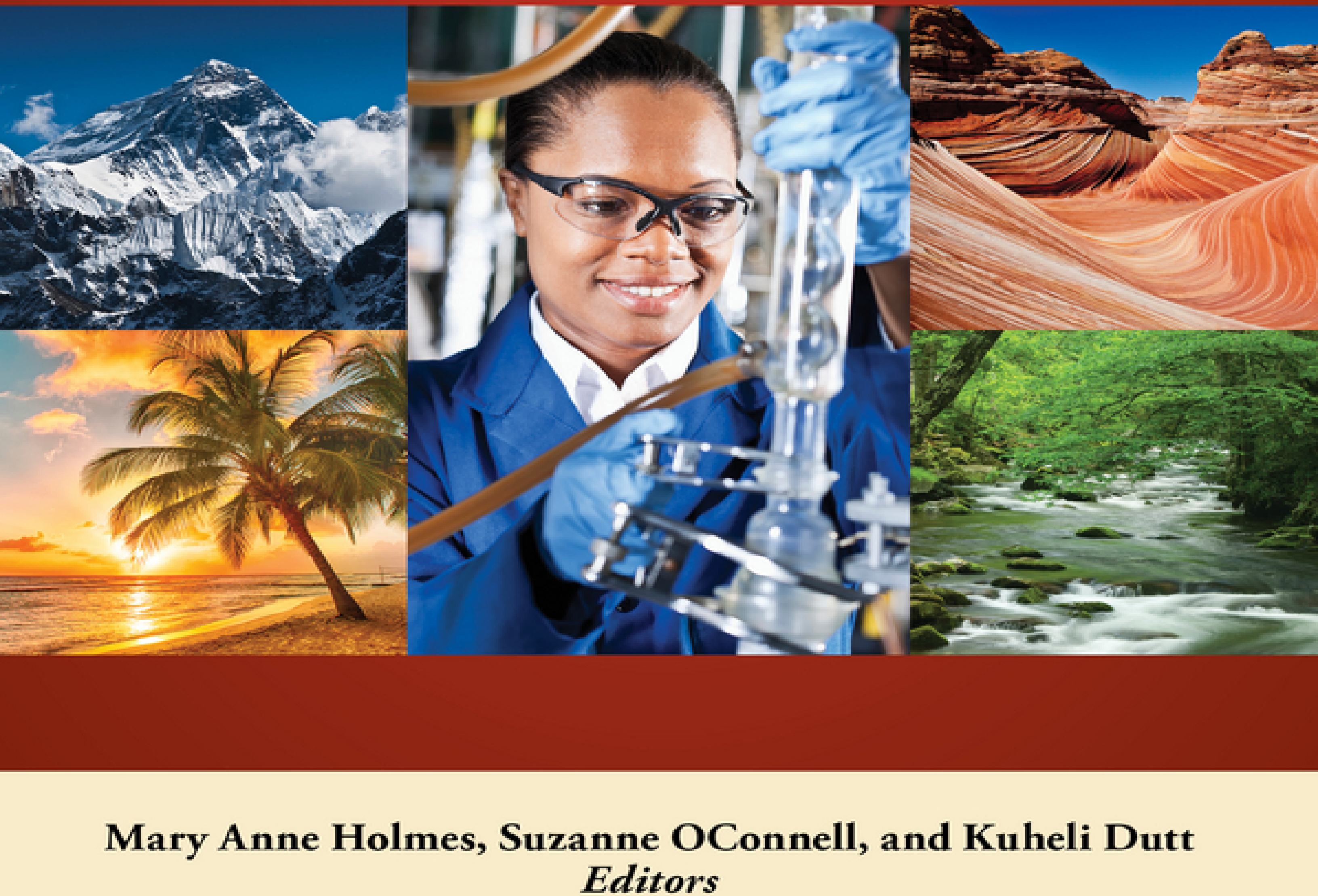
Women in the GEOSCIENCES

Practical, Positive Practices Toward Parity



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Editors

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INTRODUCTION

Does Gender Parity Matter?

The geoscience workforce has a lower proportion of women in it (21%) compared to the general population of the United States (50%) and compared to the average of all other science (37%) or mathematics (26%) fields [*NSF*, 2011]. Our workforce is overwhelmingly white: 86% compared to 68% of the total U.S. population, one of the least diverse among all the other science, technology, engineering, and mathematics (STEM) fields. In short, the U.S. geoscience workforce lacks the rich diversity of our population. According to the 2011 U.S. Census Bureau, 88% of doctoral degrees in the geosciences are awarded to white students, with only about 5% awarded to students from underrepresented minority groups.

Does this low rate of diversity matter? Obviously, since you have opened this book and many geoscientists have contributed to it, many people think so and you likely think so, too. Feelings aside, what is the evidence that it really matters? Is it something we should put our limited time and resources into addressing, to have our workforce diversity more closely match the nation’s? Does the geoscience enterprise really suffer if we never diversify to match population demographics?

The answer we contend is, of course, yes. Scott Page, an economist at the University of Michigan, uses mathematical modeling and case studies to show that diverse workplaces are more productive, more innovative, and more creative (2008). People with different backgrounds have different ways of looking at problems (what Page calls “tools”). In science, having more tools generates more working hypotheses, a necessary step in the scientific method. But not only do different types of people view problems differently, different types of people *ask different questions*, the fundamental first step in the scientific method. Bringing personal knowledge to the scientific endeavor means that different scientists sense (observe) differently, question differently, and hypothesize differently [*Selby*, 2006a,b].

Page [2007] points out that today, teams do more work (and science) rather than do lone individuals. Does diversity improve team performance? *Woolley and others* [2010] developed a measurement of group intelligence (termed *c*) and determined, surprisingly, that it does not correlate with either average individual intelligence of group members or with maximum individual intelligence (the “smartest person” in the group). Instead, they found that *c* significantly correlated with a measure of average social sensitivity of the group and negatively correlated with the presence of a few people in the group who dominated the conversation. The presence of women in the group increased the group’s intelligence as measured by its ability to perform specific group tasks. These researchers hypothesized that in this study, the women’s influence arose from their tendency to score higher on social sensitivity tests. Just having more people able to voice an opinion raised group intelligence.

Page [2007] found that when a team values diversity, a diverse work group improves the bottom line for corporations, perhaps as much as the actual ability of individual workers. In a diverse workforce, people’s abilities are superadditive: if two people have different perspectives on a problem as well as different proposed solutions, the best solution may lie in a combination of the two solutions, an outcome not possible when only one brain works on the problem.

Govindarajan and Terwilliger [2012] found that a diverse team does the most effective research brainstorming. Like Page, they use the term *diversity* to include a range of expertise, ages, disciplines, and cultures.

Valian [2004] provides additional rationales for the benefits of gender parity in academia. Broadening the applicant pool for faculty positions maximizes the chances of hiring the best new faculty. The larger the pool, the greater will be the choice and the higher the likelihood of finding a well-qualified candidate.

Students benefit from a diverse faculty. Students who see someone on the faculty “like me,” someone whose life they wish to emulate, are more likely to stay in the field. In addition, students benefit from working in diverse groups and with diverse faculty, as they will be working in a diverse workforce after graduation [*Valian*, 2004]. The benefits of being a scientist are great: scientists earn more than nonscientists and are more likely to be employed. And as scientists, we know the joy of doing science that no other field of endeavor provides.

Diversity of the geoscience workforce matters because we need a variety of minds asking a variety of questions and posing a variety of solutions. Diversity of the geoscience workforce matters because the U.S. population continues to diversify: nonwhite children became the majority of one-year-olds in 2010. We need to attract new majors and new geoscientists from the population that exists today and tomorrow or we will find our classrooms and consequently the geoscience workforce shrinking.

Paying attention to the factors that promote gender equity in departments improves the workplace for *all* faculty [*Valian*, 2004]. When we discover that mentoring, advocacy, and power networks omit women and people of color, and we construct mentoring programs for early and mid-career faculty, these benefit *all* faculty. When we address dual-career issues for women, we address dual-career issues for men, too. More than half of STEM men (56%) are married to a STEM woman [*Schiebinger*, 2008]. As more women and people of color have received PhDs and expect an inclusive workplace, the majority's perception of what makes a good work environment has evolved, too. We are not the same academy that we were 10 years ago.

Professional science societies recognize the value of diversity. For example, The American Association for the Advancement of Science has issued a statement with the Association of American Universities in support of diversity-enhancing programs (http://php.aaas.org/programs/centers/capacity/documents/Berdahl_Essay); the American Geophysical Union has a Diversity Plan (http://education.agu.org/diversity-programs/agu-diversity-plan/); the Geological Society of America adopted a position statement to embrace a diverse workforce (http://www.geosociety.org/positions/pos15_Diversity.pdf), and the American Association of Petroleum Geologists has held panels on making the bottom-line case for diversity in the petroleum industry (http://www.aapg.org/explorer/2010/06jun/regsec0610.cfm).

Yet despite broad support for the concept of gender parity, there has been little actual change in the demographics of the geoscience faculty (see chapters 1 and 2).

Why Are the Geosciences Lagging in Gender Parity?

We show from the literature through the rest of this volume that lack of gender parity is not unique to the geosciences and that, for all STEM fields, gender parity is *not* a "pipeline issue": simply adding more women to one end of the pipeline, such as PhD recipients, has not effected meaningful change in the numbers of women on the STEM faculty. Nor is the answer simply "women prefer to have families," as the numbers of single women or women with no children are not increasing on the faculty. Policies and procedures of academic institutions, as well as how we perceive and interact with each other, play important roles in whether we can achieve parity. The academy is set up for an "ideal worker" who is currently in the majority [*Williams*, 2000]. Our selection processes, those that determine who gets encouraged to enter graduate school, to complete the PhD and postdoc, and to win the job, contribute to the leaky pipeline [*Georgi*, 1999]. The academy needs to change to accommodate a variety of types of workers.

Chilly climates continue to contribute to women's attrition from the geosciences. By "climate" we mean the factors in the workplace that enable us to find meaning and joy in our work. It is an important component of job satisfaction. A variety of factors can contribute to chilly climates for women. The literature is replete with examples of women's accomplishments being discounted and ignored [*Lincoln et al.*, 2011; and see, in references, the AWIS AWARDS project to increase the number of women nominees for national awards]. In addition, women are more likely to serve on committees that are perceived as nurturing (e.g., undergraduate advisor) as opposed to committees that wield influence on academic processes, such as promotion and tenure and graduate committees [e.g., *Misra et al.*, 2011]. Women typically have higher service loads and take these on at earlier stages in their career [*Misra et al.*, 2011], in part because they are asked to serve as the "diversity" component on every committee. Women tend to be interrupted more at meetings, tend to have lower salaries, sometimes as a result of their not negotiating sufficiently [*Bilimoria and Liang*, 2011; *Valian*, 2005]. As *Valian* [2005] puts it, "Each example [of chilly climate] . . . is a small thing. One might be tempted to dismiss concern about such imbalances as making a mountain out of a molehill. But mountains *are* molehills, piled one on top of another over time."

Student Perspective

As we wrote this volume, younger women provided us with plenty of examples of the chilly climate they experience. Below, a few examples:

“The professor told the class that women really weren’t that good for geology because they value family more than anything else. The only person who objected was a male postdoc who said he thought family was just as important to men.”

“The male presenters frequently made good-natured and humorous comments about other male lecturers that were present in the lecture hall. They used each other's first names. The one time I heard a male lecturer make a comment about a female lecturer that was present, he did not use her name but referred to her as ‘that woman.’”

“A lecture given by a woman was interrupted by male organizers announcing the arrival of a new (male) lecturer and the departure of another (male) lecturer. Later on the same talk was again interrupted by another departing (male) lecturer wanting to announce he was leaving. No talk given by a man was interrupted by such departures and arrivals.”

“The female participants of the summer school were sometimes referred to as ‘girls.’ Male participants were not addressed as ‘boys’ or ‘guys,’ at least never within my hearing.”

“During an evening event, a medal was given to a distinguished male scientist. . . . After the talk the organizers took photos of the medal-winning scientist. They addressed the audience and asked for ‘girls’ to step up and have their photo taken with the awardee.”

“While I was completing an assignment in an all-female group, one of the male lecturers stopped by to inquire how we were doing, and then made a loud public comment about the beauty of our group. I heard no such comments about the appearance of the male participants."

"In three different talks, the lecturers had included in their overheads a photo of a woman in revealing clothing. In all cases, the woman had a 'conventionally beautiful' body type and general appearance. I saw only one photo that depicted a man in sparse clothing, and in that case the man was very obese. I got the feeling that female bodies were shown not only to illustrate a point, but also because they were thought to be pretty to look at (and amusing in a scientific context). The man's photo was also there to make a humorous point, but in his case the humor largely stemmed from the fact that he was very fat (and very fat guys are supposedly funny)."

The signature file from the e-mail of a (male) chair of an earth sciences department:

> *The primary duty of the University to a student is to provide him with such instructors as will make him realise that the responsibility for progress is his own and no one else's*.
>
> S.E. Whitnall, 1933

"This phrase. This 'you will ruin your career if.' It's false. It's a total, complete lie. And it really upsets me to watch so many young, promising scientists agonize and fall prey to it. Because the correct phrase is not 'you will ruin your career if,' the correct phrase is 'your career (in a TT position at an R1 institution) will be a lot easier if.' "

Isn't This Issue Behind Us by Now?

The above examples provided by women students are fairly convincing that we have not yet fully thawed the chilly climate for women. In addition, Nancy Hopkins, the author of the now-famous “MIT Study” that brought gender inequity on that campus to light [*Hopkins*, 1999; *Hopkins*, 2007], demonstrated that when there was agitation for adding women to the faculty, excellent women were found and hired at MIT (Figure 0.1). When the agitation waned, hiring leveled off. A renewal of agitation increased hiring again. Looking at women’s composition on the geoscience faculty in the earlier part of this decade, we noticed that many departments had one woman on the faculty at approximately midcareer. We all sort of rushed to hire our woman and then neglected the issue from then on. The ADVANCE program at NSF (see Chapter 4) has renewed the agitation to pay attention to this issue. When we stop paying attention, we make no progress.

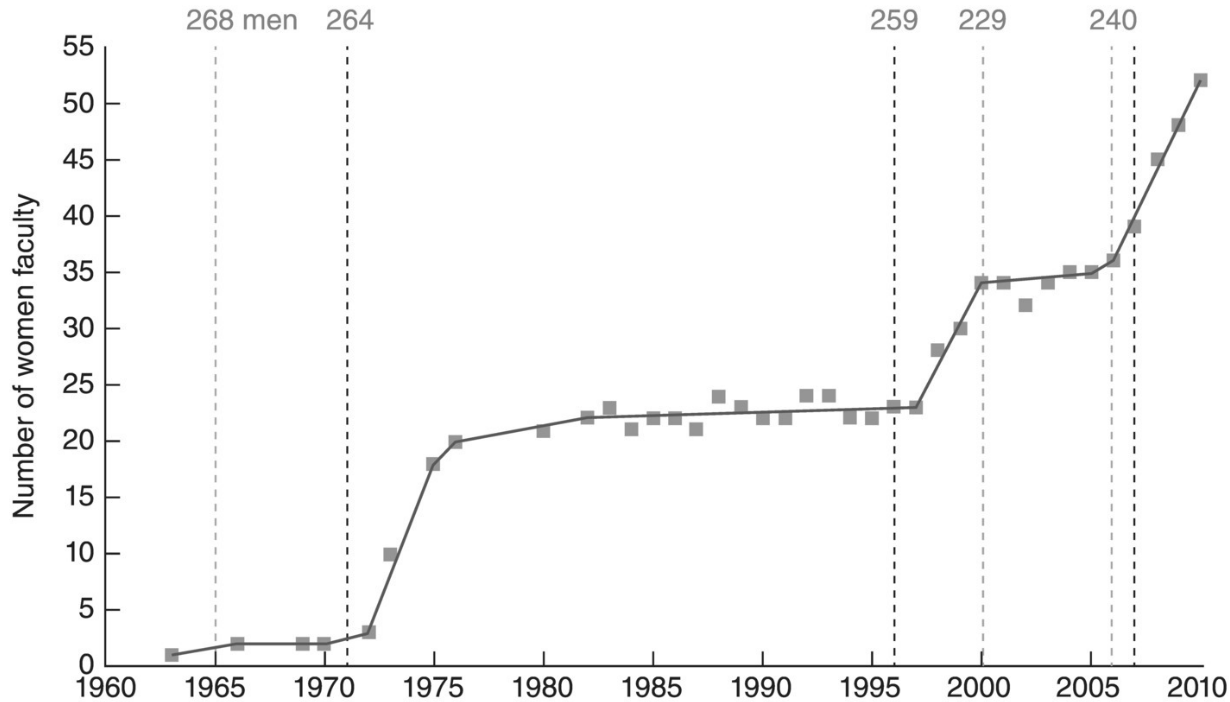

Figure 0.1 Women faculty in the School of Science at MIT (1960–2010). The numbers of women increase only when effort is focused on their recruitment and retention. Between 1970 and 2010, the percentage of women faculty at MIT increased from 8% to 19% [*from Conrad et al*., 2011].

The Pipeline Metaphor

Many women object to the concept of a pipeline: that we input students at one end and some proportion emerges ready for faculty positions. They do not wish to be considered passive in the motion from one end to the other, and particularly do not wish to be considered passive drops of water that leak out of the system.

A better metaphor for the process of developing new scientists is the interstate highway system: there are many ways to enter the science enterprise, beginning with a community college or beginning with entry into a Research I institution. The various ways to enter the path are "on-ramps." There are various stages at which a student might exit (off-ramps) and perhaps reenter via a different on-ramp at another time. Students might take "rest stops" via working in private industry or staying at home to start a family. Interstates lead to multiple destinations: academia is not the only endpoint for geoscience students. Exiting, entering, resting, and reaching a destination all imply some agency on the part of the participant.

Not all interstates are the same; some are state of the art with clear signposts and directions; others are in need of repair, perhaps rerouting, better on-ramps, or at least, better signage.

Contents of This Volume

The remainder of this volume will discuss research-based reasons for the lack of gender parity and research-based strategies to achieve gender parity. In Section I we look at data on gender parity in the geoscience student body and faculty. Chapter 1 looks at the gender composition of the recipients of geoscience degrees. Chapter 2 looks at the statistics of female faculty in Carnegie top-tier geoscience departments across the U.S.

Section II provides a conceptual framework for understanding and addressing gender parity issues. Specifically, chapter 3 explores Risman's theory of gender as a social structure that allows us to categorize types of barriers to women's entry, retention, and advancement in the geosciences.

Section III looks at various lessons learned from NSF-funded ADVANCE programs across the U.S. and the best practices learned from these programs, and summarizes the experiences of various institutions' progress made towards gender parity. This section first provides an overview of the NSF ADVANCE program, followed by examples of institutional, individual, and interactional strategies.

Chapter 4 provides an overview of NSF's ADVANCE program. Chapter 5 summarizes work done at ADVANCE institutions, that is, those that received an ADVANCE Institutional Transformation award. This chapter focuses on the effectiveness and long-term viability of organizational change efforts to create institutional environments that are conducive to the success of women as well as men in STEM. Chapter 6 presents an overview of the successful institutional transformation process of Columbia University's Lamont-Doherty Earth Observatory. Chapter 7 looks at how faculty appointments can be made more flexible and therefore conducive to retaining women; specific examples include stop-the-clock provisions, the option to work part-time, and dual-career appointments. Chapter 8 looks at the provision of on-campus lactation facilities and access to day care; since women bear a disproportionately higher burden of familial responsibilities, such facilities will help to retain them in STEM.

Chapter 9 discusses implicit bias, stereotype threat, imposter syndrome, and how these affect efforts to diversify the workforce. Chapter 10 looks at the best practices for recruiting diverse faculty by diversifying the applicant pool. Chapters 11 through 13 focus on mentoring. Chapter 11 discusses multiple and sequential mentoring, while chapters 12 and 13 expand upon intensive mentoring programs: ASCENT (Atmospheric Science Collaborations and Enriching Networks) and MPOWIR (Mentoring Physical Oceanography Women to Increase Retention). These two programs serve as excellent models not just for mentoring but also on how to increase transparency of processes in academia that lead to success of new faculty.

Chapter 14 explains the Earth Science Women's Network, ESWN, a peer-mentoring network for women geoscientists particularly targeting early-career women.

Some of what we write in this volume also applies to the issue of race and ethnicity parity in the geosciences' workforce. We focus on gender parity for this volume because it is time, after more than a decade of focused research through the ADVANCE program, to pull together a what-, why-, and how-to-proceed handbook. So far, no similar body of work exists to address racial and ethnicity underrepresentation. We hope that you find this volume useful and we welcome any constructive feedback.

ACKNOWLEDGEMENTS

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REFERENCES

AWIS AWARDS Project: http://www.awis.org/displaycommon.cfm?an=1&subarticlenbr=397. Last accessed January 2014.
Bilimoria, D., & Liang, X. (2011). Gender Equity in Science and Engineering: Advancing Change in Higher Education. Routledge Studies in Management, Organizations and Society. Routledge, Taylor & Francis Group.
Conrad, J., N. Hopkins, T. Orr-Weaver, M. Potter, P. Rizzoli, H. Sive, G. Staffilani, and J. Stubbe (2011), Massachusetts

Institute of Technology (MIT) Report on the Status of Women Faculty in Science and Engineering, 2011, http://web.mit.edu/newsoffice/images/documents/women-report-2011.pdf. Last accessed January, 2014.

Georgi, H. (1999), A tentative theory of unconscious discrimination against women in science. In *Who Will Do the Science of the Future? A Symposium on Careers of Women in Science*, pp. 45–48. NAS Committee on Women in Science and Engineering, National Research Council. National Academy Press, Washington, DC.

Govindarajan, V., and J. Terwilliger (2012), Yes, You Can Brainstorm Without Groupthink. Harvard Business Review blog network. http://blogs.hbr.org/cs/2012/07/yes_you_can_brainstorm_without.html. Accessed 26 July 2012.

Hopkins, N. (1999), A study on the status of women faculty in science at MIT, *MIT Faculty Newsletter*, *11*(4), March.

Hopkins, N. (2007), Diversification of a university faculty: Women faculty in the MIT schools of science and engineering, *New England Journal of Public Policy*, *22*(1), 11.

Lincoln, A. E., S. H. Pincus, and P. S. Leboy (2011), Scholars' awards go mainly to men, *Nature*, *469*(7331), 472–472.

Misra, J., J. H. Lundquist, E. Holmes, and S. Agiomavritis (2011), The ivory ceiling of service work, *Academe*, *97*(1), 22–26.

National Science Foundation, National Center for Science and Engineering Statistics (2011), *Science and Engineering Degrees: 1966–2008*. Detailed Statistical Tables NSF 11-316. Arlington, VA. Available at http://www.nsf.gov/statistics/nsf11316/.

Page, S. (2007), Making the difference: Applying a logic of diversity, *Academy of Management Perspectives*, November, 6–20.

Page, S. (2008), *The Difference: How the Power of Diversity Helps Create Better Groups, Firms, Schools, and Societies*, Princeton University Press, Princeton, New Jersey.
Schiebinger, L., A. D. Henderson, and S. K. Gilmartin (2008), Dual-Career Academic Couples: What Universities Need to Know. Clayman Institute for Gender Research, Stanford University. http://www.stanford.edu/group/gender/Publications/index.html.
Selby, C. C. (2006a), The Missing Person in Science: Inquiry Begins with I, *New York Academy of Sciences Update* 10–13. http://cecilyselby.blogspot.com/2012/02/missing-person-in-science-inquiry.html
Selby, C. C. (2006b), What Makes It Science: A Modern Look at Scientific Inquiry, *Journal of College Science Teaching*, *35*, 8–11. http://www.nsta.org/store/product_detail.aspx?id=10.2505/4/jcst06_035_07_8. http://cecilyselby.blogspot.com/2012/02/ what-makes-it-science-modern-look-at.html.
Valian, V. (2004), Beyond gender schemas: Improving the advancement of women in academia, *Natl Women's Studies Assoc Journal*, *16*(1), 207–220.
Valian, V. (2005). Beyond gender schemas: Improving the advancement of women in academia, *Hypatia*, *20*(3), 198–213.
Williams, J. (2000). *Unbending Gender: Why Family and Work Conflict and What to Do About It*. Oxford University Press, New York.
Woolley, A. W., C. F. Chabris, A. Pentland, N. Hashmi, and T. W. Malone (2010), Evidence for a collective intelligence factor in the performance of human groups, *Science*, *330*, 686–688. doi: 10.1126/science.1193147

SECTION I: THE DATA

1
WHO RECEIVES A GEOSCIENCE DEGREE?

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ABSTRACT

To match applicant pools for faculty positions, and ultimately, faculties with the available pool, the student population, we need data on who gets a geoscience degree. The National Science Foundation (NSF) provides these data; they reveal that in the past 10 years, 35–40% of geosciences bachelor's and doctoral degrees are awarded to women; yet, less than 30% of geoscience assistant professors at doctoral-granting institutions are women. The principal leak in the academic pipeline, then, occurs at the entry-level hiring stage.

How many women should be on geoscience faculty? We propose that the proportion of women on the geoscience faculty should approximate the proportion who earn geoscience degrees. An analysis of NSF data on gender and race/ethnicity of STEM degree recipients in the U.S. in the last 10 years reveals that 35% to 40% of geosciences bachelor's and doctoral degrees were awarded to women. Yet less than 30% of geoscience assistant professors at doctoral-granting institutions are women.

1.1. Bachelor's Degrees

The National Science Foundation and the American Geosciences Institute collect data on who receives what degree in STEM and earth and atmospheric sciences (EAS) fields, respectively (http://www.nsf.gov/statistics/sestat/; http://www.agiweb.org/workforce/). NSF's data extend from 1967 to the present (no data were supplied for 1999). Undergraduate degrees awarded to women in EAS fluctuate from 1967 to the present, but there is an overall upward trajectory, from 10% in 1967 to around 40% in 2010 (most recent data available; [*NSF*, 2011, 2013]) (Figure 1.1). Fluctuations appear to coincide with perceptions of the job market; that is, when the "oil bust" occurred in the mid-1980s, enrollments in geoscience programs declined rapidly. The decline was steeper for women than for men as indicated by the decrease in percentage of bachelor's degrees awarded to women during the oil bust (Figure 1.1). We have no explanation for why women would disproportionately not choose or would leave EAS when the oil job market declined. No studies of this phenomenon exist to date.

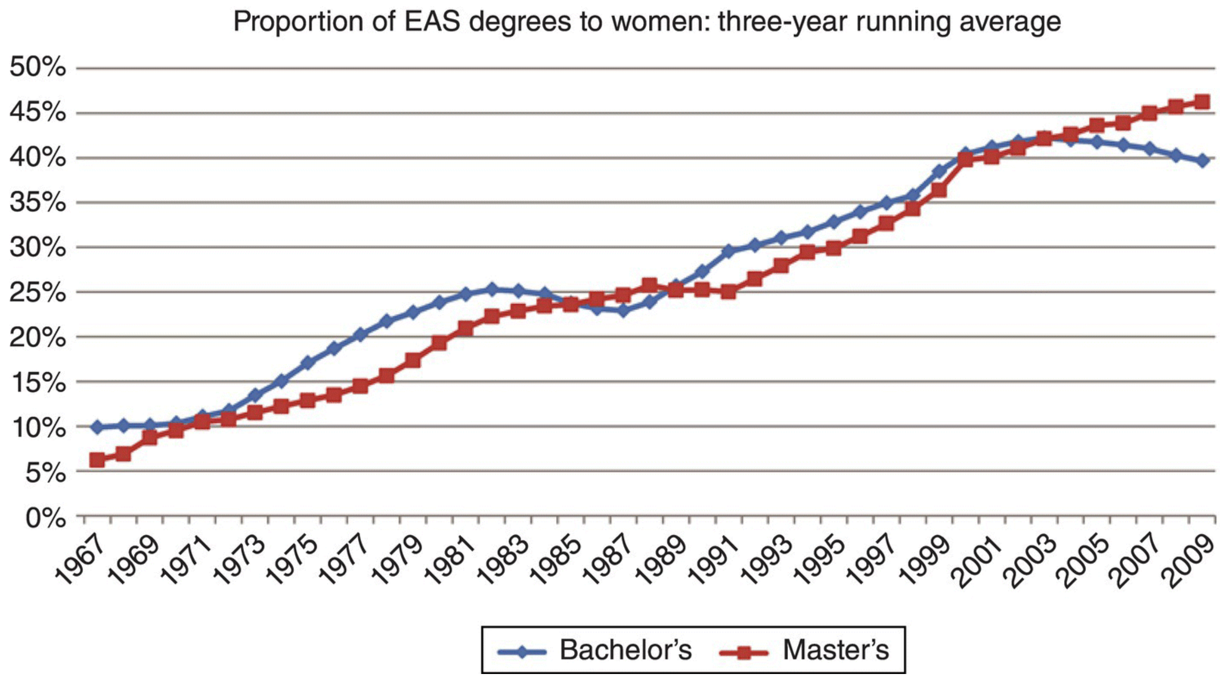

Figure 1.1 Proportion of Bachelor's and Master's degrees in EAS awarded to women.

Data from *NSF*, 2013.

With time, the downward trend of the mid-1980s reversed. However, the proportion of women receiving EAS bachelor's degrees reversed again from its peak of 43% in 2002 (Figure 1.1). We know of no data that explain the current decline. In general, EAS underrecruits women to the field: since 1981, more than 50% of earned bachelor's degrees have been awarded to women; since 2000, more than 50% of earned STEM bachelor's degrees have been awarded to women [*NSF*, 2013]. The higher percentages are in the life sciences; the physical sciences and engineering continue to underrecruit women even more than does EAS.

Why would women not be attracted to EAS as a major? We asked focus groups of students for their ideas on this question, and both men and women cited their appearance, their clothing, as a turn-off to some portion of the student body. "We wear Carhartts and hiking boots and don't wear makeup" were the sorts of comments the students made. They told anecdotes of their roommates in other disciplines noticing our appearance and sometimes making disparaging or humorous remarks of the "field look." This phenomenon deserves more and better study; we suspect that there are additional explanations for the underrecruitment that our research did not reveal. Positive things we can do to increase recruitment of the underrepresented are to focus on "critical incidents" in the geosciences pipeline, as detailed in *Levine and others* [2007].

1.2. Graduate Degrees

The proportion of women who receive a master's degree in EAS closely tracks the proportion receiving a bachelor's until the mid-2000s, when a greater proportion of women receive master's than bachelor's degrees in EAS (Figure 1.1). These data demonstrate that until the mid-2000s, EAS did a great job of equably recruiting students by gender from bachelor's programs into master's programs. This is not true of the physical or biological sciences: both disciplines lose women from their pipelines after the bachelor's degree [*NSF*, 2013; see chap. 1 for discussion of using the pipeline metaphor]. Why men are now being disproportionately lost from bachelor's to master's programs needs further study. Unless they are heading straight to PhD programs, this trend is cause for concern.

The proportion of women who receive a PhD in EAS declines from the proportion who receive a bachelor's or master's degree (Figure 1.2). As for most STEM disciplines, women leak from the pipeline disproportionately between the bachelor's and the PhD. When asked to explain this decline, geoscientists in focus groups in 2002 provided gendered responses: men mentioned "societal pressures" on women to have families, while women cited chilly department climates and the lack of structural support, such as daycare facilities [*Holmes et al.,* 2008].

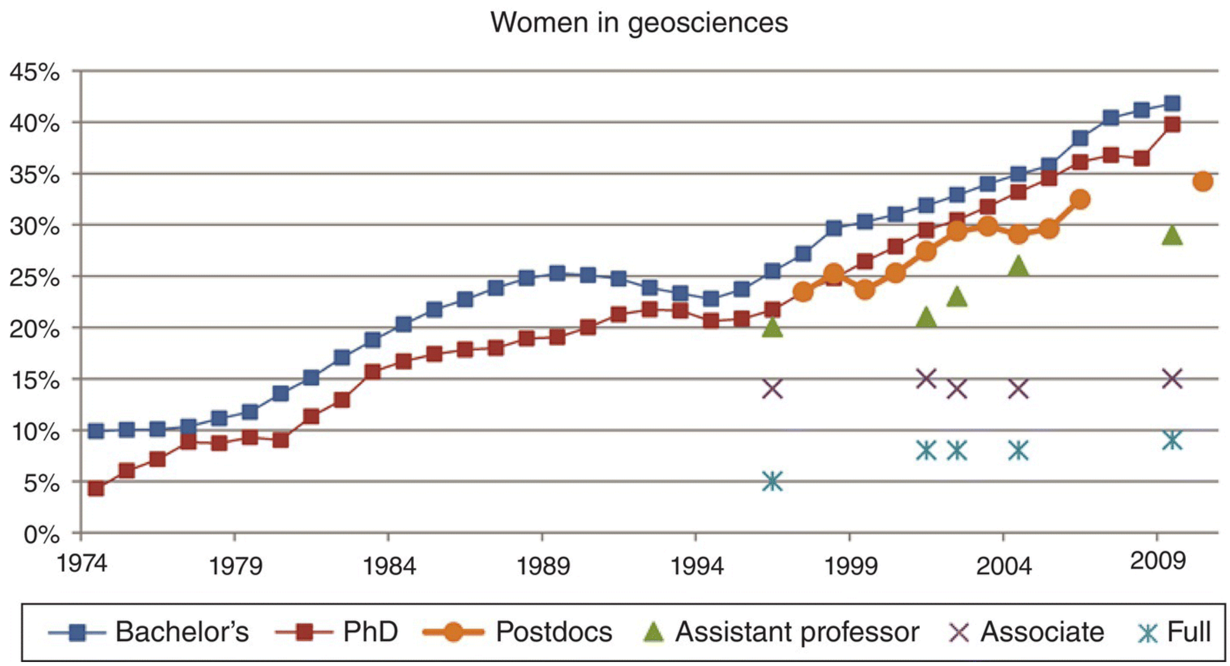

Figure 1.2 Proportion of women at various stages in the geoscience workforce pipeline. Student and post-doc data from *NSF*, 2013. Bachelor's degrees are forwarded by seven years to compare with PhD recipients. Faculty data from *AGI*, 1996–2012, for PhD-granting institutions. Bachelor's and Master's granting institutions have 3–5 higher percentage points of women faculty than doctoral granting institutions.

1.3. On to the Profession

The proportion of women in postdoctoral positions closely matches the proportion who receive a PhD, indicating no or a small loss in the pipeline between PhD and postdoc [Figure 1.2; *NSF*, 2013].

The greatest leak (off-ramping) leading to academic positions occurs at hiring women into assistant professor positions (Figure 1.2). Research demonstrates that women feel both "push" factors for leaving the field between PhD and faculty position, and "pull" factors. "Push" factors are external factors such as implicit bias (see chap. 3), pressure from family or society to leave, lack of mentorship and encouragement to proceed in her career, lack of structural support for child care, and immobility due to partner's position, to name a few of these factors. "Pull" factors are those in her own life, personal circumstances that preclude her ability, interest, or desire to stay on an academic track. These might be a desire to care for family members (elders, siblings, or other family) or the overwhelming sense of a need to focus attention on a newborn.

Based on these data, applicant pools for faculty positions, and ultimately, the faculty itself, should have around 30% to 40% women in them to match the supply produced at the PhD and postdoc levels. We suggest strategies to increase the diversity of applicant pools in chapter 10.

The next chapter analyzes the faculty of the top 100 geoscience graduate programs in the U.S. as a sort of scorecard to see how we are progressing in creating a faculty that looks like our student body.

REFERENCES

American Geosciences Institute, *Directory of Geoscience Departments*. Issues from 1997, 2001, 2002, 2005, 2010, 2011, and 2012.

Holmes, M.A., S. OConnell, C. Frey, and L. Ongley (2008), Gender imbalance in U.S. geoscience academia, *Nature Geoscience*, *1*(2), 79–82. doi:10.1038/ngeo113.

Levine, Roger, S. Gonzalez, S. Cole. M. Fuhrman, and K. C. LeFlock (2007) The geoscience pipeline: A conceptual framework, *Journal of Geoscience Education*, *55*, 458–468.

National Science Foundation, National Center for Science and Engineering Statistics (2011), *Science and Engineering Degrees: 1966–2008*. Detailed Statistical Tables NSF 11-316, Arlington, VA. Available at http://www.nsf.gov/statistics/nsf11316/.

National Science Foundation, National Center for Science and Engineering Statistics (2013), *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2013*. Special Report NSF 13-304, Arlington, VA. Available at http://www.nsf.gov/statistics/wmpd/.

2
WE ARE THE 20%: UPDATED STATISTICS ON FEMALE FACULTY IN EARTH SCIENCES IN THE U.S.

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ABSTRACT

This paper presents data on the numbers of female and male professors at the 106 top US earth science PhD-ranting graduate programs during the 2010–2011 academic year. Overall, 20% of earth science faculty at PhD-granting research universities were women (470 female faculty members out of 2,324 total). By rank, 36% of assistant professors, 24% of associate professors, and 13% of full professors were women. Large ranges in percentages (0%–40%) of female professors were observed between departments. No geographic trends were observed, nor was there any correlation between the national ranking of department and the percentage of women faculty. A small positive correlation between the size of the department and the percentage of female faculty was present as department sizes increased from 5 to 30 faculty members, and a small decline occurred between 30 to 50 faculty. Percentages of tenured female faculty were generally lower than the total percentage of female faculty members in each department. The top 5 departments in terms of percentages of female faculty were SUNY Buffalo Department of Geology (40%), Louisiana State University–Baton Rouge Department of Geology and Geophysics (40%), University of New Hampshire Department of Earth Sciences (37%), University of Massachusetts–Amherst

Department of Geosciences (36%), and University of Nevada–Las Vegas Department of Geoscience (35%).

> *"I have always claimed that there was no merit in being the only one of a kind."*
>
> —**Florence Bascom** (1862–1945), first woman PhD from Johns Hopkins University, first woman geologist hired by U.S. Geological Survey, first woman officer of Geological Society of America, Bryn Mawr professor, founder of the Bryn Mawr geology department and mentor to numerous prominent female geologists. She modeled the geology program at Bryn Mawr on programs at male colleges, and insisted that her female students conduct field work, despite the fact that women's participation in geology had previously been primarily indoors (paleontology, cartography, etc). Many of the women geologists in the first part of the 20th century were followers of Florence Bascom [*Clary and Wandersee*, 2007].

Earth science is of vital importance to society: geoscientists strive to predict earthquakes and volcanic eruptions, forecast the effects of global climate change, and understand the evolution of life and global biogeochemical cycles through time, just to list a few research themes. Many women are fascinated by these topics, as illustrated by the fact that nearly 50% of the bachelor's degrees in earth science departments are granted to women [*Holmes et al.*, 2008].

The percentage of female graduate students in earth sciences is also relatively high: around 40% in the 2000s. The story changes going from graduate school to postdoctoral programs, and especially from postdoctoral programs into assistant professorships. Research has shown a large leak in the pipeline in between graduate school and assistant professorships [*Holmes and OConnell*, 2003; *Holmes et al.*, 2008], implying that academic earth science is a less attractive career choice for female PhDs. This gap is not filling at nearly the rate expected if the problem was simply the lag time needed for the increased numbers of female PhDs to climb the ranks in academia [*Holmes et al.,* 2008].

I compiled data on the numbers of female and male professors at all ranks (assistant, associate, and full, as well as research professors at the same three ranks) for the 106 top U.S. earth science PhD-granting graduate programs from the 2011 *U.S. News & World Report* college rankings, with a minimum of 5 faculty in the department and a maximum of 50 faculty. These data were obtained by counting the numbers of female and male professors listed on the faculty pages of each department's webpage; counts were made between November 2010 and May 2011. Adjunct and emeritus professors were not counted. Taken all together, 20% of earth science faculty at PhD-granting research universities were women (470 female faculty members out of 2,324 total); by rank, this varied from 36% for assistant professors (33% for assistant research professors), 24% for associate professors (30% for associate research professors), and 13% for full professors (10% for full research professors) (Figure 2.1). These numbers are up ~10% across the ranks from a 2002–2003 dataset, which found that on average 12% of the total earth science faculty were female: 26% female assistant professors, 14% female associate professors, and 8% female full professors [*de Wet et al.*, 2002; *Holmes and OConnell*, 2003; *Holmes et al.*, 2008]. However, the 2010–2011 data remain well under the ultimate goal of 50% female earth science faculty at all ranks.

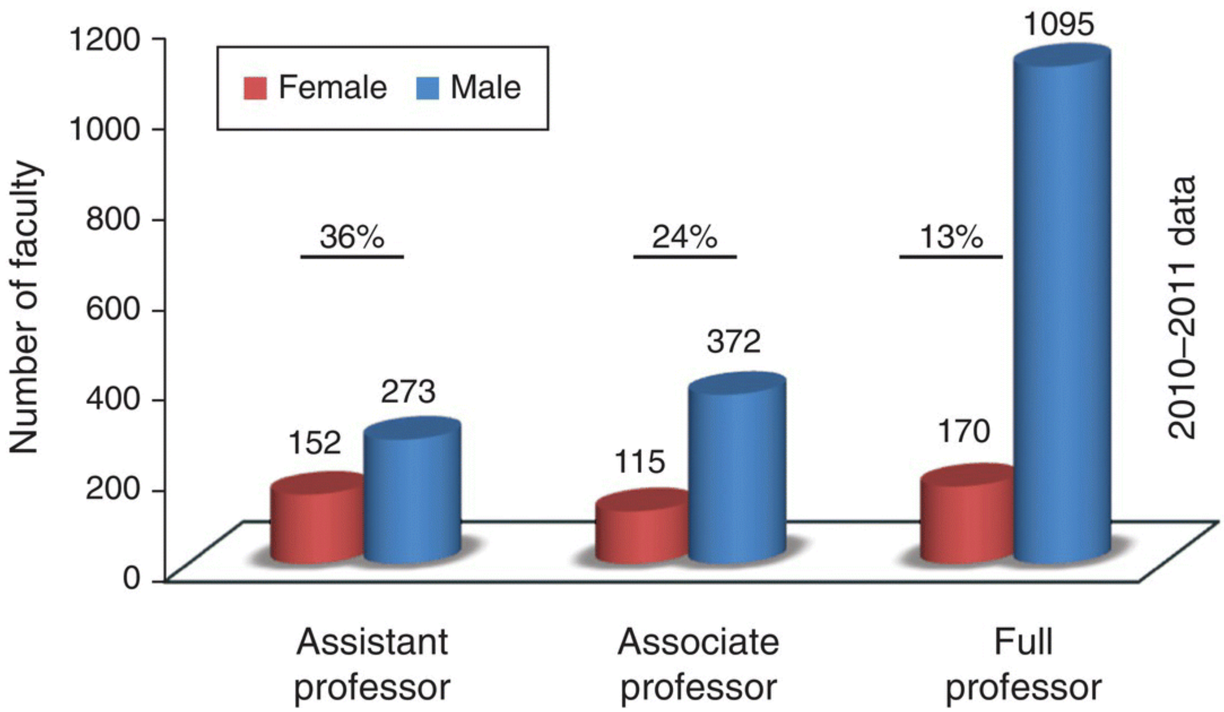

Figure 2.1 Numbers of female and male faculty members by rank at the 106 top-ranked PhD-granting geoscience departments. Data for 2010–2011 academic year.

On a departmental level, there was a large range in the percentages of total faculty who were women, from 0% to 40% (Figure 2.2). One might suppose that departments with the most women are concentrated in a certain portion of the country. In fact, there are no clear geographic trends in the percentages of female faculty (Figure 2.3). There is also no correlation between ranking of department and the percentage of women faculty: the two top-ranked earth science graduate programs at Caltech and MIT have 22% and 18% female faculty, respectively, whereas two of the lowest ranked programs at University of Alabama and Baylor University have 27% and 7% female faculty, respectively. There was a very loose positive correlation between the size of the department and the percentage of female faculty as department sizes increased from 5 to 30 faculty members, and then a small decline in the percentage when the department size increased between

30 and 50 faculty. Percentages of tenured female faculty (associate and full professor) are generally lower than the total percentage of female faculty members in each department, with a few notable exceptions (Colorado State University: 50%, where 50% of the tenured professors are women; U. Nevada–Las Vegas: 44%; Georgia Tech, 38%; University of Wyoming: 27%; University of Wisconsin: 24%; Figure 2.2). This is important because women may be attracted to departments where there are already a significant number of senior female faculty members.