

University of Nebraska - Lincoln

DigitalCommons@University of Nebraska - Lincoln

Papers in the Earth and Atmospheric Sciences

Earth and Atmospheric Sciences, Department
of

2003

Where Are the Women Geoscience Professors?

Mary Anne Holmes

University of Nebraska-Lincoln, mholmes2@unl.edu

Suzanne O'Connel

Wesleyan University, soconnell@wesleyan.edu

Follow this and additional works at: <https://digitalcommons.unl.edu/geosciencefacpub>



Part of the [Earth Sciences Commons](#)

Holmes, Mary Anne and O'Connel, Suzanne, "Where Are the Women Geoscience Professors?" (2003).
Papers in the Earth and Atmospheric Sciences. 86.

<https://digitalcommons.unl.edu/geosciencefacpub/86>

This Article is brought to you for free and open access by the Earth and Atmospheric Sciences, Department of at DigitalCommons@University of Nebraska - Lincoln. It has been accepted for inclusion in Papers in the Earth and Atmospheric Sciences by an authorized administrator of DigitalCommons@University of Nebraska - Lincoln.

NSF/AWG FOUNDATION SPONSORED WORKSHOP

Where are the Women Geoscience Professors?



GEOSCIENCE
PROFESSORS



Mary Anne Holmes *and* Suzanne O'Connell

Leaks in the Geoscience Pipeline



WOMEN IN THE GEOSCIENCES

>50%
High School

40%
BA/BS

38%
MA/MS

30%
PhD

21%
Assistant Professor

15%
Associate Professor

6%
Full Professor

What really got me into geoscience was just taking a random class in college as an undergraduate.

Female Assistant Professor



NSF/AWG FOUNDATION SPONSORED WORKSHOP

Where are the
Women Geoscience Professors?

Mary Anne Holmes *and* Suzanne O'Connell

Report on the Workshop

Where Are the Women Geoscience Professors?

September 25-27, 2003, Washington, D.C.

Sponsors

National Science Foundation (Grant No. 123669)

Association for Women Geoscientists

Association for Women Geoscientists Foundation

Acknowledgments

This workshop was conducted with funds from National Science Foundation Grant #123669 and with support from the Association for Women Geoscientists (AWG) and the AWG Foundation. Twenty-five geoscience professors (23 women and 2 men), 14 students (12 women and 1 man) and 4 National Science Foundation Directors participated in the two day workshop held September 25-27, 2003, at the State Plaza Hotel in Washington, D.C. Ms. Karen Spaulding of the National Academy of Engineers and Ms. Toni Penton of the University of Nebraska-Lincoln helped us enormously with logistics, for which we are most grateful. Ms. Heather Henkel of the U.S. Geological Survey is the outstanding webmaster who created the workshop website and keeps it up to date for us. We would also like to thank the contributors and participants for their insights and commitment to gender equity in geoscience classrooms. Julie DeAtley and Julie Jackson turned the workshop prose into this colorful and vibrant document; we can't thank them enough.

Contributors

Mary Anne Holmes, *University of Nebraska-Lincoln*
Suzanne O'Connell, *Wesleyan University*
Gail Ashley, *Rutgers University*
Robin Bell, *Columbia University*
Joanne McGrath Cohoon, *University of Virginia*
Carol de Wet, *Franklin & Marshall College*
Connie Frey, *University of Southern Illinois at Edwardsville*
Pamela Hallock Muller, *University of South Florida*
Julie Winkler, *University of Michigan*

Credits

Photos: Cover – Mountains (Digital Vision); Sampling an outcrop (L. Savoy, AGI Image Bank). Page 5 – Never Summer Range, Rocky Mountain National Park, CO (S. Killgore). Page 15 – Arches National Park, UT (S. Killgore). Inside back cover – Big Thompson River, CO, and Arches National Park, UT (S. Killgore). Back cover – World relief map (Digital Wisdom); Wesleyan commencement photo (B. Buckhart). All other photos courtesy of S. O'Connell, NASA, and Hemera.

Project Management: Julia A. Jackson, GeoWorks
Design: DeAtley Design
Printing: Ries Graphics

CONTENTS

Foreword 4

Preface 5

1 WHAT THE DATA SHOW 6

- Geoscience Faculty Comparisons 8
- Geography Faculty 10
- Status of Geoscience and Geography Faculty 11
- Women Geoscience Faculty by Speciality 12
- Where Geoscience Faculty Earn Degrees 13

2 WHAT THE PERCEPTIONS ARE 14

- What Attracts People to Become Geoscientists 16
 - Undergraduate Experience 17
 - Love of the Outdoors and the Subject Matter 17
 - Family Influences 17
 - Miscellaneous Influences 18
 - K-12 Teacher, Experience 18
- Experiences that Encourage Staying or Leaving 18

3 STRATEGIES TO INCREASE WOMEN FACULTY 20

- Expanding Female Undergraduate Recruitment 21
- Retaining Women through the PhD 24
 - The Role of Faculty 24
 - Professional Development for Graduate Students 25
- Recruiting Women into the Academic Applicant Pool 26
- Tenure Guidelines 27
 - Developing Your Strategic Plan 28
- Retaining Women Professors Beyond Tenure 30
- Other Issues Women Face 30
 - Isolation 30
 - Resolving Family Issues 32
 - When To Have Children 32
 - Maternity and Family Leaves 34
 - Child Care Questions 34
 - Handling Fieldwork and Professional Travel 35
- Looking Towards the Future 35

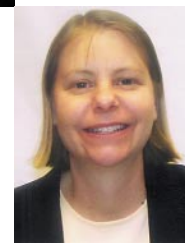
Appendix 36

References 40

List of Participants *Inside back cover*



Margaret Leinen



Jackie Huntoon

FOREWORD

The issues investigated by geoscientists are complex and of great importance to society. Only a diverse workforce can respond to the needs of society with solutions that are based on high-quality basic research and an awareness of the cultural issues that influence human actions. The unique perspectives and approaches employed by women contribute to the geoscience community's success in developing innovative solutions to these problems. Fortunately, the number of women obtaining Bachelor's, Master's, and PhD degrees in the geosciences increased substantially during the last half-century. This trend has benefited the geoscience community in its efforts to develop innovative and creative approaches to our science. The importance of maintaining and building diversity in the workforce will only increase in the future.

Compared to the time during which we were in college, the geosciences have become, for the most part, a comfortable place for women students. Sufficient numbers of women are now enrolled in academic programs that an extensive peer network can exist. The formal and informal peer-mentoring provided by and for women through this network contributes to increased confidence, aspirations, and success of women throughout the geosciences. Women who now occupy prestigious positions within academia and in industry serve as role models for other, more junior women. The battles fought and won by the pioneering women who now occupy prominent positions have helped to ensure that it will be easier for women to be successful as they pursue challenging careers. Such women can serve as mentors and role models.

The use of peer-mentoring networks and role models are two of the most effective strategies to increase gender diversity. The geoscience community needs to continue to expand these types of activities—both formally and informally. Other methods should also be tested, evaluated, and implemented as appropriate. Despite the geoscience community's success at attracting greater numbers of women during the last two generations, there is room for improvement: women make up approximately 50 percent of the world's population, but less than 20 percent of the geoscience academic workforce. Within academia, the percentage of women in faculty positions falls steadily with increasing rank, and many women are employed in part-time or other non-tenure track positions. It is significant that more than 60 geoscience PhD-granting institutions in the United States have no women on their faculty, and over half have only one. The importance of role models and mentors cannot be overstated; one of the best ways for the geoscience community to continue to diversify its ranks is to diversify its faculty.

"Where Are the Women Geoscience Professors" compiles an extensive set of data on the status of women in the geosciences. The identification of successful strategies for increasing diversity as well as obstacles that hinder efforts will make this report of interest to many. The lessons learned and best practices that arise from this report will help geoscientists continue to increase the gender diversity of their community. Some of these lessons also provide insight into ways to improve the racial and ethnic diversity of the geosciences. We congratulate the contributors to this report on their effective use of a data-based approach to investigating and documenting gender-related issues in the geosciences!

Margaret Leinen, Assistant Director for Geosciences, National Science Foundation

Jackie Huntoon, Program Director for Diversity and Education, National Science Foundation

P R E F A C E

When we graduated with a cohort of 20 percent female students 30 years ago, we thought that by this stage of our careers we would not be asking, "Where are the women geoscience professors?" Scientists in all fields at the National Science Foundation (NSF) asked the same question for their fields, and in 2001, they inaugurated the ADVANCE program to increase the numbers of women in academic positions in science, technology, engineering, and math (STEM) fields. As president of and chair of the Outstanding Educator Committee (respectively) for the Association for Women Geoscientists (AWG) at the time, we felt that AWG was the perfect organization to address this question for the geosciences. Since its inception in 1977, AWG has been devoted to enhancing the quality and level of participation of women in the geosciences and to introducing girls and young women to geoscience careers by providing opportunities and support for women at all stages of their careers.

Although any career in which geoscientists feel fulfilled is a success, we wonder why fewer women choose an academic career than their male peers. The workshop, "Where are the women geoscience professors?", funded by NSF, the AWG, and the AWG Foundation, was conducted to bring together as many geoscientists as possible to share data on the status of women in the geosciences and to brainstorm positive strategies to increase the proportion of women in geoscience academia from its current 13 percent. This report is designed to disseminate the information we gathered together for all interested in gender equity in the geosciences, particularly chairs of geoscience departments, and to provide junior faculty with some guidance on negotiating a successful academic career.

We provide data on the numbers of women in geoscience departments by type of degree granted, what ranks women hold, where they get the PhD degree and the specialty of their PhD degree. We provide the results of 12 focus groups we conducted with geoscientists from a variety of institutions by teleconference in early 2003 to determine what attracts a student into our field and some factors that might drive someone out of it. Finally, we offer strategies for departments to recruit and retain female professors. This list of recommendations was generated from a brainstorming session at the end of the workshop.

A department can begin to create a faculty that reflects the undergraduate and graduate makeup by recognizing that gender equity is an issue and by discussing ways to resolve the issue. They might then examine the strategies as well as the critical leaks in the pipeline to see what opportunities are available for turning things around. Recognizing the problem is the initial step toward solving it, but the next step, adopting practices and strategies to positively change the situation, is essential for success. We hope that with discussion and positive strategies, the graduating class of '04 will never wonder what happened to their peers along the way to an academic career.

Mary Anne Holmes and Suzanne O'Connell
December 2004



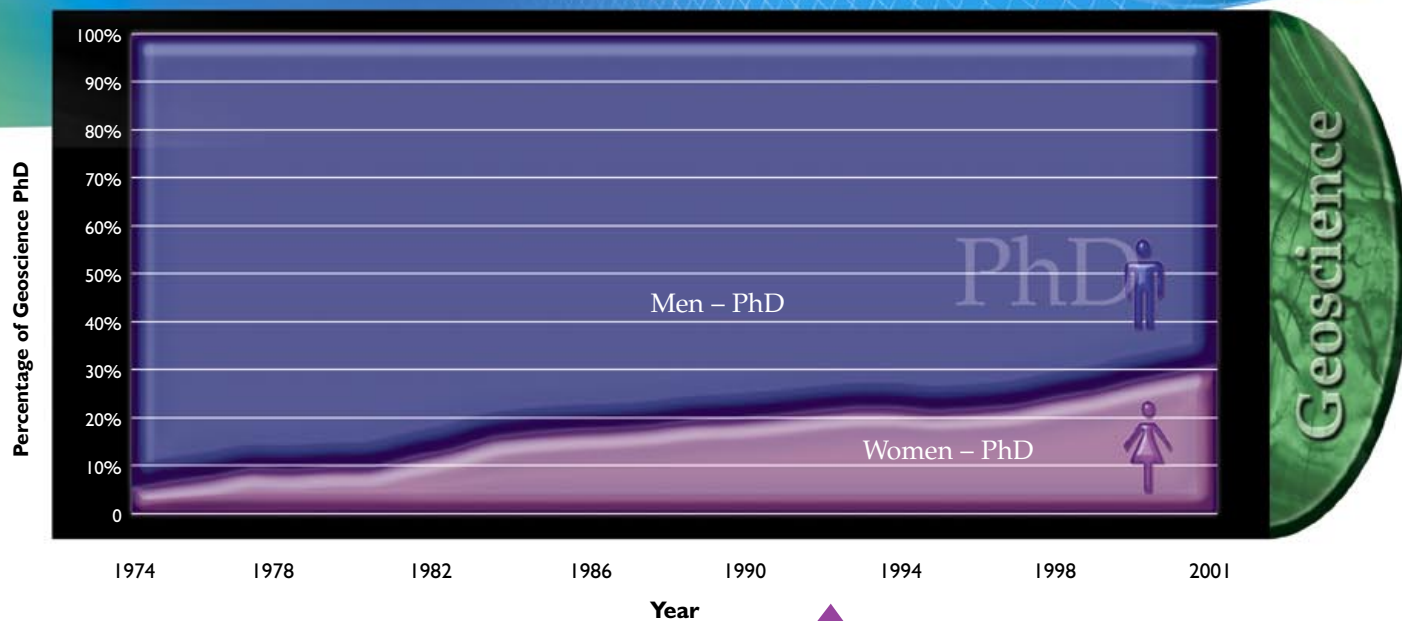
WHAT THE DATA SHOW

1

- As the diversity of the U.S. population increases, gender diversity of the geosciences must increase to supply future geoscientists.
- Current supply from undergraduate pool is insufficient to increase the number of women geoscientists; there are too many *"leaks in the pipeline"*.
- Small increases in numbers of female students can produce large increases in diversity provided retention is increased.
- Major reasons for lack of gender diversity of the faculty in the geosciences are
 - Under-recruitment of women into the major,
 - Too many women drop out before obtaining a PhD, and
 - Low rate of hiring women into tenure-track positions.

Between 1974 and 2001, the number of women receiving geoscience degrees increased, and the number of men receiving geoscience degrees decreased. Thus, the percentage of women who earned geoscience degrees during this period increased. These data indicate that there is a small leak (< 5%) of women out of the geoscience academic pipeline between bachelor's and doctorate degrees. This leak has decreased since 2001.

GEOSCIENCE PhD DEGREES

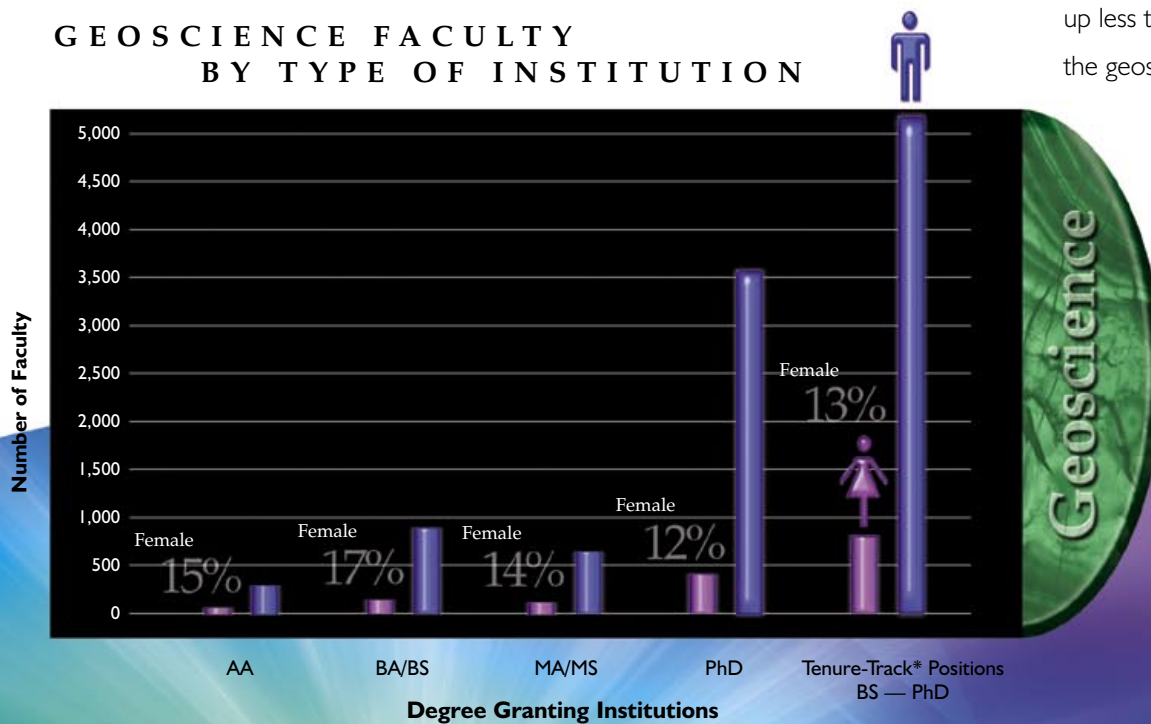


▲ In 2000, 230 women and 527 men received PhD degrees in the geosciences. These data are compiled by the National Science Board for the National Science Foundation. Tabulated data appear in the Appendix.

Geoscience Faculty Comparisons

At most colleges and universities women make up less than 15 percent of the geoscience faculties.

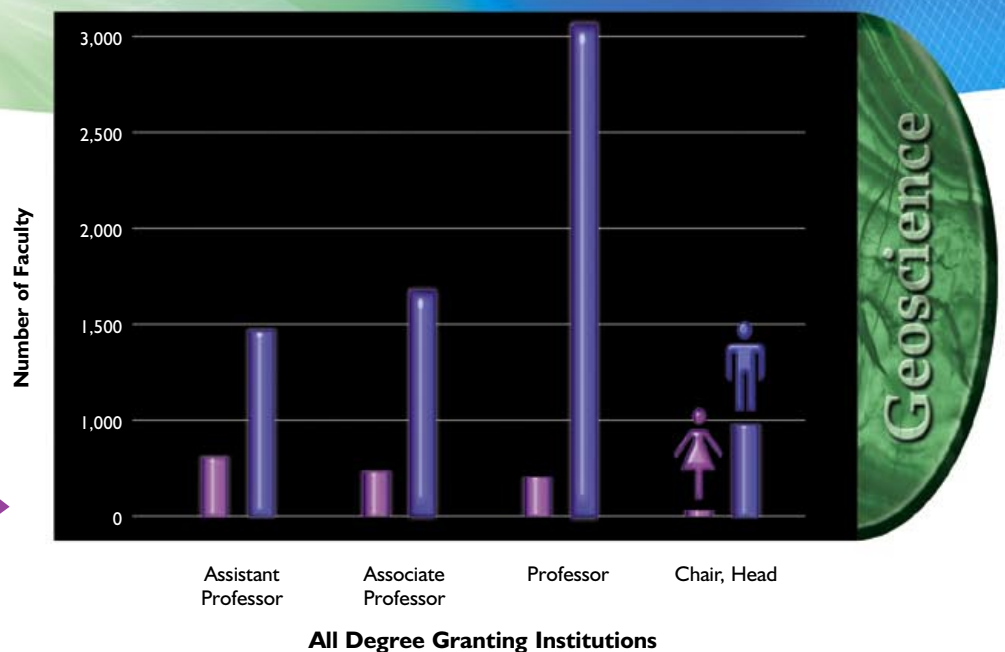
**GEOSCIENCE FACULTY
BY TYPE OF INSTITUTION**



◀ Data are from Holmes and others' analysis of the American Geological Institute's *Directory of Geoscience Departments* (Holmes et al., 2003). *Based on total male and female, and gender unspecified. Emeriti faculty not included.

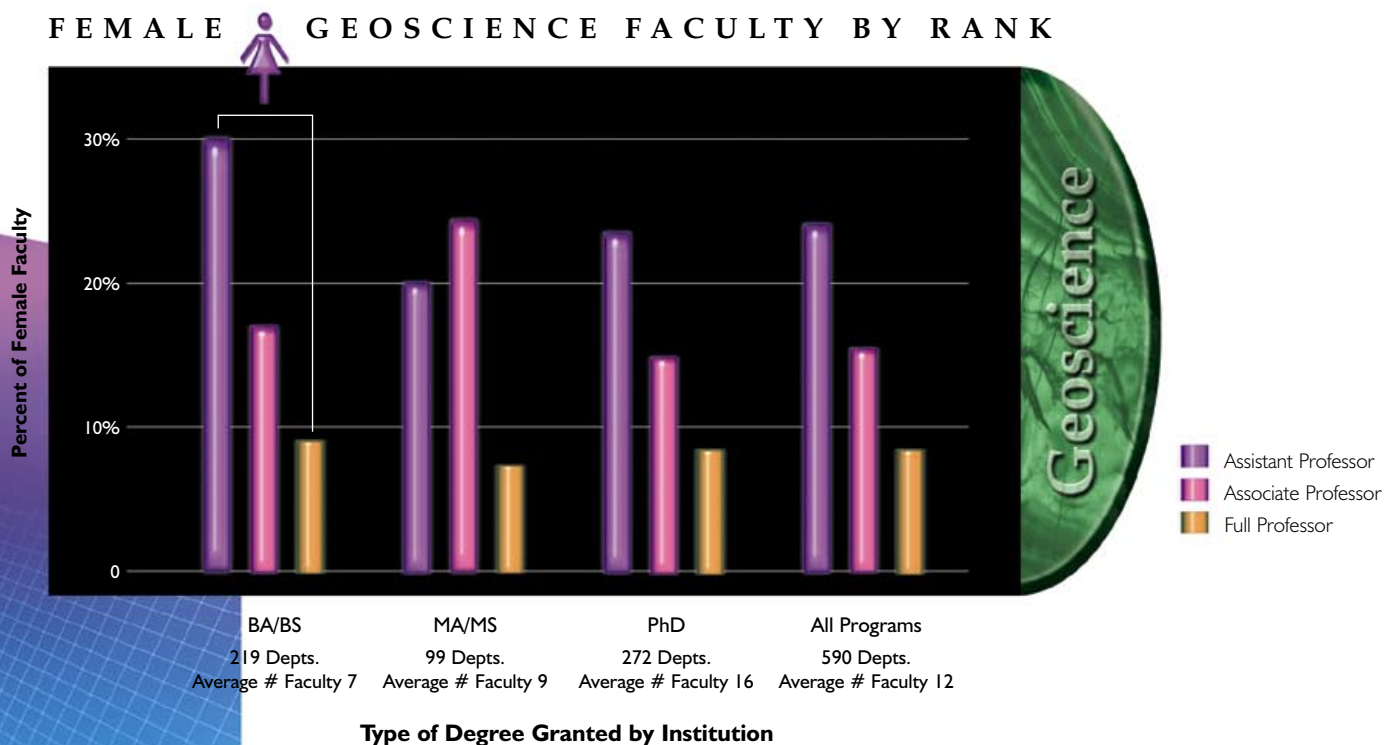
Most women in geoscience departments hold the rank of Assistant Professor, and most men hold the rank of Professor. Fewer than 10 percent of the women are full professors or department heads.

GEOSCIENCE FACULTY BY RANK



▶ In geoscience departments, the proportion of women declines at increasingly advanced ranks. Data from AGI *Directory of Geoscience Departments*, 2002.

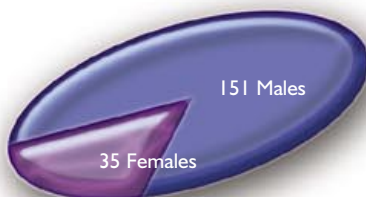
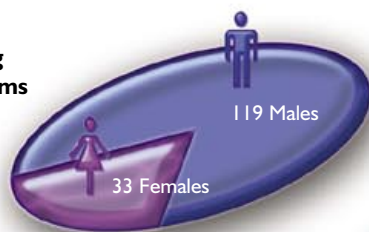
When faculty rank is compared by type of institution, the percentage of "Assistant Professors" who are women decreases as the degree granted by the institution advances. The percentage of "Full Professors" who are women is roughly the same among the three types of institutions.



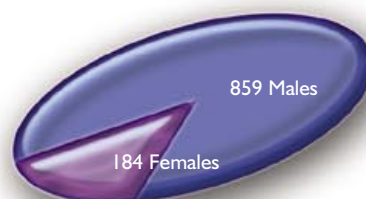
OTHER RESEARCH AND TEACHING INSTITUTIONS

At other research and teaching institutions that employ geoscience PhD's, the proportion of women working in substantive positions ranges from 13 to 18 percent.

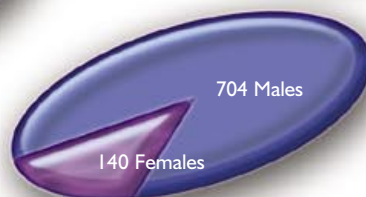
Non Degree Granting Academic Programs



Museums



State Geologic Surveys



Research Centers

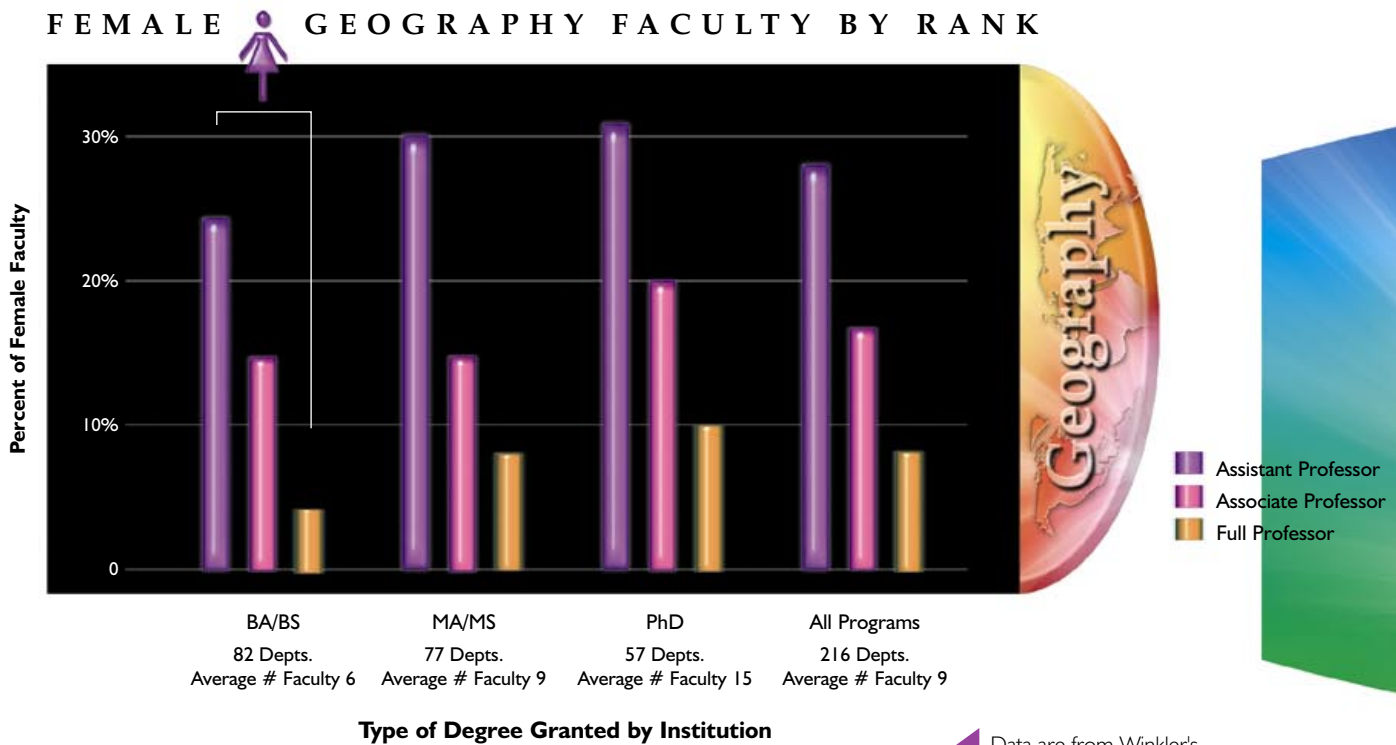
Substantive positions are defined as positions such as research associate, director, and do not include adjuncts, visitors, or administrative assistants. Data are from Holmes et al., 2003b.



Geography Faculty

In geography as in geoscience departments, most women hold the rank of Assistant Professor. However unlike the geosciences, more women in geography teach at PhD-granting institutions than at BA/BS-granting institutions.

FEMALE GEOGRAPHY FACULTY BY RANK

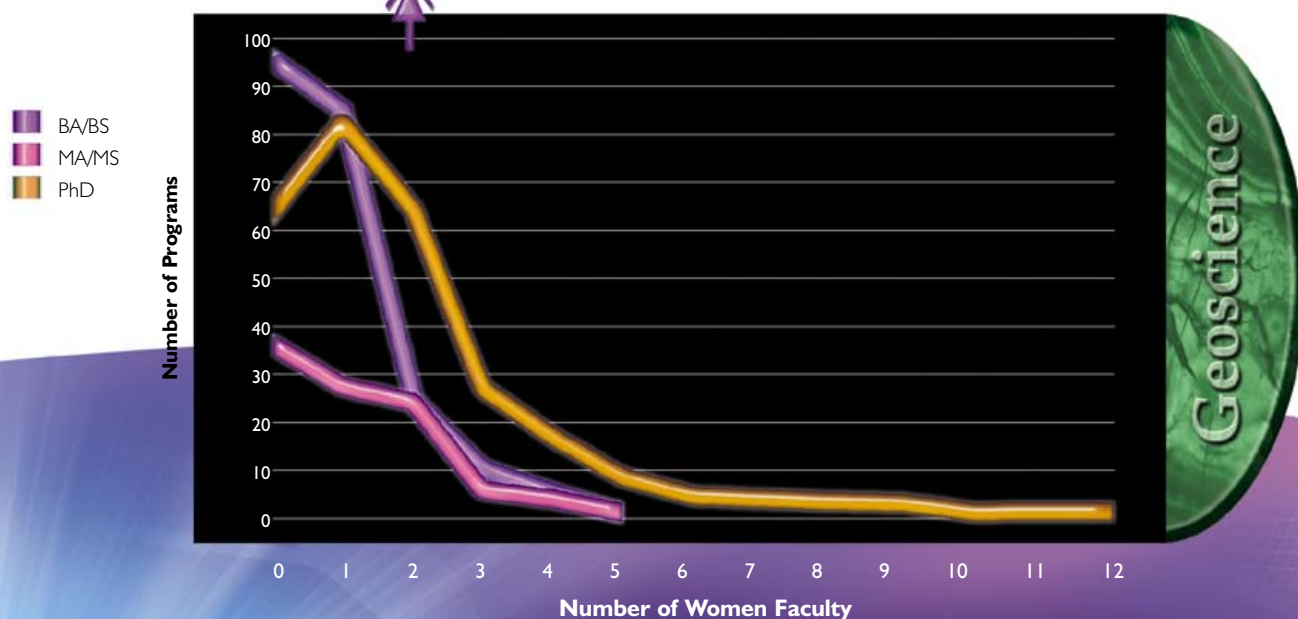


◀ Data are from Winkler's analysis of the 1997-1998 *Guide to Geography Departments* published by the Association of American Geographers.

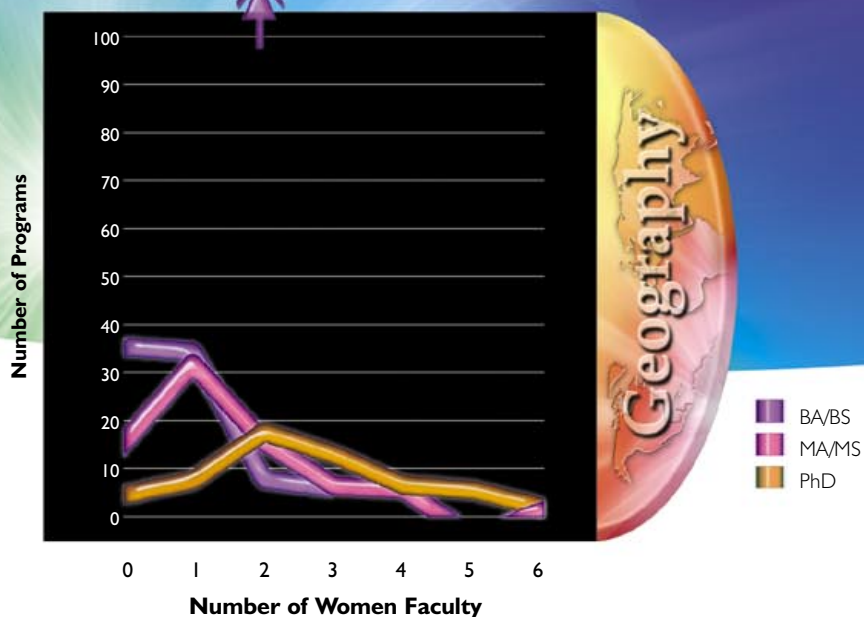
Status of Geoscience and Geography Faculty

At PhD-granting geoscience institutions, more than 60 departments still have no women on their faculty. The types of departments include engineering, geology/geoscience, agronomy, and oceanography. Most departments have 11-15% women on their faculty, which is about one woman per typical department. One BA/BS school has one woman faculty member and no males. Isolation is a critical problem that exacerbates retention issues for "only woman in the department" faculty. According to the *Guide to Geography Departments*, (1997), 56, or 26% of departments still have no women on their faculty. Most departments have 1-3 women. Isolation is also a problem for female faculty in many Geography departments.

FEMALE GEOSCIENCE FACULTY

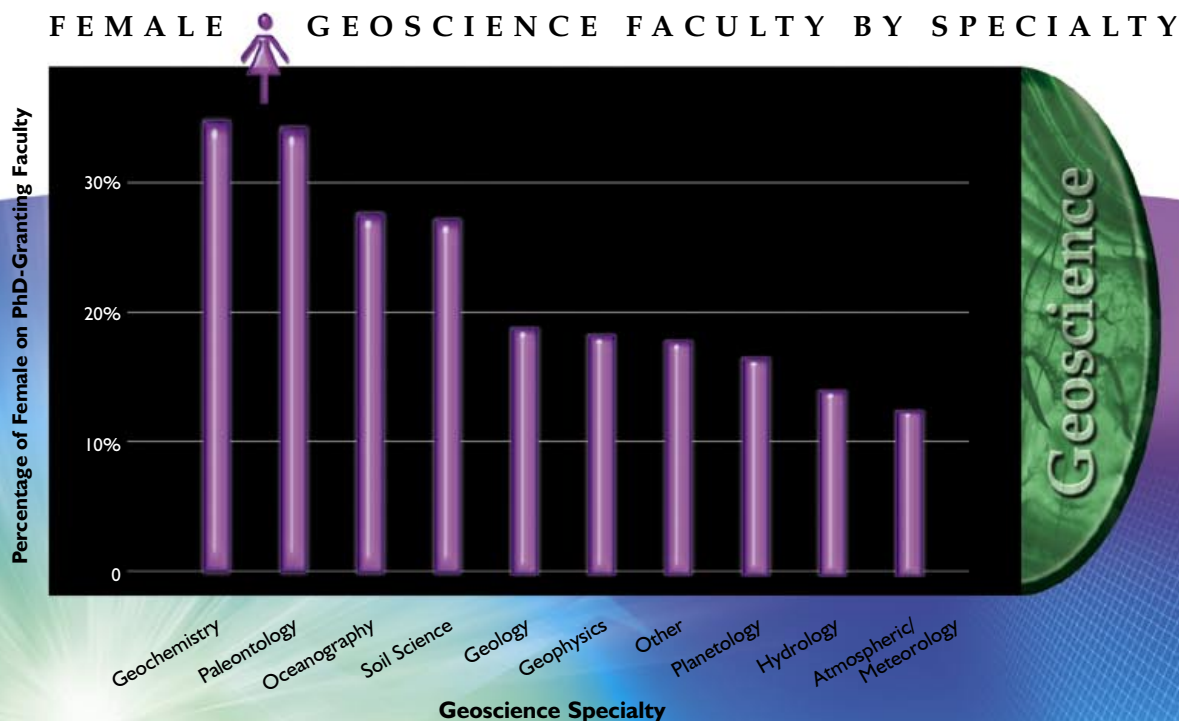


FEMALE GEOGRAPHY FACULTY



Women Geoscience Faculty by Speciality

A higher than average percentage of women in tenure-track positions at PhD-granting institutions, who received their PhD in the last 10 years, were hired in the fields of geochemistry, paleontology, oceanography, and soil science.



These "specialties" are self-reported in the AGI Directory, 2002. Individuals may select up to three "specialties" to be listed with their entries.

"Geology" includes the following fields: general geology, archaeological geology, environmental geology, geomorphology, glacial geology, marine geology, mineralogy & crystallography, paleolimnology, petroleum geology, general petrology, igneous petrology, metamorphic petrology, sedimentary petrology, sedimentology, physical stratigraphy, structural geology, tectonics, volcanology, mathematical geology, mineral physics and history of geology.

"Other" includes the following fields: General Earth Sciences, Earth Science Education, Physical Geography, Ocean Engineering/Mining, Remote Sensing, Soil Science, Material Science, Land Use/Urban Geology, and miscellaneous.

For a comparison of PhD production by specialty compared to hiring at PhD-granting institutions over the last 10 years, see Holmes et al., 2003. Recall that the average female geoscience PhD production between 1991 and 2001 is 24 percent. Detailed tables of specialty and gender composition are given in the Appendix.

Where Geoscience Faculty Earn Degrees

Between 1991 and 2000, 8,032 PhDs were awarded in the geosciences. Twenty-four percent of these PhDs went to women. 1,213 of the total PhDs (15%) are listed in the 2002 AGI *Directory of Geoscience Departments*. Most (n=800) are now employed at PhD-granting institutions.

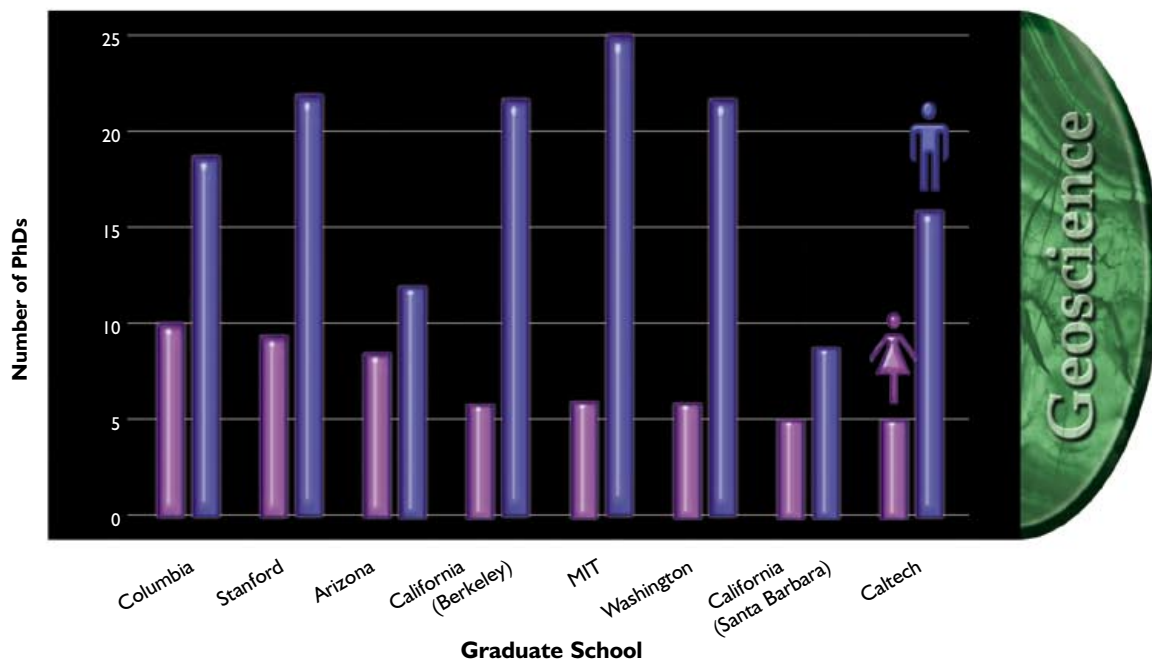
More than half of the people now employed by PhD-granting geoscience departments, who received a PhD between 1991 and 2000, and are listed in the 2002 AGI *Directory of Geoscience Departments* received their PhDs from 25 schools. 52 percent of the men graduated from 25 schools and 62 percent of the women graduated from 25 schools. This concentration of graduate institutions suggests that a degree from one of these schools may accelerate an academic career. However, the degree from a select school may not benefit men and women equally.

Of the 331 women who received a PhD between 1991 and 2000 and who are listed in the 2002 Directory, 176 (53%) are at PhD-granting institutions, 50 (15%) are at Master's-granting institutions, and 105 (32%) are at Bachelor's-granting institutions. For men, the proportions are significantly different (using chi-squared distribution): 624 (71%) of the 1991-2000 PhDs in the 2002 AGI Directory are now at PhD-granting institutions, 158 (18%) are at Master's-granting institutions, and 100 (11%) are at Bachelor's-granting institutions. Fifty-one percent of the hires at Bachelor's-granting institutions between 1991 and 2000 were women, while only 22% of the hires at PhD-granting institutions over the same time period were women.

The top 25 schools for women match 14 of the top 25 schools for men. In addition to the schools listed in the figure below, Johns Hopkins, Miami, SUNY (Stony Brook), Arizona State, North Carolina, Oregon State, Utah, Brown, and UC-Davis are among the top 25 PhD-producers for females but not for males.

TOP SCHOOLS FOR FEMALE GEOSCIENTISTS

The top eight schools for female geoscientists who are now in tenure-track positions at PhD-granting institutions. These data cover the period from 1991-2000. During the same period, schools not listed here include five that have produced four female PhDs, 10 that have produced three, and 12 that have produced two female geoscientists who are in tenure-track positions.



WHAT THE PERCEPTIONS ARE

2

- Many women perceive that they are not welcome in the geosciences.
- Many geoscientists perceive that women will always be "held back" by family responsibilities.

Q ➤ Many geoscientists perceive that if we wait, the "pipeline" will eventually accomplish gender equity in the geosciences.

A ... However, the undergraduate pool is insufficient to increase diversity; there are too many "leaks in the pipeline." If current trends persist and we wait for the pipeline to provide gender equity, we will wait another 46 years.

Q ➤ What proportion of women is "equity"? Should academic geoscientists mirror the makeup of the general population, the college population, their own undergraduate pool, or the pool of PhD recipients?

A ... Perhaps equity is achieved when there are enough women to provide a range of role models so that each undergraduate who might aspire to an academic career will have an inspiration, a person on the faculty whose life they wish to emulate.



We conducted 12 focus groups in early 2003 to learn geoscientists' perceptions of gender equity and associated issues. We focused discussion on the following student and faculty groups, because leaks in the pipeline, i.e., the loss of female geoscientists, occur between each category.

1. Bachelor's and Master's candidates
2. PhD's and Post-Docs
3. Assistant Professors
4. Associate and Full Professors
5. Administrators
6. Non-tenure track personnel

Each category had a separate male and female focus group. Participants for groups 3, 4, and 5 were selected at random from the 2000-01 *AGI Directory of Geoscience Departments* and included persons from AA-granting institutions through research institutions. We attempted to recruit persons from under-represented groups and were successful for about half of the focus groups. Participants for groups 1, 2, and 6 were recruited by calling randomly selected geoscience departments and asking for potential participant names. Potential participants were recruited via e-mail and telephone and offered a \$50 incentive. Each focus group had five to nine participants and a total of 91 geoscientists participated in the study.

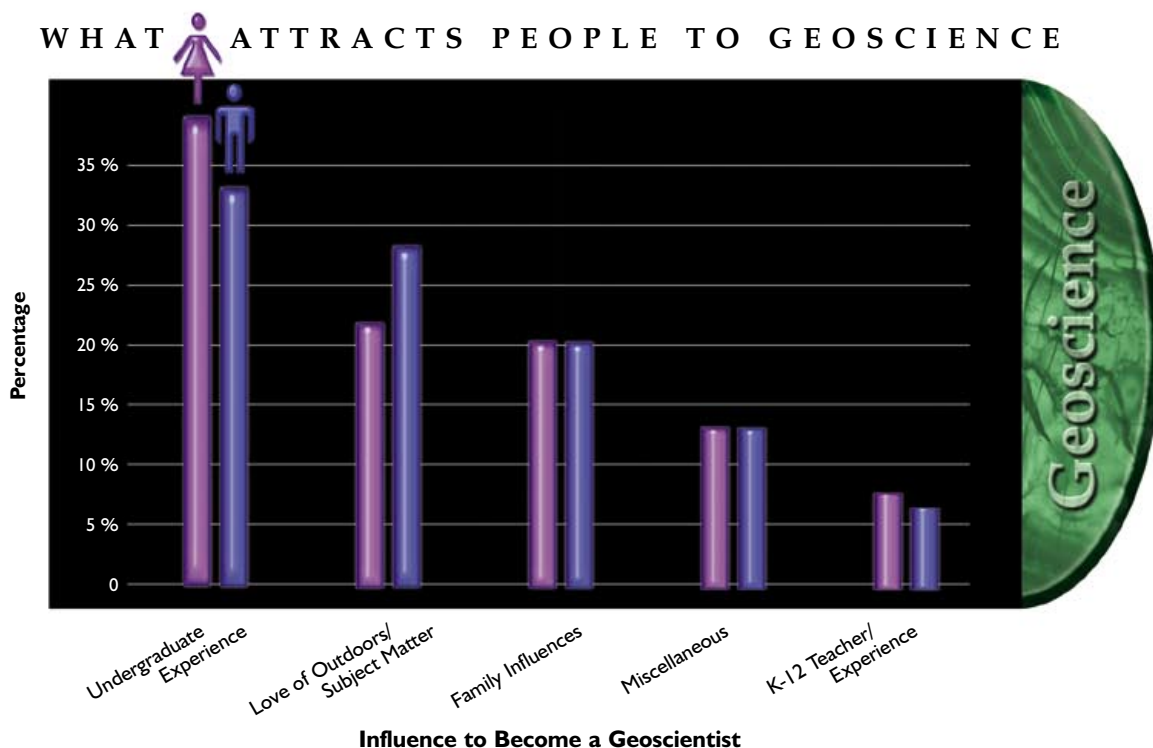
The focus groups were conducted via teleconference so that we could include persons from across all U.S. time zones. Each focus group was tape-recorded, and the teleconference company provided written transcripts. The focus group leaders, Connie Frey and John Horvick, are from the University of Nebraska-Lincoln Bureau of Sociological Research. She led the female groups,

and he led the male focus groups. For most of the focus groups, Mary Anne Holmes participated on a muted line and communicated with Connie and John via instant messaging/internet. (Details of the relative benefits of teleconferencing vs. face-to-face focus groups are given in Frey and Horvick, 2003.)

Protocol for focus groups calls for an opening "ice breaker" question, and we chose "What brought you into the geosciences?" as a question to get participants talking. Responses to this question yielded a wealth of valuable information. Following the "ice breaker" question, we asked participants what their perception is of women's status in the geosciences. Then we asked them to open an envelope that contained the data given in Section I of this report. After perusing the data, participants were asked about their perceptions of the data and how the data coincided or conflicted with their pre-conceptions of the status of women in the geosciences.

What Attracts People to Become Geoscientists

Five major themes emerged as participants discussed what had brought them into the geosciences. The top reason for women (and men) is a compelling experience at the undergraduate level, generally an interesting, exciting course and/or professor (teacher). The most effective means to increase recruitment to the geosciences is to have interesting, exciting freshman-level classes. These classes are of prime importance to the health of our field.



Undergraduate Experience was cited by 38% of the female participants and 33% of the males as the most common reason for pursuing a career in the geosciences. The greatest number of participants mentioned a specific class that excited them (n=31). The second highest influence was a specific teacher (n=16). Other participants cited a particularly fun or impressive field trip (n=8), a friendly, helpful atmosphere within their department (n=8), or a meaningful experience working in a laboratory (n=3). The women were slightly more likely to couch these positive experiences in terms of relationships with professors, peers, colleagues or mentors than were the men.

“I took an intro geology course in college and that pretty much got me hooked.

Male PhD candidate

Love of the Outdoors and the Subject Matter A few more men (28%) cited this attractor than women (22%). Some participants had "always loved the outdoors" and were delighted to find they could study what they loved.

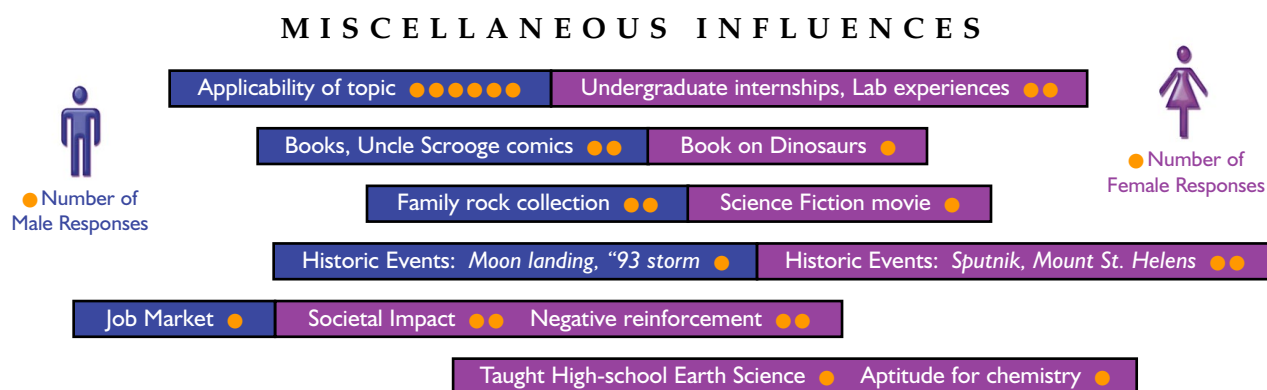
Family Influences Geoscientists recalled vacations with their families, or a parent, sibling, aunt, uncle or grandparent who was interested in or collected rocks (for geologists). Equal proportions of men and women (20%) cited these experiences as being the most influential in bringing them into the field.

- Women mentioned (in order): 1) father, 2) mother, 3) sister, boyfriend
- Men mentioned (in order): 1) father, 2) grandfather, wife, friend, 3) brother
- For both: family vacations, traveling

“My dad had... an influence... we would go on family trips and look at geological points of interest along the way.

Female Assistant Professor

Miscellaneous Influences The same proportion of men and women (13%) gave a variety of influences from books to historic events to the job market. Two women cited "negative reinforcement" as a motivator to become a geoscientist. This motivator included male professors telling them that they did not belong in the field or could not become geoscientists.



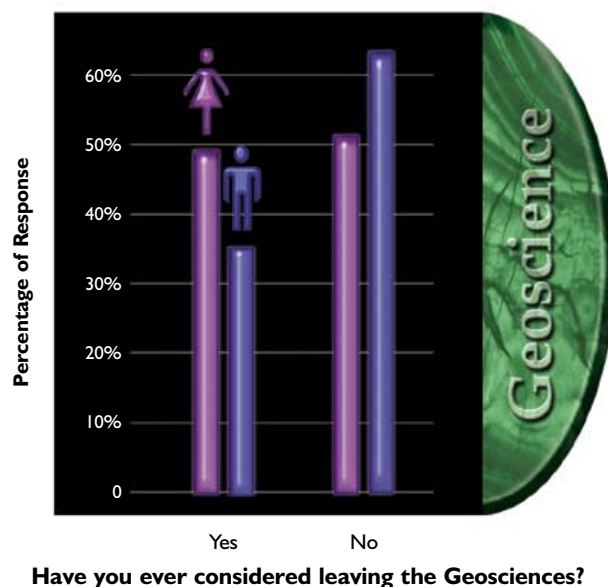
K-12 teacher, experience A small proportion of respondents cited some pre-college teacher or experience as a primary motivation for entering the geosciences. This small proportion probably reflects the fact that the geosciences are not taught in many high schools and that where it is taught, it is often perceived as the "soft" science, the "science for dummies".

Experiences That Encourage Staying or Leaving

Participants were asked "Have you ever considered leaving the geosciences?" to derive some sense of how comfortable males and females are with the current atmosphere in the geosciences. Nearly half of the women said "yes", while only one third of the men said "yes". The reasons cited for leaving varied by gender as well.

The most-cited reason for men who had considered leaving the geosciences was "uncertain job market," and one respondent who had concerns that his graduate student stipend would not support a family. The most-cited reason for females was "family issues" followed closely by "problems with graduate advisor".

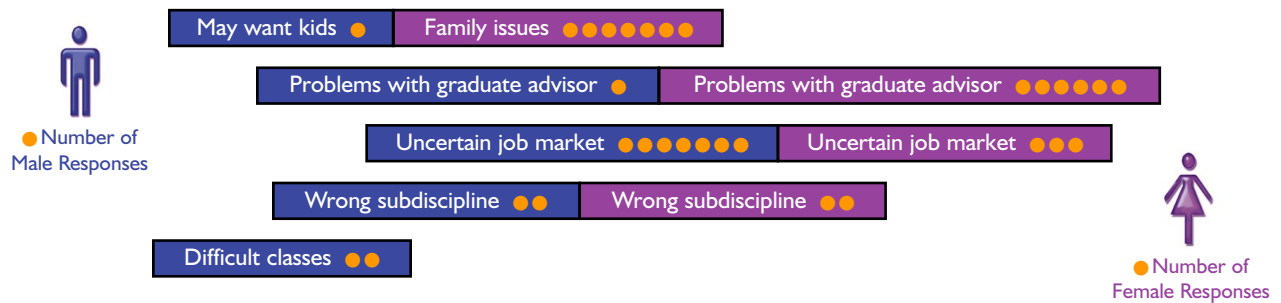
RESPONSE TO LEAVING THE GEOSCIENCES



“I considered leaving when I had my second child and had just gone through tenure....I had a lot of teaching, a lot of research, and a lot of pressure...I felt overwhelmed.”

Female Full Professor

REASONS FOR LEAVING THE GEOSCIENCES



In addition, the issue of advising must be addressed if we are to retain women. Six of thirty female respondents mentioned graduate advisor issues, using such phrases to describe their advisors as, "cold...contemptuous...", "not encouraging", "gave unrealistic job market advice" and described their own situation thus: "taken advantage of".

Several respondents discussed advisors who held a "sink or swim" attitude, wherein the advisor lavished attention on the student to recruit her or him to a graduate program, then offered no information on how to navigate the graduate program and did not specify what actions were expected of the student once the student enrolled. Such students felt isolated, felt they were to blame, and floundered for a period of one to two years before either switching advisors or muddling through the graduate program.

Geoscience faculty can and should use mentoring and good advising to benefit all students. If the geosciences are to retain women in the pipeline towards academia, colleges and universities must deal with the issues of lack of mentoring, poor advising, providing daycare options, and accommodation of the fact that some of their students and faculty will have children. The following section includes information and resources on these topics.

STRATEGIES TO INCREASE WOMEN FACULTY

► Strategies to increase diversity in the geosciences:

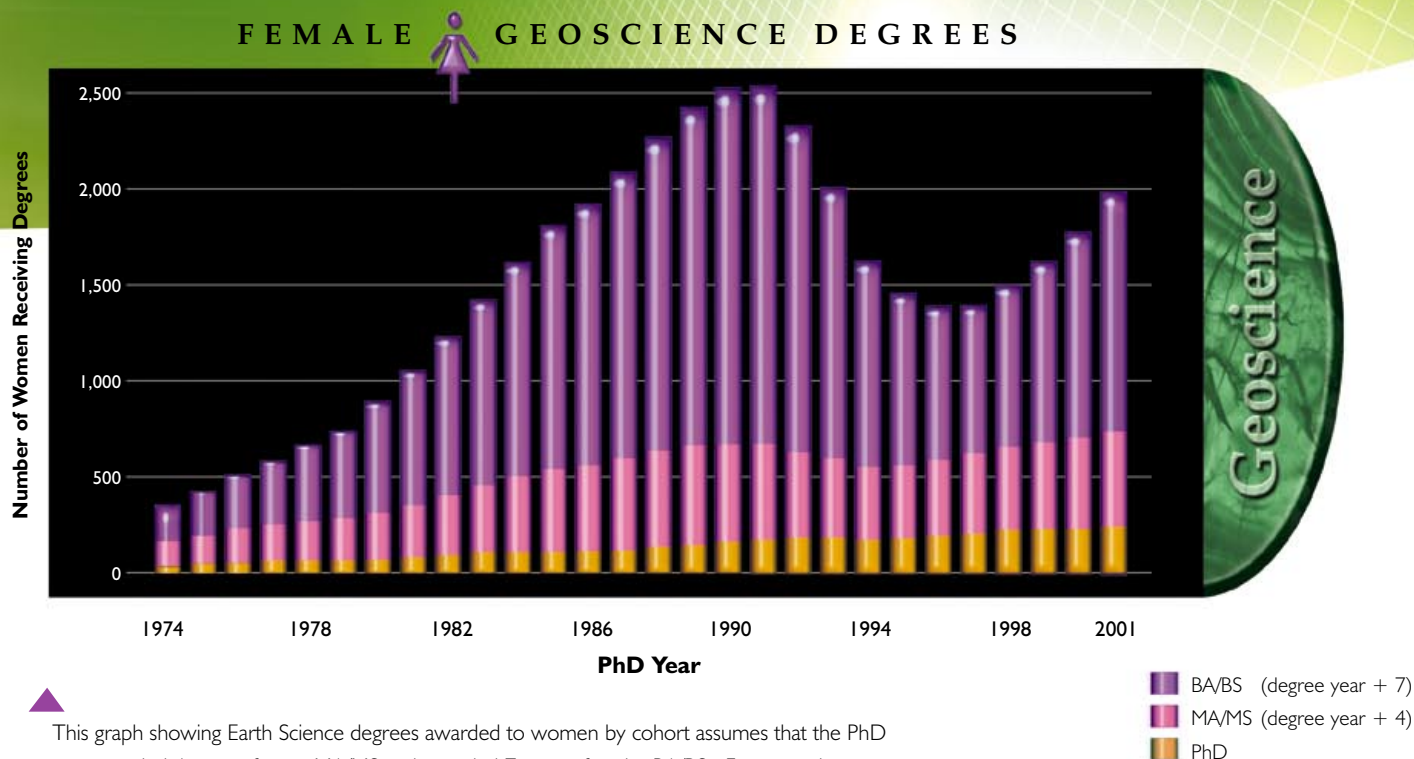
- Fairness in the classroom,
- Good advising at all levels,
- Mentoring,
- Aggressive recruitment, and
- Flexible tenure-track appointments.

► Other issues women face:

- Resolving family issues,
- When to have children,
- Maternity and family leave,
- Childcare questions, and
- Handling fieldwork and professional travel.

Expanding Female Undergraduate Recruitment

Undergraduate programs are the lifeline for the geosciences. Since the geosciences do a better-than-average-STEM-discipline of retaining females into PhD programs, a small percentage increase at the undergraduate level will yield more female PhDs. Cohoon and others (2003) estimate that a 6 percent increase in female undergraduate majors will produce parity in PhD production sooner. This amounts to an additional 104 female undergraduate baccalaureate recipients nationwide each year. At the current rate of bachelors' receipt, i.e., with no increase in recruitment to the major or retention, women will not reach parity at the PhD level until approximately 2032 (Cohoon et al., 2003).



This graph showing Earth Science degrees awarded to women by cohort assumes that the PhD was awarded 4 years after an MA/MS and awarded 7 years after the BA/BS. For example, someone who received a PhD in 1994 would have received an MA/MS in 1990 and a BA/BS in 1987. The number of women receiving PhDs in the Earth Sciences continues to grow. The number of female PhDs has not increased as rapidly as the number of women receiving BA/BS degrees.

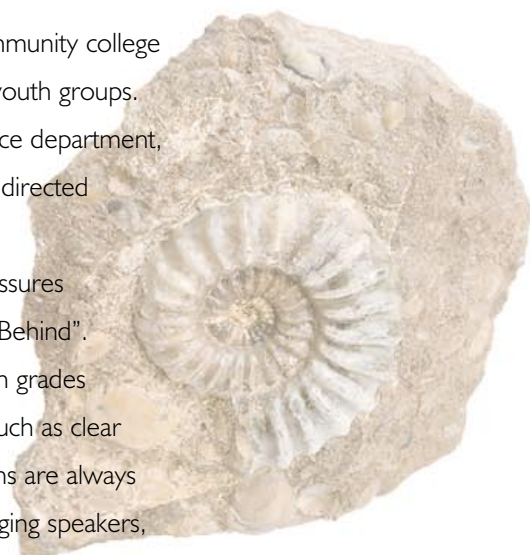
To increase female undergraduate geoscience majors, geoscience departments can increase outreach efforts to pre-college and community college students. For such efforts to work, departments must place value on outreach in the faculty reward system. There are several outlets for funding geoscience outreach programs, from small efforts by the AWG Foundation to larger scale efforts from the National Science Foundation. Outreach efforts are now an essential component for normal research grant proposals to NSF because of the requirement that principal investigators demonstrate “broader impacts” of the proposed research on the community.

A variety of outreach programs can be conducted in pre-college and community college classrooms, in informal settings such as museums, with scouts, 4-H, or other youth groups. Other outreach possibilities include visits by pre-college students to a geoscience department, and field trips and courses to areas of local geoscience interest. Efforts may be directed towards students or towards teachers and teachers-in-training.

In formal classroom settings, geoscientists need to be sensitive to the pressures already on teachers to fulfill requirements of mandates such as “No Child Left Behind”. Those doing outreach should be familiar with the local curriculum, know which grades are covering which areas of science, and provide resources for the teachers, such as clear handouts and appropriate, reliable websites. Rock, mineral, and fossil specimens are always welcome to cash-strapped schools. Departments should send their most engaging speakers, including graduate students who may appear more approachable to students and teachers alike.

Our focus group results indicate that “the field”, the outdoors, is what captured the imagination of at least one-fourth of currently practicing geoscientists. Finding their own fossil or mineral specimen is a thrill few children can resist, and there are many ways to provide that opportunity. In October, geoscience departments can participate in Earth Science Week, an annual event started by the American Geological Institute to promote awareness and understanding of the earth sciences. Scouts troops and 4-H groups provide a ready pool of young students pre-disposed to the outdoors, and they supply accompanying adults and insurance coverage. Museums or departments can hold “meet-a-scientist” day, participate in local Science Olympiads, judge at local Science Fairs, and participate in “Expanding Your Horizons”, sponsored by the local American Association of University Women (AAUW) chapter. The AWG Speaker’s Bureau can be used as a resource for professional women geoscientists to serve as keynote speakers at such events. Find what local AWG members are doing by visiting the AWG website or request local AWG members to contact the department to help by sending a message to AWG E-Mail News (editor@awg.org).

Gender equity in the classroom is essential to attract and retain female students. Even the best teachers may have an unconscious bias, as demonstrated by Sadker and Sadker (1995) and AAUW (1995). Instructors should be careful to call on all students in a classroom, noticing tentative hands as well as robustly waving arms. Instructors may even collect data on themselves, noting whether they are calling on male and female students proportionately.



Sadker and Sadker and researchers for AAUW noted that female students commonly are tentative and timid in their answers (and questions), and often inflect answers as questions. Instructors tend to lose patience with such behavior, cutting the student off, finishing the sentence for them, or allowing another student to interrupt. In a fair classroom, an instructor will make eye contact with the speaking student, and never interrupt him or her, nor allow any other student to interrupt.

Sexual harassment in any form is illegal. Particular care should be taken to keep field camps completely free of any hint of sexual harassment, with spot visits by the department chair, if necessary. Section 703 of Title VII of the 1964 Civil Rights Act, states:

*Unwelcome sexual advances, requests for sexual favors, and other verbal or physical conduct of a sexual nature constitute sexual harassment when 1) submission to such conduct is made either explicitly or implicitly a term or condition of an individual's employment, 2) submission to or rejection of such conduct by an individual is used as the basis for employment decisions affecting such individual, or 3) **such conduct has the purpose or effect** of unreasonably interfering with an individual's work performance or **creating an intimidating, hostile, or offensive working environment.** (emphasis added)*

This law applies to graduate student teaching assistants as well as to faculty of either gender. Inappropriate posters, cartoons, or other paraphernalia have no place in graduate student or faculty offices. A statement to this effect from the department chair on an annual basis, particularly included in new teaching assistant orientation, will go far to eliminate this heinous form of discrimination.

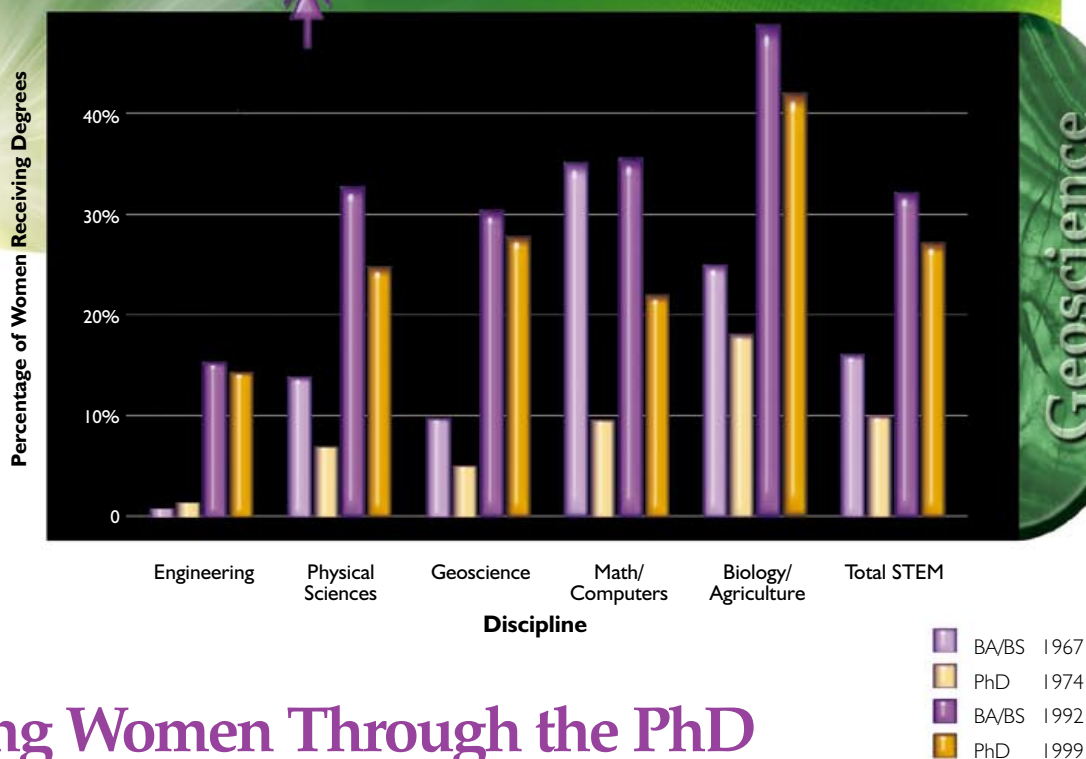
Awareness of cultural differences can encourage female students from minority cultures to consider your department for a major, or at least, not discourage them. Students have varying comfort levels with the outdoors. Not every geoscientist needs to be a rugged, backpacking camper to have a successful career, so these aspects need not be emphasized on field trips or at field camps. On field trips, consideration of students' dietary needs will make for a more inclusive climate. Students may be vegetarians (eat no meat), vegan (eat no meat, eggs, or dairy), or have religious dietary restrictions: Hindu (no beef), Muslim (no pork, caffeine or alcohol), Jewish (no pork, possible Kosher restrictions). Identify your students' dietary requirements before finding yourself deep in the field with no food to give them. Be aware of religious dress codes, e.g., Muslim head covering, and religious holidays. Jewish holidays may be found at: <http://www.hebcal.com>. Muslim holidays may be found at <http://www.moonsighting.com/calendar.html>.

Expose students to a wide variety of role models. If your department lacks female faculty, bring in female geoscience speakers (AWG maintains a Speaker's List, with a subset of Distinguished Lecturers). Use images of women geoscientists at work on your website and in publications (contact AWG's E-Mail News for images: editor@awg.org). Use images of geoscientists with their families on websites and in publications. Several career profiles appear in the Appendix, and the American Geological Institute and AWG websites contain biographies of women geoscientists.



FEMALE PhDs BY STEM DISCIPLINE

Women who receive a BA/BS in the Earth Sciences are more likely than any other science, excluding engineering, to continue on for a PhD. However, as a percentage of the field, fewer women major in the Earth Sciences than any other science, again excluding engineering. One important way to increase the number of PhDs is to increase the number of female BA/BS degrees.



Retaining Women Through the PhD

The Role of Faculty

Advising is a key issue for all students throughout their undergraduate and graduate years.

Advisors cannot assume that students will “learn the ropes” about department and graduate school procedures on their own. Although many advisors state that “getting it” (learning what to do, how to spend their time, what activities are important, what forms are due to whom and when, etc.) is part of the graduate school degree process, we disagree. “Getting it” commonly involves perceiving and correctly interpreting non-verbal cues from advisors and peers, and amounts to expecting our students to become mind-readers. When women are in the minority in a department, they may be at a disadvantage at such communication. Results from our focus groups indicate to us that women at times felt confused and abandoned in graduate school.

Good advising requires a set of clear expectations that are communicated explicitly to the student. Results from our focus groups indicate that geoscientists are particularly concrete in their discourse. Participants from all academic levels demanded explicit instruction and guidance during the discussions, at times to the consternation of the sociologists conducting the sessions.

An up-to-date graduate student handbook can help both advisors and students keep track of procedures. Many examples are available on the Web. You can find them by searching “geoscience graduate student handbook” or by contacting the authors for paper or electronic copies of graduate student advising handbooks.

Generosity, especially from fully promoted, tenured professors, in sharing credit and co-authorship will give your department's students an advantage in the job market. Co-authorship should be clarified at the beginning of any project to avoid misunderstanding when it's time to hand the manuscript in. Generosity extends to taking students to national meetings and workshops. This includes finding the funds to pay for their transport and lodging. Graduate students often work out multiple roommate arrangements to save costs at national meetings, but if your student is the lone female, make sure that she feels comfortable with such arrangements. Female roommates for national meetings can be found by making such a request to the Association for Women Geoscientists' E-Mail News (editor@awg.org). Once at the meeting, be sure the student is introduced to future colleagues.

Many focus group participants suggested that mentoring is a key component for student success in graduate school, and that the lack of female mentors may explain the pipeline loss for women in graduate school. Women do not need female mentors to succeed, as the initial wave of successful women geoscientists demonstrated. Most male and female students need a good mentor to reach their full potential. A good mentor advises well. Beyond advising, a good mentor keeps track of the protégé and is available for consultation throughout the career.

Professional Development for Graduate Students

Graduate students must take charge of their own professional development and not wait and hope it all works out. Do not hesitate to ask questions. If you do not receive a satisfactory answer, keep asking. If you find that you are not receiving adequate guidance from your advisor, maintain an amicable relationship but seek guidance elsewhere. A good resource for mentors is the Association for Women Geoscientists (www.awg.org). Any question can be put to the AWG electronic newsletter (editor@awg.org) for free.

Geoscientists need negotiating skills, grant-writing skills, time-management skills, and paper-writing skills. Many departments, colleges, and universities offer workshops to help graduate students develop these skills. Find out about them, ask the department office about them, and arrange your schedule to participate in them. If no such workshops are offered locally, keep an eye on national geoscience (or other professional) organizations' meetings; often, such workshops are held in conjunction with the meeting. Books on these topics and resources on the web are also available.

Be visible at regional and national professional geoscience meetings. Let your advisor know that you want to present your research at a professional meeting. Master's candidates often present at regional meetings. Doctoral candidates should present their research at national meetings. Venues for presenting research include the meetings of societies, such as the American Geophysical Union (AGU), the Geological Society of America (GSA), the American Meteorological Society (AMS), and many others, as well as specialist conferences where the meeting is smaller, more intimate, and you can become better acquainted with future colleagues. Deadlines for abstract submittal for a particular meeting are usually posted on the organization's website.



When you submit an abstract, you may be asked if you would consider chairing a session in your field. This will involve your receiving pre-selected abstracts, arriving at the meeting ahead of time, and keeping a series of speakers within time limits. Say yes! Chairing a session is a great way to raise your visibility in your field.



Use your time at professional meetings to meet people in your discipline, attend their talks, ask them questions. Bring along a business card with your name on it, the institution you attend, your contact information, your specialty and your title/position, e.g., "Master's Candidate" or "Doctoral Candidate". Be prepared to hand your card to anyone from whom you want further information or assistance. Learn the ropes as much as you can from as many respected professionals as you can. Not every advisor has every skill honed to perfection.

Recruiting Women into the Academic Applicant Pool

One of the largest leaks in the pipeline occurs at the academic entry, assistant professor. It is not known if the leak occurs because females are not applying or because they are not being hired. Although different strategies will be necessary to improve female recruitment into academia, application and employment efforts will benefit from believing that diversity matters, advertising through the Association for Women Geoscientists, (www.awg.org), finding and recruiting women doctoral candidates at meetings, and inviting women doctoral candidates to visit pre-interview.

An excellent resource for search committees is the University of Michigan's ADVANCE/STRIDE website: <http://www.umich.edu/~advproj/> (click on "STRIDE"). STRIDE (Science and Technology Recruiting To Improve Diversity and Excellence) compiles data on the status of women and under-represented groups on their website and develops recruiting strategies to increase diversity in STEM (Science, Technology, Engineering, Mathematics) fields.

Tenure Guidelines

Achieving tenure is usually based on the candidate's scholarship (research), teaching, and colleague-ship/service. The weighted importance of these three tasks varies among schools. Major research institutions might weigh scholarship 99%; liberal arts colleges might weigh teaching and research equally with a small consideration for colleagueship/service. At most institutions, once they've hired you, they would like you to get tenure, because failed tenure cases are disruptive to a department and searches and new hires are expensive. In a nutshell:

- Find out what is expected,
- Develop a strategic plan for each area of tenure evaluation,
- Follow the plan, and
- Seek guidance and help early and often.

Find out early what is expected to achieve tenure. Some institutions have a written description in a faculty handbook. But go beyond this information. Often the expectations are subtle, so seek multiple opinions. Ask your department chair, ask several different people, both inside and outside your department, and talk with recently tenured faculty in the sciences to see what their tenure package contained. The expectations might change but they are unlikely to change drastically in the years between your arrival and tenure year.

Make a strategic plan. Every tenure case is different. Once you understand what is expected, decide what you are likely to accomplish by the time of tenure, add dates for what you plan to accomplish and when. If your school has an annual or biannual review process, use this to mark progress in your strategic plan. If not, find someone to share this plan with. Members of your "tenure class" can be valuable resources and allies. Like you, they may be facing learning to teach, submitting papers and proposals, and negotiating the new institutional culture at the same time. It can be reassuring and informative to create a support group with a weekly lunch, dinner, or beer hour. Your doctoral advisor has been through this process and may also offer valuable guidance.

Tenure review at most institutions is a multi-step process. Initially, you, the candidate, prepare a dossier or tenure package. A tenure package is likely to consist of your *curriculum vitae*, papers you have published, grant information, syllabi from courses, teaching evaluations, and statements about teaching and research. Many schools have someone help you prepare this dossier. If your school doesn't, find someone to help you.



Your *vitae* and copies of your publications are sent to outside reviewers, usually recognized scholars in your field. How these people are selected varies widely. At some schools you can submit a list of names and a few of the reviewers are selected from this list. You can sometimes also specifically request that someone not be consulted. The department tenure committee determines other reviewers. These reviews are critical. Each reviewer comments, often for several pages, about the importance of your work to the field. They may also be asked whether your record would get you tenure at their school.

Your tenure package is complete when all of the review letters are gathered. The department or a departmental subcommittee is the next step in the review process. They decide, on the basis of the outside reviews and teaching evaluations, whether or not to put forward your tenure case. If the reviews are favorable and your teaching evaluations and

colleagueship/service record meets your institution's standards, the committee prepares your dossier to send to a university or college committee. At most institutions these are faculty from other disciplines, who know little or nothing about your work. They base their decision on the case the department has prepared and usually pay particular attention to the outside letters. At many schools the departmental tenure committee meets with the university or college committee to answer questions. If this committee vote is positive, the case may move to the dean, in the case of a college review, or directly to the president or board of trustees. This step varies widely and is often a formality.

Negative decisions at any step in the tenure process may or may not have an appeal process. Increasingly these cases end up in court. This situation is forcing universities to pay more attention to providing mentoring and guidance along the way, through a more complete review process in the pre-tenure years.

Developing your strategic plan

Scholarship. Even schools with high teaching loads may expect a high level of scholarship. Find out when you accept the job, how the outside review process will be conducted. If letters are requested about you by people in your field and/or subfield, make sure you have developed a good reputation. Build your reputation through publishing and presentations at national and international meetings. The importance of publishing quality work in refereed journals cannot be emphasized enough. Force yourself to carve out time every week to write papers and proposals. Remember that the paper review process may take up to a year from the time of initial submittal to final acceptance, making the time to prepare for tenure even shorter. If you have a strong publication record and don't get tenure, you will be in a much better position to find another job.



Many institutions may place heavy emphasis on grant awards. If this is the case, work with colleagues to help you prepare grant proposals. Many institutions provide assistance from a professional grant-writer to help polish grants prior to submittal. Some organizations, e.g., the Council on Undergraduate Research, also provide review assistance. Large research organizations such as NASA and NSF have program managers for specific award areas. Find out who your program manager is and discuss your ideas with them. There may be smaller pots of money to help junior faculty get started. NSF lists people who have received awards. Find out who has been funded in your area and ask if you can see their proposal. Once a proposal has been funded, most researchers are happy to share.

Teaching. Teaching loads and what constitutes “teaching” varies widely. Find out how teaching is evaluated. Will senior faculty attend your classes? How much will student evaluations be counted? What should you do if you receive poor student evaluations? Unlike the humanities, most science students may have had very little experience teaching in graduate school. Giving an occasional lecture or running a lab session is very different from preparing a course and developing exams and other evaluation tools. If you got through graduate school, you can learn to teach.

“How to” books can help and articles in the *Journal of Geoscience Education* may offer specific exercises that you can use. Currently NSF has funded, “On the Cutting Edge” Workshops to prepare faculty for teaching (Early Career Workshop), as well as specialized workshops, e.g., “Innovative Course Design,” “Visualization,” etc.

Many institutions have resource centers for teaching. These services are usually confidential and you can ask for assistance, such as having a class videotaped and reviewing the videotape with a professional to work on technique. Teaching is also performance; if students think you are boring, take a theater class.

When your teaching skill is at an acceptable level, don't keep revising lectures and adding new courses until after you receive tenure. Your outside reviewers will not know, or probably care, about your teaching. They might mention that they've heard you give a talk or two at professional meetings and think you're likely to be an excellent teacher, but that is not where their opinion matters.

Colleagueship/Service. This category will not make or break you, in most cases. It can involve service to a professional organization (AGU, GSA, AMS), granting agencies (NSF panel) community service and/or service to your department or institution. In deciding how much of these activities to take on, you need to balance the visibility of being on a committee with the time commitment. Professional organization committees can help you get to be known by researchers in your field. This experience could help you in developing ideas, writing papers and ultimately in getting strong scholarship reviews. University committees and community service do not usually have that benefit. Find out what the minimum is and don't do more than that. Once you have tenure, you can work on service committees, but you won't be there to do that if you don't have tenure.

Retaining Women Professors Beyond Tenure

Sadly, even after receiving tenure women continue to leave the geosciences or never get promoted to full professor. Although little data is available on this situation, circumstantial evidence points to burnout and overload. Burnout and overload are particularly problems for the lone female member in a department. She may find herself the token female on “every” committee and mentoring the majority of the female students.

Many popular books suggest general techniques for dealing with burnout. Suggestions for avoiding burnout include rewarding yourself and finding colleagues to reduce the sense of isolation. In academia, faculty members have the option of a sabbatical/leave to give them time to reassess.

Other Issues Women Face

Isolation

PhD-granting geoscience and geography departments in the United States have an average of two women on their faculty, while Master’s- and Bachelor’s-granting geoscience and geography departments have an average of one woman on their faculty. Being the lone geoscientist of your gender in a department is a heavy burden that very few male geoscientists ever encounter.

In addition to simply not having anyone quite like you to talk to, and not having any senior person like yourself to emulate or consult with, the single woman or pair of women geoscientists in a department is often perceived as representing “all women”, while a single male geoscientist is generally perceived as simply representing himself. If the first woman in a department somehow fails to live up to expectations, it can take decades before a department will venture into hiring another female. The first female may be viewed with suspicion by faculty wives, and male faculty may avoid field excursions or lunch meetings for fear of being the object of gossip. The lone female faculty member may find herself with no colleagues to work with, particularly in the field, because no one is sure how to behave around her and no one wants to take any risks.

When the proportion of female faculty is low, the women who are available (particularly female scientists) are asked to serve on nearly every type of committee as the token female, both in the





department and throughout the college and university. She will be asked to, or will default to becoming, the mentor for every female student. In addition to receiving many committee assignments, isolated women often find themselves on committees that wield no power. No one was available to tell them that this or that committee accomplishes little or has no voice where it matters in the administration. Junior faculty should be shielded from such committees unless the institution absolutely requires it for tenure. Department chairs need to be sensitive to the committee loads on their female faculty, and women geoscientists must learn to (and be given an atmosphere conducive to) say “no” to superfluous committee assignments. While this situation may be difficult when institutions are required to have under-represented groups on each search committee, un-tenured women in particular must manage their time and make sure that enough of it is spent writing grant proposals and papers rather than reviewing job applications for another department.

To retain women in PhD programs and in academic positions, this issue of isolation must be addressed. One way to reduce isolation may be a local chapter of the Association for Women in Science (AWIS); www.awis.org. Its many local chapters allow women scientists of all specialties to gather and share information and success strategies. The department can become an institutional member of the Association for Women Geoscientists and/or AWIS and provide funding for women to travel to work with colleagues or to bring in a colleague(s) of their choice.

Some departments have hired two or more women simultaneously to leap over the hurdle of the isolation period. Many institutions set aside funds for “opportunity hires”: rising stars, or risen stars who can enter with tenure, whose records allow circumvention of possibly biased search processes.

Department chairs need to ensure that women faculty members are informed of available department resources: funding for travel, funds for special courses, lab or teaching equipment. Chairs should ensure that female faculty are included in group grant proposals and that they have the support they need to do field work.

At what point does isolation diminish as an important issue for women faculty? We propose that there is no firm percentage or number of women, but rather, isolation diminishes when all people in a department have one or more collegial associates, when all people have one or more senior person in whom they can confide and obtain unbiased guidance from, when all people in the department feel that committee loads and student advising are distributed equitably, and when all people in the department feel that any job or student applicant will be judged solely on merit and not on gender.

Resolving Family Issues

Although both men and women participate in family life, family responsibilities are often unequally distributed. Women are more likely to be the primary childcare and eldercare givers. In any demanding, time-intensive job, the personal fulfillment that comes with family care giving may impact professional progress.

When To Have Children

There is no “good” time to have children, but some times are better than others. Women who contemplate motherhood concern themselves with the “biological clock”. However, academic women must also concern themselves with the “tenure clock”. Unfortunately, these two clocks overlap at such critical times that a woman aspiring to an academic career understandably wonders when is the best time to fit it all in.

Biological clock Carol de Wet and Gail Ashley are mothers and geoscientists (see Appendix). They worked with Daniel Kegel, an obstetrician, to examine the overlap of the biological and tenure clocks (de Wet et al., 2002). The figure on page 33 illustrates the possible span of most women’s reproductive years, ages 15 to 45. The rate of miscarriage increases from 10 percent of pregnancies at age 30 to more than 50 percent of pregnancies at age 45. The rate of Down’s syndrome in infants increases from very few per thousand births at age 30, to 60 per thousand births at age 45. These data suggest that for the greatest chance of having a healthy baby carried to full term, women should have their babies before the age of 35.

Tenure clock A woman’s academic career overlaps the entire range of healthy child-bearing years. The average age for receipt of a PhD in the geosciences, about 34, is slightly later than that for other sciences (Czjuko, 2002). The typical geoscientist begins his or her first academic job at age 34 (or later, if one takes one or more post-doc appointments). Earning tenure takes six years of hard work. Thus, if a woman waits until she has established her academic career to start her family, she will be at least 40 years old. The chances for a miscarriage at this age are 30 percent, and for having a baby with Down’s syndrome, 10 in 1000.

Having a baby while trying to finish a PhD or achieve tenure is a unique challenge not faced by our male colleagues. Some women indicate they can get a great deal of writing done when the baby is young, but they find it difficult to be in a classroom on time. Other women find writing impossible if the baby has any health challenges. We ardently urge all academics to consider ways in which the tenure clock can be made more flexible so that we can keep the most capable, best-trained women in our field regardless of their maternal aspirations.

Several mechanisms to make the tenure clock more flexible are being used by some institutions. These include “stop-the-clock”: giving the new parent an extra year towards tenure to cope with a new child in the family; and “assignment shift”: temporary (1 to 2 semesters) relief from

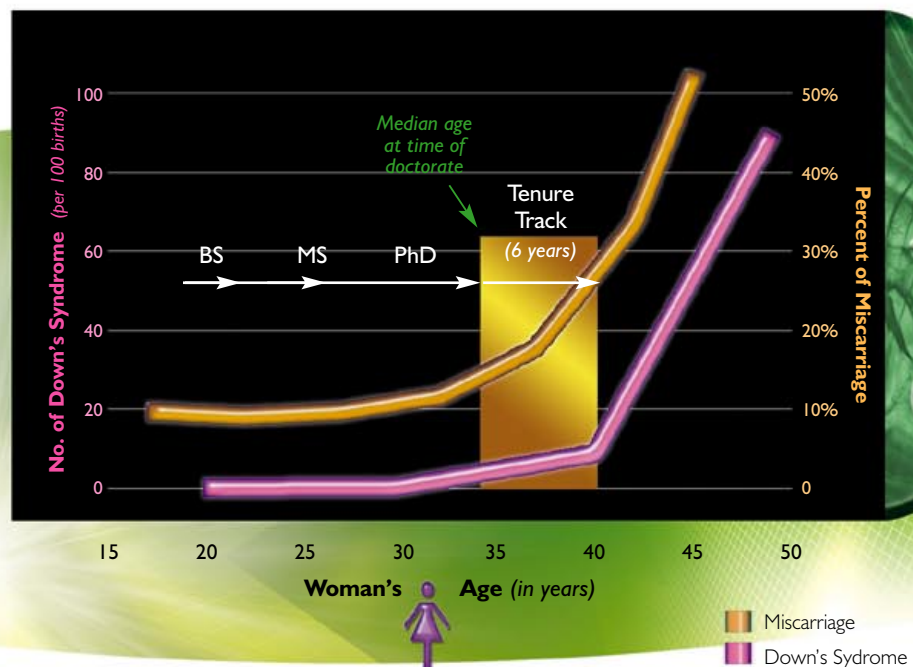
teaching and/or service assignments. We find that such practices are unevenly applied within institutions. Some departments may adopt them and then retreat from them, while other departments never consider such practices. Administrators can help by determining a policy and requiring its implementation across all units within the college or university.

Studies indicate that many new parents are reluctant to use such policies, fearing that they will somehow be stigmatized for “getting extra time”. Administrators can also help eliminate this perception with a uniformly enforced policy. Particularly with “stop-the-clock” policies, administrators from department chairs on up, need to avoid the perception that extra time should result in extra productivity from the tenure candidate: more papers or presentations.

A study highlighted in the *Chronicle of Higher Education* suggests that the worst time for a woman to have a baby and get tenure is to have the baby within 5 years of receiving a PhD (Wilson, 2003). Women who had their babies more than 5 years before receiving the PhD, or more than 5 years after receiving the PhD, had a significantly greater chance of getting tenure than women who had a baby near the time of receiving the PhD. These data are based on PhDs received in all fields between 1974 and 1984.

OVERLAP of the BIOLOGICAL & TENURE CLOCKS

The data show that overlap of the tenure clock and a woman's biological clock limit her options for receiving tenure and bearing healthy babies.
(Figure from deVet et al., 2002)





Maternity and Family Leaves

The federal Family and Child Leave Act of 1993 requires employers to provide 12 weeks of leave with pay without penalty of losing a job. Some universities do better than this.

For faculty. Many universities provide family leave. The family leave can consist of a reduced teaching load with full pay or no-teaching with less or full pay. At some schools this policy can be used by men and women and can be used to care for a sick family member (child, parent, or spouse).

For students. Whether or not graduate students are employees is continually debated at many universities, and this question has led to some picket lines and law suits. If students are employees they are subject to the requirements of the Family and Child Leave Act.

Child Care Questions

Is on site day care an option? An increasing number of academic institutions provide high-quality on-site day care for faculty and/or staff and students. The pressure to create such facilities comes from the faculty or students. Child care is an issue that will not go away. If colleges and universities are serious about having a diverse faculty, they must find ways to have onsite day care available for faculty with newborns and young children.

How long is the waiting list? Although on-site day care is an option at some institutions, at many places the demand is higher than the available spaces, and the day care provider might not be able to accommodate every child.

What are the hours? Possible hours vary considerably. Some institutions offer day care for 12 hours or even longer days, e.g., Ohio State; others, such as Wesleyan University, are limited to a standard 8 a.m. to 5 p.m. work day.

At what age can a child begin? Most child care facilities are regulated by the state. They have specific requirements for space and the number of care givers per child. Infants require a higher ratio of care givers per child and infant care may be more expensive than the cost for older children.

What does child care cost for a 40 hour (9-5) week? Most institutions that provide on-site child care provide some type of subsidy. However, if child care workers are to be paid a professional wage and real estate values are high, full-time child care expenses may be over \$800/month. Some institutions have a sliding scale to meet the needs of low-income parents.

What Are the Provisions for Additional Child Care? Emergencies arise. Extra child care may be needed for a sick child or when the woman professor needs to meet a deadline.

Handling Field Work and Professional Travel

Geosciences are unlike most other STEM fields in that extensive time away may be necessary to do research. Professional meetings and conferences are short-term leaves from home, lasting a few days. Field work can result in an extensive leave, up to several months, away from home.

Meetings

Most scientific societies provide professional on-site daycare during their meetings (Pray, 2003), but it is a good idea to bring an additional care giver to a meeting if possible, particularly for younger children.

Field work

If you can take the child (or children) with you to the field, consider bringing along an extra caregiver (student, family member) so that you can concentrate on the work you need to do. The field experience can be a world-widening one for your children, and can instill in them a life-long love of the outdoors. If you can set up a “headquarters” in a nearby town for days or weeks, it may be possible to find day care there.

Some institutions provide “sea pay” to make up for the hardship of being at sea, and this can be used to provide child care or to hire someone to live in or work at your house to assist with the work that you usually do. If possible, consider arranging to have a family member to help in your absence.

“

...no prospect for an end

James Hutton

Looking Towards the Future

Since 1967, when data were first systematically gathered on this topic, the number of geoscience degrees awarded to women has increased significantly. Across the country, 40 percent of our undergraduate population is female, and nearly that amount comprises our Master's degree candidate population. But women represent a much smaller proportion of those receiving a doctorate degree, and an even smaller proportion of those hired at the entry level for academia, Assistant Professor. At the current rate of leakage from the pipeline, it will be decades before “Where are the women geoscience professors?” is no longer a question. Unless more geoscience departments move toward gender equity, their students will not have the opportunity to learn from or emulate female faculty.

The authors and the workshop participants hope that the critical leaks identified by this and similar studies, and the strategies for sealing them will benefit geoscience departments and their graduates. The proportion of women in the geosciences will continue to grow. The rate of growth depends on all of us.

”

A P P E N D I X



Gail Ashley, Professor of Geological Sciences, Rutgers the State University of New Jersey, married as an undergraduate, had children at ages 20 and 24, finished MS at age 30 and PhD at age 36. She was hired as a professor (teaching/research) at age 36, divorced at age 41, and received tenure at age 43. She is married to a geologist at Rutgers. Her research interests are sedimentology, Quaternary geology, and paleoclimate of East Africa. She served as President of SEPM (Society for Sedimentary Geology) in 1991 and as President of the Geological Society of America in 1999.



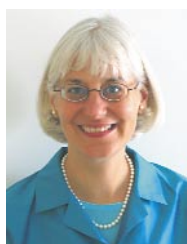
Carol de Wet, Associate Professor and Chair of the Department, shares a tenured position at Franklin & Marshall College with her husband. They married in graduate school. She had her first child at age 29 during post-doc and her second and third (at ages 33 and 36) before receiving tenure. Her research interests are carbonate sedimentology; depositional environments and diagenesis, particularly in microbial carbonates. In 2000, she received the Geological Society of America's Biggs Earth Science Teaching Award.



Mary Anne Holmes, a part-time Research Associate Professor at the University of Nebraska-Lincoln, went straight through an MS program in Agronomy at Virginia Polytechnic Institute and State University. She left a PhD program at the University of Kentucky to end a long commute with Mr. (now Dr.) Right, which brought her into geology. Since following her spouse to the University of Nebraska-Lincoln, she has held a variety of non-tenure track positions, including her current one. Her research interests are what clays reveal about environments of deposition, paleosols, and barriers to advancement of women in the geosciences. She served as President of the Association for Women Geoscientists in 2000-2001.









Suzanne O'Connell, Associate Professor and Chair of the Department of Earth and Environmental Sciences, Wesleyan University, did almost everything late. She entered a PhD program at age 29. At age 38, during her first semester of a tenure-track position at Wesleyan, she had her only child. She persevered, with lots of help from family and friends, and received tenure at age 45. Her research interests are paleoclimate (ocean cores and modeling), human impact on rivers and coasts, geoscience education, and barriers to the advancement of women in the geosciences. She served on the Executive Committee of the American Geological Institute (AGI) from 1998-2000 and on AGI's Strategic Plan Update Committee in 2002.



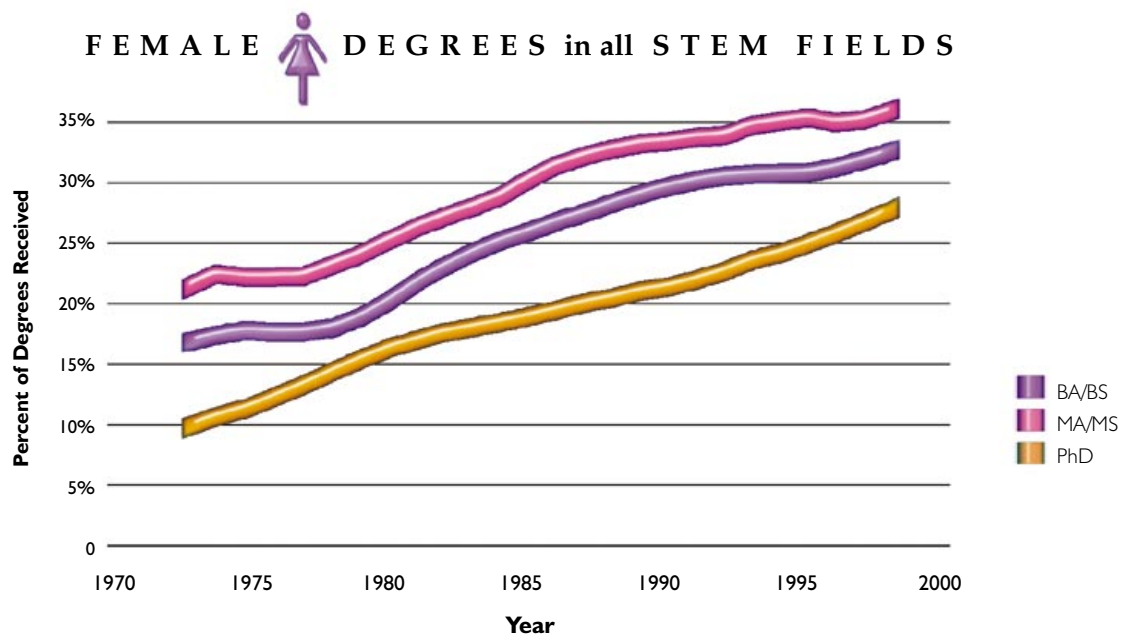
Julie Winkler, Professor of Geography, Michigan State University, received her PhD at age 28 and immediately accepted a tenure-stream appointment. After several difficult and disappointing years, she moved to her current position, restarted the tenure clock, and met her husband, who was also an assistant professor at the time. She married at age 39, shortly after receiving tenure. Her research interests include synoptic climatology, the potential impacts of climate variability and change, and women in academia. She served as National Councillor and Secretary of the Association of American Geographers from 1999-2001 and currently is the Commissioner for Education and Human Resources for the American Meteorological Society.

GEOSCIENCE DEGREES 1991-2000

Year	BA/BS				MA/MS				PhD			
			Total	Percent Female			Total	Percent Female			Total	Percent Female
1991	782	1,946	2,728	29%	383	1,116	1,499	26%	179	636	815	22%
1992	1,024	2,177	3,201	32%	368	1,057	1,425	26%	188	606	794	24%
1993	1,050	2,453	3,503	30%	391	1,006	1,397	28%	160	611	771	21%
1994	1,203	2,665	3,868	31%	424	994	1,418	30%	183	641	824	22%
1995	1,524	2,954	4,478	34%	451	1,032	1,483	30%	170	610	780	22%
1996	1,485	2,972	4,457	33%	436	1,051	1,487	29%	172	622	794	22%
1997	1,542	2,924	4,466	35%	487	948	1,435	34%	210	668	878	24%
1998	1,599	2,722	4,321	37%	494	932	1,426	35%	219	595	814	27%
1999	1,083	2,370	3,453	31%	187	768	955	20%	209	596	805	26%
2000	1,617	2,430	4,047	40%	513	832	1,345	38%	230	527	757	31%



Data from the National Science Board, 2002.


FEMALE DEGREES in all STEM FIELDS





The percentage of women receiving degrees in all STEM fields, science, technology, engineering, and mathematics, is increasing. Three-year running average of Bachelor year-7, Master year-4, and PhD year.

GEOSCIENCE FACULTY SPECIALTIES

				Percent Female
Specialty				
Geology	Geology	28	123	19%
	General Geology		3	0%
	Archaeological Geology	1	2	33%
	Environmental Geology	2	6	25%
	Geomorphology	2	20	9%
	Glacial Geology	3	8	27%
	Marine Geology		4	0%
	Mineralogy & Crystallography		3	0%
	Paleolimnology	1	2	33%
	Petroleum Geology		4	0%
	General Petrology		8	0%
	Igneous Petrology	1	2	33%
	Metamorphic Petrology	2	2	50%
	Sedimentary Petrology		19	0%
	Sedimentology	7	7	50%
	Physical Stratigraphy		20	0%
	Structural Geology	4	8	33%
	Tectonics	3	3	50%
	Volcanology	2	1	67%
	History of Geology		1	0%
EC	Economic Geology	0	3	0%
	Metals		3	0%
Geochemistry	Geochemistry	33	64	34%
	General Geochemistry	4	14	22%
	Analytical Geochemistry		3	0%
	Experimental Petrology/Phase Equilibria	2	3	40%
	Exploration Geochemistry	1		100%
	Geochronology & Radioisotopes	3	3	50%
	Low-temperature Geochemistry	10	12	45%
	Marine Geochemistry	3	6	33%
	Organic Geochemistry	5	8	38%
	Stable Isotopes	5	13	28%
	Trace Element Distribution		2	0%
Geophysics	Geophysics	16	71	18%
	General Geophysics	2	15	12%
	Experimental Geophysics	1	3	25%
	Exploration Geophysics	1	6	14%
	Geodesy	1	1	50%
	Geomagnetism & Paleomagnetism		1	0%
	Gravity	1	2	33%
	Seismology	3	29	9%
	Marine Geophysics	7	14	33%

 The AGI *Directory of Geoscience Departments* uses specialty codes to indicate the primary research or teaching specialty of the faculty listed. Individuals may select up to three specialties to be listed with their entry. These data are from the 2002 *Directory*.

Specialty				Percent Female
Paleontology	Paleontology	17	33	34%
	General Paleontology	1	5	17%
	Paleostratigraphy		1	0%
	Micropaleontology	1	3	25%
	Palynology	1		100%
	Vertebrate Paleontology	1	5	17%
	Invertebrate Paleontology	2	4	33%
	Paleobiology	1	3	25%
	Paleoecology & Paleoclimatology	7	7	50%
Hydrology	Geobiology	3	5	38%
	Hydrology	9	59	13%
	General Hydrology	1	9	10%
	Ground Water/Hydrogeology	7	33	18%
	Quantitative Hydrology		5	0%
	Surface Waters		6	0%
Soil Science	Geohydrology	1	6	14%
	Soil Science	18	46	28%
	Soil Physics/Hydrology		8	0%
	Soil Chemistry/Mineralogy	4	15	21%
	Pedology/Classification/Morphology	2	6	25%
	Forest Soils/Rangelands/Wetlands	3	2	60%
	Soil Biology/Biochemistry	5	4	56%
Engineering Geo.	Other Soil Science	4	11	27%
	Engineering Geology	0	16	0%
	General Engineering Geology		3	0%
	Earthquake Engineering		1	0%
	Mining Tech/Extractive Metallurgy		1	0%
	Mining Engineering		5	0%
	Petroleum Engineering		3	0%
Oceanography	Rock Mechanics		3	0%
	Oceanography	24	61	28%
	General Oceanography		5	0%
	Biological Oceanography	8	17	32%
	Chemical Oceanography	6	9	40%
	Geological Oceanography	4	13	24%
	Physical Oceanography	4	16	20%
Planetology	Shore and Nearshore Processes	2	1	67%
	Planetology	1	5	17%
	Cosmochemistry	1	1	50%
	Extraterrestrial Geology		2	0%
Other	Extraterrestrial Physics		2	0%
	Other	31	140	18%
	General Earth Sciences		1	0%
	Atmospheric Sciences	5	44	10%
	Earth Science Education	2	1	67%
	Physical Geography	3	7	30%
	Ocean Engineering/Mining	1	3	25%
	Remote Sensing		17	0%
	Meteorology	2	10	17%
	Material Science	1	2	33%
	Land Use/Urban Geology	1	2	33%
	Miscellaneous	14	45	24%

REFERENCES

- American Association of University Women, 1995. *How Schools Shortchange Girls: The AAUW Report: A Study of Major Findings on Girls and Education*. Marlowe & Co., New York, 223 p.
- Association of American Geographers, 1997. *Guide to Programs in the United States and Canada 1997-1998*. Washington, D.C.: Association of American Geographers.
- Claudy, N. (ed.), 2002. *Directory of Geoscience Departments, 2001-2002*, American Geological Institute, Alexandria, VA.
- Claudy, N., (ed.), 2001. *Directory of Geoscience Departments, 2000-2001*, American Geological Institute, Alexandria, VA.
- Cohoon, J. M., Kidd, D., and Liuti, S., 2003. "Still Seeping Out." <http://curry.edschool.virginia.edu/Tatrit/Presentations/GeoScience.pdf>
- Czujko, R., 2002. "The Earth and space sciences: a statistical overview." *Eos*, Transactions American Geophysical Union, Fall meeting program, San Francisco, CA, p. 199.
- de Wet, Carol B., Ashley, G. M., and Kegel, Daniel P., 2002. "Biological clocks and tenure timetables: restructuring the academic timeline." Supplement to Nov. 2002, *GSA Today*. pp. 1-7. <http://www.geosociety.org/pubs/gsatoday/0211clocks/0211clocks.htm>
- Frey, C., and Horvick, J. (2003, May 20). "Comparison of traditional and telephone focus groups." A paper presented as part of a session entitled "Focus Groups" at the International Field Directors and Technologies annual conference in Nashville, TN.
- Holmes, M.A., O'Connell, S., Frey, C., and Ongley, L., 2003. "Academic Specialties Shifting: Hiring of Women Geoscientists Stagnating." *Eos*, Transactions American Geophysical Union, v. 84, pp. 457, 460-461.
- National Science Board, *Science and Engineering Indicators – 2002*, National Science Foundation, Arlington, Va., 2002.
- National Science Foundation, 2000. *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2000*. Arlington, VA. (NSF 00-327).
- Pray, Leslie, 21 March 2003, Conference Childcare: An Emerging Career Development Issue, *Science: The Next Wave*. <http://nextwave.sciencemag.org/cgi/content/full/2003/03/20/5>
- Sadker, M., and Sadker, D., 1995. *Failing at Fairness: How Our Schools Cheat Girls*. Touchstone, New York. 347 pp.
- Wilson, Robin, Dec. 5, 2003. "How Babies Alter Careers for Academics": Having children often bumps women off the tenure track, a new study shows, *Chronicle of Higher Education*, Section: The Faculty, v. 50, n. 15, p. A1. <http://chronicle.com>

Additional Resources

- Academic Salaries, *Chronicle of Higher Education*. <http://chronicle.com/stats/aaip/200>
- Bell, Robin E., Kastens, Kim A., Cane, Mark, Miller, Roberta B., Mutter, John C., and Pfirman, Stephanie, 2003. "Righting the Balance: gender diversity in the geosciences." *Eos*, Transactions American Geophysical Union, v. 84, pp. 292-293.
- Claudy, N., (ed.), 1997. *Directory of Geoscience Departments, 1996-1997*, American Geological Institute, Alexandria, VA.
- de Wet, C.B. and de Wet, A.P. 1995. "Making It Work Together: Spouses on the Tenure Track." *Geotimes*, v. 40, n. 4, pp.17-19.
- Holmes, M.A., and O'Connell, S., 2003, "Where are the Women Geoscience Professors?" Workshop. *Eos*, Transactions American Geophysical Union, v. 84, pp. 564, 565.
- Nelson, D.J., 2002. "The Nelson Diversity Surveys" Norman, OK. <http://cheminfo.chem.ou.edu/faculty/djn/diversity/top50.html>
- Valian, V., 1999. *Why So Slow? The Advancement of Women*, MIT Press, 424 p.
- Williams, F. Mary and Emerson, C.J., 2002. *Becoming Leaders: A Handbook for Women in Science, Engineering and Technology*, NSERC/Petro-Canada Chair for Women in Science and Engineering and Women in Science and Engineering Newfoundland and Labrador, St. John's, NL, Canada.
- Winkler, J.A., 2000. "Faculty Reappointment, Tenure and Promotion: Barriers for Women." *Professional Geographer*, v. 52, pp. 737-750.

Where are the Women Geoscience Professors?

WORKSHOP PARTICIPANTS

Dr. Elizabeth Anthony

Department of Geological Sciences
University of Texas at El Paso

Dr. Gail M. Ashley

Department of Geological Sciences
Rutgers, The State University of New Jersey

Julia Baldwin

Department of Geology
University of Maryland

Dr. Robin Bell

Lamont-Doherty Earth Observatory
Columbia University

Dr. Jonathan Berg

Department of Geology and Environmental
Geosciences
Northern Illinois University

Dr. Ana Carmo

Department of Geological Sciences
University of Kentucky

Jessie Cherry

Lamont-Doherty Earth Observatory
Columbia University

Dr. Beth A. Christensen

Department of Geology
Georgia State University

Dr. Geoffrey Cohen

Department of Psychology
Yale University

Dr. Joanne McGrath Cohoon

Department of Leadership, Foundations,
and Policy
University of Virginia

Dr. Patricia Cooper

School of Ocean & Earth Science
and Technology
University of Hawaii at Manoa

Dr. Cynthia R. Coron

Department of Earth Sciences
Southern Connecticut State University

Dr. Rachael Craig

National Science Foundation
Carbon Cycle and Biogeosciences Program

Dr. Carol de Wet

Department of Geosciences
Franklin & Marshall College

Dr. Sonia Esperança

National Science Foundation
Petrology and Geochemistry Program

Connie Frey

Sociology & Criminal Justice Studies
Southern Illinois University at Edwardsville

Dr. Deidre Gibson

Marine and Environmental Science
Department
Hampton University

Irina Gorodetskaya

Lamont-Doherty Earth Observatory
Columbia University

Dr. Alison Henning

Department of Earth Science
Rice University

Dr. Mary Anne Holmes

Geosciences Department
University of Nebraska-Lincoln

Dr. Julie Hood

MAST Academy

Dr. Blythe Hoyle

Department of Geology
Bryn Mawr College

Warner Ithier-Guzman

College of Marine Science
University of South Florida

Emily Kamara

Earth and Atmospheric Sciences
Saint Louis University

Dr. Jill Karsten

American Geophysical Union

Kalyani Kelkar

Department of Earth and Environmental
Sciences
University of Illinois at Chicago

Dr. Donna Khallauf

Department of Geology
Georgia State University

Anjana Khatwa

Department of Geography
University of Utah

Yolanda Lee-Gorishti

Anthropology Department
Southern Connecticut State University

Allegra LeGrande

Lamont-Doherty Earth Observatory
Columbia University

Dr. Patricia Manley

Geology Department
Middlebury College

Dr. Nancy Marcus

Department of Oceanography
Florida State University

Katayoun Mobasher

Department of Geology
Georgia State University

Dr. Pamela Hallock Muller

College of Marine Science
University of South Florida

Dr. Pamela D. Neal

College of Geosciences
University of Oklahoma

Dr. Suzanne O'Connell

Department of Earth and Environmental
Sciences
Wesleyan University

Dr. Carol Pride

Marine Science Program
Savannah State University

Dr. Ashanti Pyrtle

College of Marine Science
University of South Florida

Dr. Sue M. Rimmer

Department of Geological Sciences
University of Kentucky

Dr. Jill Singer

Department of Earth Sciences
Buffalo State College

Dr. Constance Soja

Department of Geology
Colgate University

Marilyn Suiter

National Science Foundation
Division of Human Resource Development

Atieh Tajik

Department of Geology
Georgia State University

Dr. Karen Viskupic

Department of Geosciences
Boise State University

Dr. Julie Winkler

Department of Geography
Michigan State University

Sarah Zaranek

Dept of Geological Sciences
Brown University





Association for Women Geoscientists

www.awg.org

office@awg.org