their age, work experience, and salaries differ substantially from those finding initial employment after graduation.
- Recent PhDs in the Earth and space sciences are, as a group, the oldest among all of the natural sciences and engineering, according to the National Science Foundation. Geoscientists also spend the most years completing their degrees and delay beginning graduate school an average of four and a half years after earning their bachelor's degree.

Introduction

The American Geophysical Union (AGU) and the American Geological Institute (AGI) have been collecting data on recent PhDs in the geosciences for five years. Each year letters are sent to Earth and space science departments requesting addresses of their recent PhD graduates. The graduates are then contacted directly and asked to answer questions about their education and employment specialties, information on efforts to find their first job, experiences in graduate school, as well as demographic information.

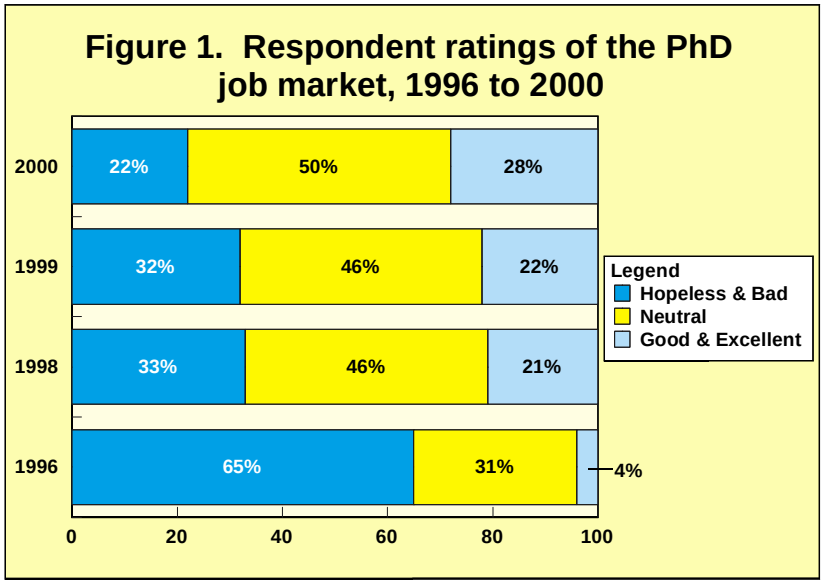
Of the 270 PhDs who received surveys from us, 148 responded, for a response rate of 55%. This report does not include new PhDs who left the US or those who earned their degrees from departments that do not have a geoscience term in their name.

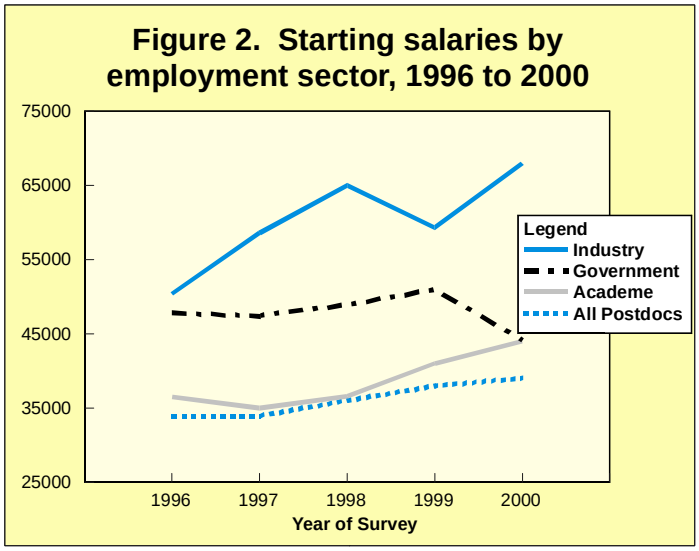
In 1996 and 1997 the data were collected as part of a multidisciplinary effort coordinated by the Commission on Professionals in Science and Technology (CPST). In years 1998 to 2000, AGU and AGI continued the effort with their own funds and included additional questions to provide a more complete picture of the graduates. This report draws on the results of the surveys of five PhD classes (1996 to 2000) in the Earth and space sciences as well as data from the National Science Foundation (NSF).

The Job Market

Over the last five years continual improvement has been recorded in the job market through indicators such as time to find employment and starting salaries. As these indicators continue to improve, so too does the perception of the job market in general. This change in perception has been documented. In 1996, about two-thirds of the recent graduates felt that the job market was hopeless or bad, and only 4% felt it was good or excellent. By 2000, only 22% found the job market bad and 28% believed it was in good shape for geoscientists (**See Figure 1**).

Over the past five years, the time to find employment has decreased steadily. In 1998, graduates spent an average of 5.5 months looking for a job. In 1999, the average was 4.7 months and by 2000, it was only 3.4 months.





Starting salaries have increased steadily over the last five years in all areas except government, where they fluctuated (**See Figure 2**). Readers should be cautioned that the apparent drop in government starting salaries for the class of 2000 may be due to the small number of respondents in that category.

While 29% of respondents are currently working in government, more than half of these government workers have been employed for more than one year. Because the salaries reported from these workers are not starting salaries, their data are not included in Figure 2 (see methodology section for details). For the government workers already employed while in graduate school, the median salary for the class of 2000 was $70,000. (Refer to Appendix Table A1 to see which types of employment are included in the three major sectors mentioned throughout this report.)

Another encouraging finding about recent PhD graduates is that they had many positive comments about their jobs. When asked about the most rewarding aspect of their job, 25% indicated it was the intellectual challenge of conducting one's own research, 19% said that it was the opportunity for continued learning, 13% cited teaching and working with students as the best part, and 10% said that collaborating with colleagues was the most rewarding aspect. A few respondents said simply that it was rewarding "doing what I enjoy," that it was "a dream come true" to work in the field, and that "I enjoy it 24/7." Apparently all of the hardships of a PhD program were worth the work.

Finding work: Where and How?

Geoscientists can head down a variety of career paths upon receiving their PhD. They may find permanent employment, or they may obtain a postdoctoral position. Postdoctoral appointments are defined as temporary positions in academe, industry, or government; they primarily provide continued training or education in research. The class of 2000 had about the same proportion of graduates taking postdocs as in the previous four years: 42%. About one-half of the recent graduates are finding full-time permanent employment. The remaining 8% found other temporary (non-postdoctoral) positions.

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. The method of job search cited as most effective varies from year to year. One-third of the class of 2000 said that some informal channel - a colleague or friend - was the most helpful. This suggests that those who make connections through networking while still in school may have more opportunities open to them when they embark on their job search (**See Appendix, Figure A2**).

Table 1. Employment sector by postdoc status and year of graduation, 1996 to 2000

	2000 %	1999 %	1998 %	1997 %	1996 %
Postdocs					
Academe	23	25	32	30	33
Government	15	12	11	6	6
Industry	1	-	-	1	2
Non-Profit	4	1	8	4	4
Non-Postdocs					
Academe	23	27	20	24	25
Government	14	17	8	9	10
Industry	19	16	20	24	17
Non-Profit	1	2	1	2	3
Number of Respondents	150	157	144	235	231

Note: A dash (-) indicates less than 1%

Electronic resources have also become increasingly important. One-sixth of PhDs said that this method, which may include professional society and employer job listings on the Internet, was the most effective. Magazines and journals containing job openings were cited as most essential in the job search by 16% of respondents, while 9% said that their faculty advisor was their best link to finding employment. Another 9% found employment through a contact from a former job.

Interestingly, important differences were noted in the emphasis placed on particular job-searching strategies utilized versus their effectiveness in finding a job. For example, although more than 60% of postdocs relied on their advisors for assistance during the search, less than 10% of the group felt their advisors had played an important role in the process (**See Appendix, Figure A1**).

Academe is the most popular employment sector for recent PhDs (**See Table 1**). Almost half of all respondents work at universities. About one-fifth of the class of 2000 went to work in the industrial sector. Government employees make up another 29% of the working graduates and government labs have been increasingly hiring postdocs. This shift in the concentration of postdocs from academe to government may be due to the number of large programs in government which recruit students heavily.

This shift may also be due to a more desirable working environment in government as a postdoc, compared to academic postdoc positions. We found that starting postdocs in academe make an average salary of $36,750; those in the government start at $42,000. While the qualitative indicators show some similarities between the two sectors, those in government are somewhat more likely to feel that their positions are both commensurate with their education and consistent with what they expected to be doing after graduation (**See Table 2**).

Table 2. Postdoctorate opinions on qualitative aspects of their careers, 2000

	Government Postdocs %	Academic Postdocs %
My position is commensurate with education	96	81
My position is related to my field	93	91
My position is professionally challenging	93	85
My position is similar to what I expected to be doing when I began my doctoral program	71	60
Number of Respondents	28	34

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 and 5=Strongly Disagree. The above data reflect the percentage of respondents who chose 1 or 2.

Graduates are not limited to employment in the field of their doctoral dissertation. PhDs may find work in a different subfield, or in a field outside of the Earth and space sciences.

The vast majority (82%) of graduates find their first job in a geoscience field. Of those who leave the Earth and space sciences, about one-quarter teach science, one-quarter are employed as engineers, and 12% work in computer science. Very few (less than 3%) work outside of science and engineering.

In 2000, there were half as many PhDs whose first job was in oceanography, compared to those who specialized in this subfield in graduate school (**See Table 3**). This departure is significantly larger than that of all other fields in the Earth and space sciences combined. In past years (1998 and 1999), PhD concentration in oceanography was balanced out by the same proportion of jobs in oceanography (+/-1%). This year saw a substantial increase in the proportion of PhDs concentrated in this field.

The recent National Research Council document "Trends in Federal Support of Research and Graduate Education" states that graduate enrollment is directly related to federal research funds through graduate support. It was reported that funding in oceanography has steadily increased, while that for all other disciplines in the Earth and space sciences has decreased. These data support our findings that there are a greater number of new PhDs in oceanography. Employment opportunities did not catch up to production.

Oceanographers found employment in water and environmental sciences, engineering, and every other subfield of the geosciences. While one-third of them cited a lack of openings in their dissertation field as a barrier to employment, the news was not all negative. Of these displaced oceanographers, more than two-thirds feel that their employment is related to their PhD field.

Table 3. Percent change[a] between PhD area and employment area, 2000

Subfield	Percent Change	Degree %	Employment %
Oceanography	-14	26	12
Space Science	- 4	15	11
Solid Earth Geology	- 2	14	12
Atmospheric Sciences	- 1	17	16
Chemical Earth Science	-	9	9
Hydrology and Environmental Science	+ 1	11	12
Solid Earth Geophysics	+ 2	9	11
Other Science and Engineering[b]	+18	(N/A)	18

(a) Percent change indicates the change between the percent of respondents who earned their degrees from a particular subfield and the percent employed in that subfield. Positive change indicates that *more* people are employed in that subfield than earned degrees from that subfield. Negative change shows that *fewer* people are employed in that field than earned degrees in that field.
(b) "Other Science and Engineering" includes engineering, computer science, science education, and non-science. See Appendix Table A2 for a complete list of subfields included in the above categories.

Table 4. Degree to which new PhDs use the following skills on the job, 2000			
	PhDs who often use these skills		
	Academe %	Industry %	All %
Cognitive skills	85	100	88
Technical skills	83	92	86
Knowledge of principles that govern the physical world	85	69	80
Knowledge of dissertation field	82	35	73

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 and 5=Not at all. Those who chose 1 or 2 are said to use that skill, while those who chose 4 or 5 are said not to use that skill.

What PhDs do greatly depends upon the sector in which they work. More than half (57%) of all respondents list their main work activity as "research." Of those employed in industry, only 18% primarily do research, almost one-third do consulting, 11% are in professional services, and 14% are involved in design, development, and engineering.

While the majority of respondents indicated that they used the skills learned in graduate school at work, there were substantive differences by employment sector. PhDs in industry are less likely than those in academe to use their knowledge of their dissertation field or their knowledge of principles that govern the physical world. Industrial PhDs are more likely to use cognitive and technical skills than PhDs working at universities (**See Table 4**).

The Graduate School Experience

The most recent graduating class had a more positive experience in school than graduates four years ago. Half of the PhD class of 1996 thought about dropping out regularly or constantly. In the class of 2000, only one-tenth reported that they had considered dropping out of their PhD program regularly or constantly. The vast majority considered it only occasionally or never. The most common reasons cited for considering dropping out of graduate school were financial worries, concern about career opportunities, doubt about one's abilities, family responsibilities, and a poor relationship with one's advisor (**See Table 5**).

Table 5. Top reasons for considering dropping out of PhD program, 2000	
	%
Financial concerns	38
Poor job market	33
Didn't feel intellectually capable	31
Family concerns and responsibilities	24
Poor relationship with advisor	21

Note: This table is based on the 59% 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.

Table 6. Percent of those working at least one year prior to earning PhD by employment sector, 1998 to 2000

	Postdocs %	University, 9-mo salary %	University, 12-mo salary %	Govt and non-profit %	Industry %	Overall %
Began position after earning PhD	100	98	81	66	88	90
Employed at least one year before earning PhD	-	2	19	34	12	10
Number of Respondents	198	57	47	67	84	453

When asked what they would change about their graduate school experience if they had it to do over, 24% said that they would change nothing. The changes suggested most frequently include taking more technical classes (25%), working with a different advisor (17%), and working in a different subfield (16%).

Respondents were asked to rate how strongly they agreed with the phrase "My advisor was helpful in my career planning", on a scale of 1 to 5 where 1 represents "strongly agree" and 5 "strongly disagree." Most (53%) respondents chose 1 or 2. When asked similar questions about other sources of career support, 29% said that their scientific society was helpful, 23% agreed that their department was helpful, and only 16% found their university to be helpful.

PhDs have been working for seven years by the time they finished their doctorates.

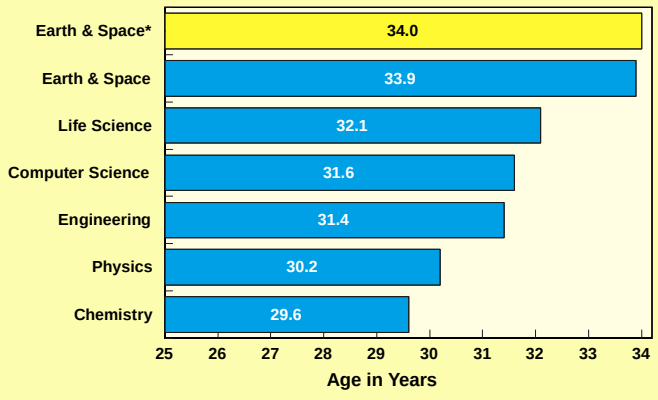
This appears to be a positive trend in several respects. First, our 1998 survey reported that the majority of graduates in the geosciences incur little debt related to their education. Nearly two-thirds accumulated no debt and less than 5% owed more than $20,000. Of those already employed upon graduation, 92% had no student loan debt. Second, PhDs employed while in school tend to have salaries 60% higher than their counterparts finding initial employment after graduation. They are 8 to 9 years older and start graduate school more than five years later on average than those who do not work, giving them the opportunity for more work experience.

Special Populations

There are several characteristics that are unique to PhDs in the geosciences. Unlike other physical science graduates, a significant number have been working full-time prior to earning their PhD. Ten percent of graduates over the past three years started their current job more than one year before formally receiving their degree. On average, these

Half of those working full-time at least one year prior to earning their PhDs were employed in government. Most of the rest were evenly split between industry and academe on a 12-month salary base (**See Table 6**). The PhDs who were government employees while in school are concentrated in federal agencies, particularly the United States Geological Survey (USGS) and the National Oceanic and Atmospheric Administration (NOAA).

Figure 3. Median age at time of doctorate, 1999



*Source: Blue bars represent data from the NSF Survey of Earned Doctorates, 1999; the yellow bar represents data collected by the AGU/AGI Study of Recent PhDs, class of 1999

Differences in employment subfield are also apparent for this group. Recent graduates employed prior to graduation are heavily concentrated in solid earth geology (41%) followed by atmospheric sciences (19%) and oceanography (12%). (See Appendix Table A2 for a breakdown of subfields by category.)

A second distinguishable feature of Earth & space science PhDs is their age. For each of the last several years, a higher proportion of recent graduates were over the age of 40: 16% in 1998, 20% in 1999, and 23% in 2000. The National Science Foundation (NSF) reports the age of PhD recipients of all fields (**see Figure 3**).

These older graduates differ from younger PhDs in several respects. Those over 40 are concentrated in solid earth geology employment subfields and they are much less likely to take postdoctoral appointments. Of those who had been employed more than one year before finishing school, 65% were over 40.

Another distinctive characteristic of Earth and space science graduates is the length of time they spend in school and length of time they wait to begin graduate school. In 2000, the average time between earning a bachelor's and starting a graduate program was 4.6 years. Remarkably few (37%) of the graduates enter a PhD program less than two years after earning a bachelor's (**See Figure 4**).

Figure 4. Time between finishing college and beginning graduate school, 2000

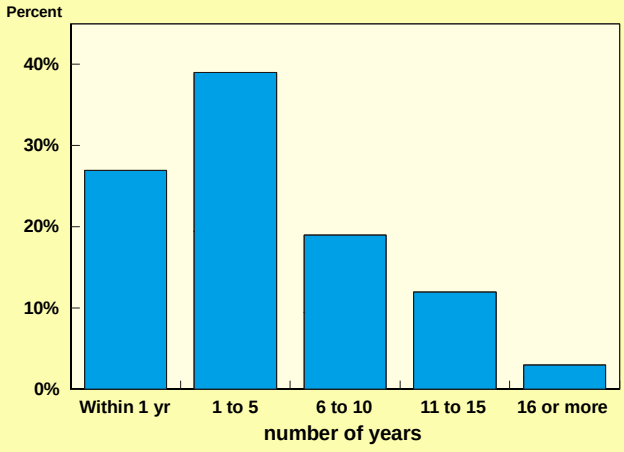
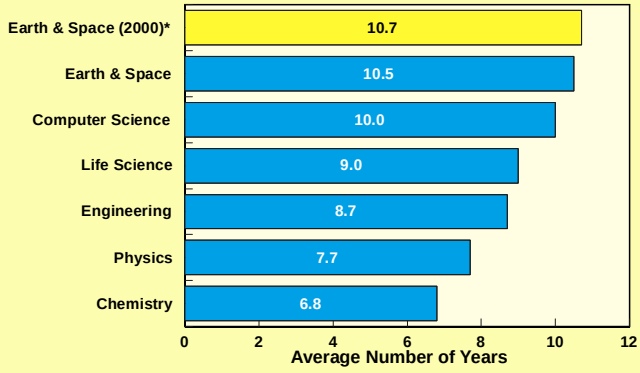


Figure 5. Total time lapsed from baccalaureate to doctorate degree, 1999



*Source: Blue bars represent data from the NSF Survey of Earned Doctorates, 1999; the yellow bar represents data collected by the AGU/AGI Study of Recent PhDs, 2000. This item was not asked on our 1999 survey.

Because of the amount of time they wait to begin school, coupled with employment for some during periods of graduate work, Earth and space science students allow the most time to lapse (10.5 years) between earning their undergraduate degrees and their PhDs, according to the NSF (**See Figure 5**).

Gender

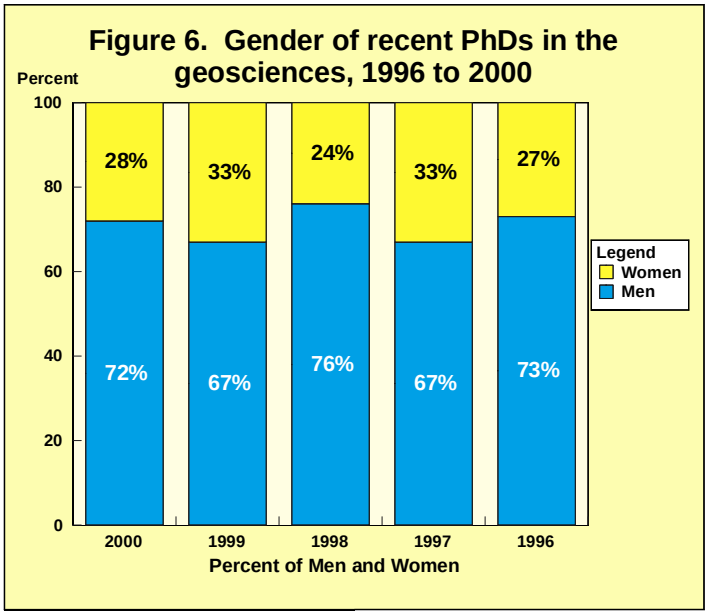
Women in the Earth and space sciences are under-represented compared to the general population. However, the representation of women among geoscience PhDs is higher compared to other scientific disciplines.

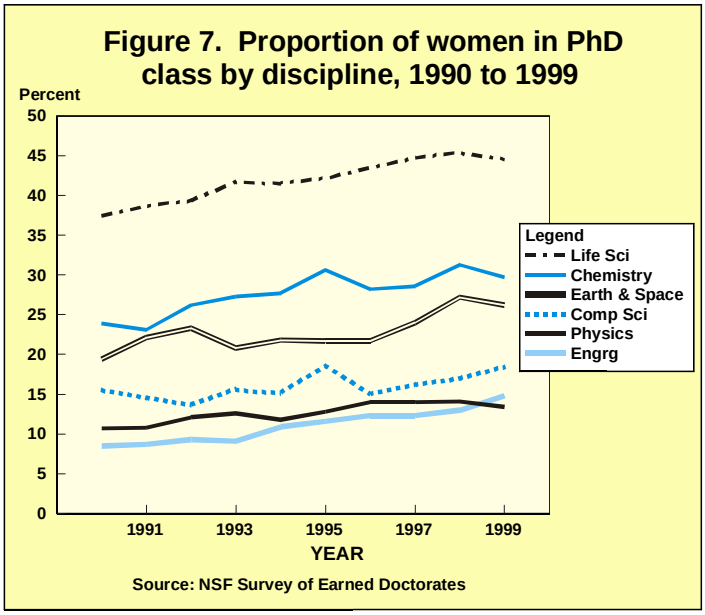
Our study found that each PhD class from 1996 to 2000 had graduated only between one-quarter and one-third women (**See Figure 6**). The NSF Survey of Earned Doctorates also found little improvement in the proportion of female graduates over the past ten years.

While this is not comparable to the proportion of women in the general population, it is among the higher of the scientific disciplines in granting PhDs (**See Figure 7**). Only the life sciences and chemistry produce more female science PhDs than the Earth and space sciences. Physics and engineering have the lowest concentration of women: only about one-eighth of their graduates are female.

The women who graduated with a PhD in 2000 reported employment characteristics similar to those of their male colleagues. There are no substantial differences between men and women on any of the items we surveyed. Average salaries are not significantly different. The amount of time reported to finish school and to find a job were virtually identical for both sexes.

This equity in employment characteristics is encouraging news for current female graduate students. However, over the last decade, the overall number of female graduates has remained low.





APPENDIX

Methodology

In September 2000, 209 PhD-granting Earth and space science departments received a request for the names and addresses of students who earned a PhD between July 1999 and June 2000. Those who did not respond received a second request in January 2001 and a third in February. By April, 138 departments replied, yielding a 66% response rate.

Questionnaires were sent to 310 recent PhDs between January and April. Of these, 40 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 270 PhDs with valid addresses, 148 responded, for a response 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. Ten 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, 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 1999 and October 2000. Eight students were excluded from the analysis because they received their degrees outside of this range. Five respondents from last year's study have been included in the current analysis because they received their PhD after October 1999. They were not included in the analysis of the previous report, *Earth & Space Science PhDs, Class of 1999* (Giesler, et al) published December 2000. Two other respondents were excluded from the study because their degrees were in unrelated fields. They were surveyed because the institutions they attended granted degrees in the Earth and space sciences.

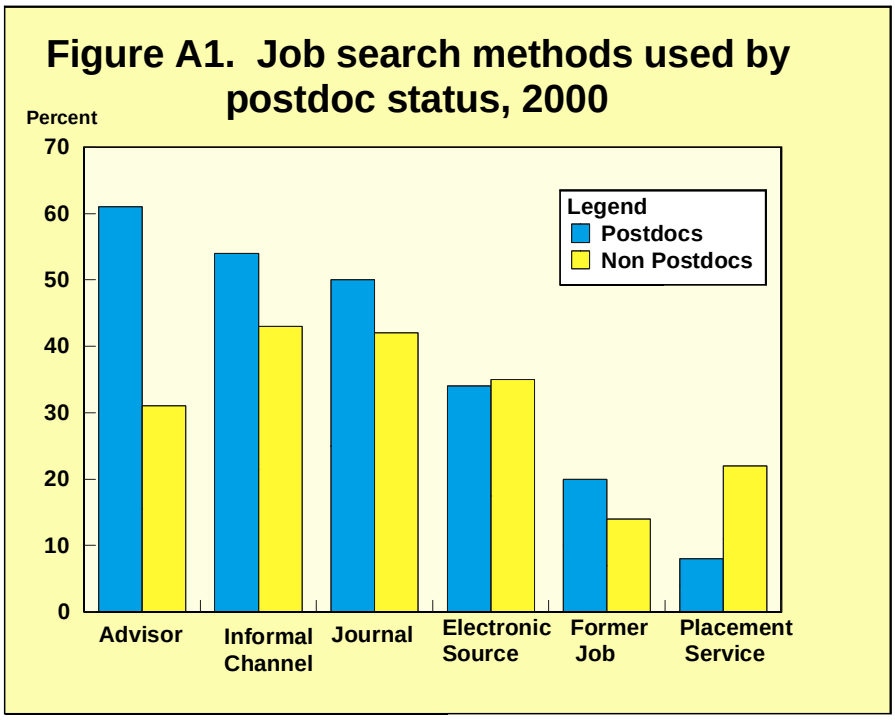
A total of 153 PhD recipients are included in the analysis of this report. Data are excluded only as a last resort when the information provided by the respondent either is not comparable to the aspect under study or does not make sense given other factors. For example, a postdoctorate working at a university could not earn a salary of $80,000 and a full-time worker in industry would not make less than $20,000. Convention leads us to exclude data like these from our analysis, which seldom occurs. The salaries for two respondents were more than two standard deviations away from the mean and were excluded from the salary analysis. Fifteen who have been working at their current job for more than one year and two who are employed abroad were also excluded. Our focus is on initial employment in the US only.

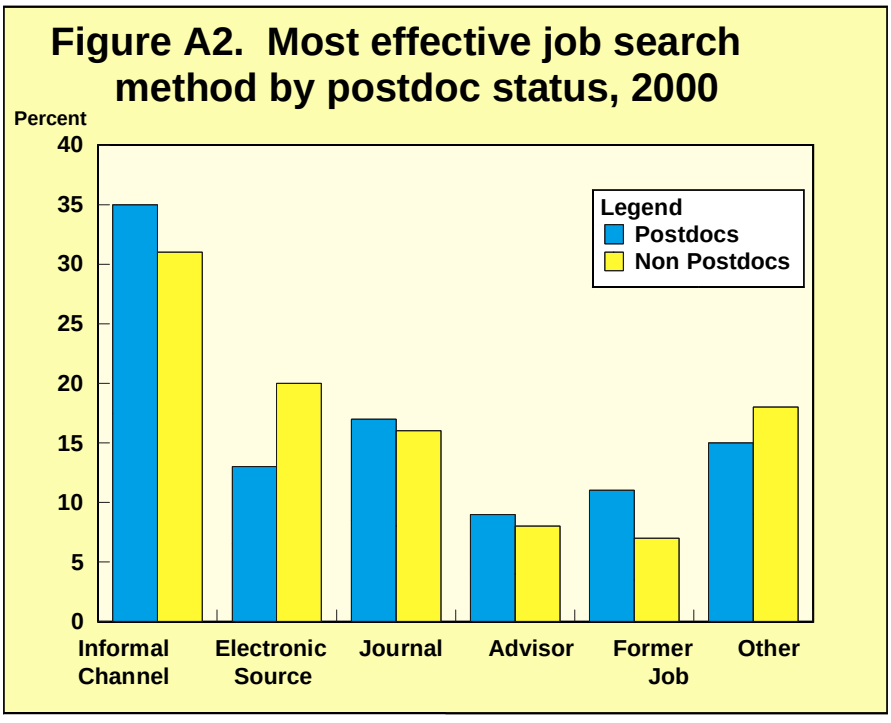
Table A1. Types of employment included in each of the employment sectors

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





Note: Respondents were asked to select all job search methods they used from a list of 11 choices. Figure A1 shows the most common job search methods used, while Figure A2 shows the job search methods that respondents felt were most effective.