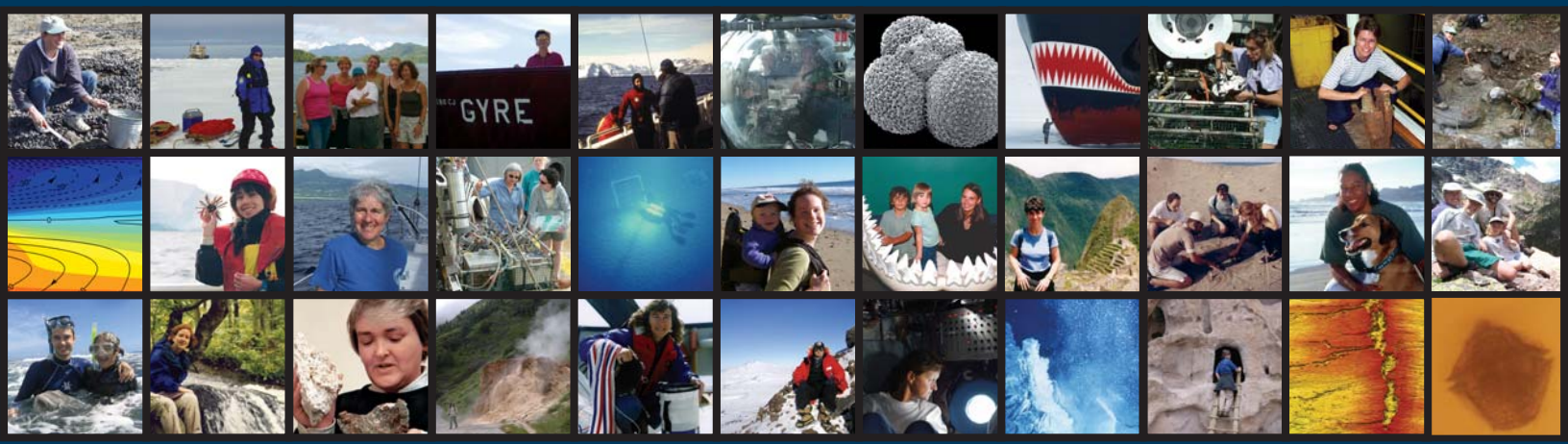
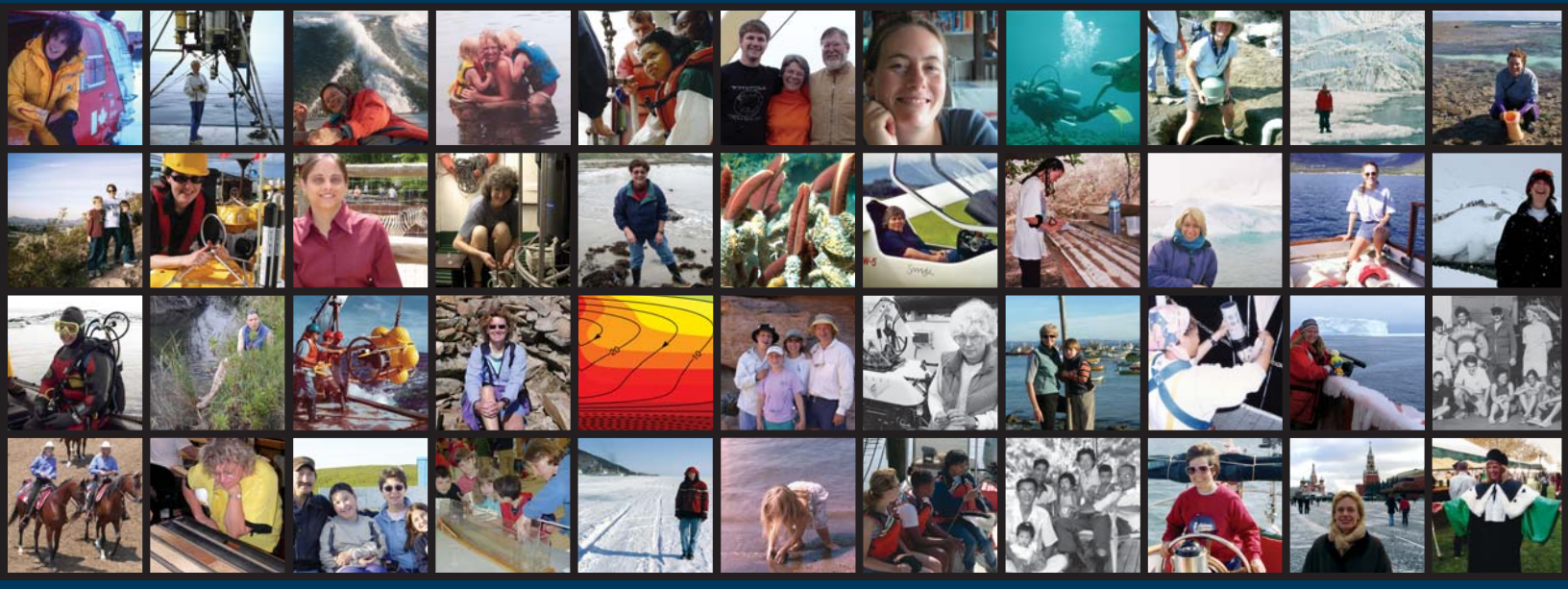


AUTOBIOGRAPHICAL SKETCHES OF

WOMEN IN OCEANOGRAPHY



INTRODUCTORY LETTER FROM PEGGY DELANEY

In the following pages, you will have the opportunity to explore scientific autobiographies of more than 150 modern women oceanographers. These personal portraits give direct and compelling glimpses into the accomplishments, motivations, challenges, and lives of women scientists who come from a range of countries, institutions, career paths, job titles, levels of seniority, and areas of emphasis in ocean sciences.

Why autobiographies? A number of years back, I taught two undergraduate seminars on "women in science" at the University of California, Santa Cruz (UCSC). I found that my fascination with exploring the statistical data—the representation of women in different areas of science, the pipeline issues about career pathways, the different demographics in different fields and countries, the programs that worked to improve science teaching, the changes through time in women's representation in science—was matched only by the students' fascination for stories. While they patiently listened to, read about, and thought about data and their implications, what they most wanted was to read about, hear about, and think about individual women in science—what they had done, how they had faced challenges, what they found rewarding, and why. I decided to explore that same balance in this issue, combining a series of articles largely about data (see issue introduction for an overview of these) with the stories of individual women oceanographers.

To accomplish finding the stories, we used what I term a "viral communication campaign" to solicit potential contributors by e-mail invitation. We started with a list of women oceanographers I could think of—women I had worked with, women in my e-mail address book, women I had been on committees with, women I had been in graduate school with, women I had met at meetings—and complemented this list with contacts that Ellen Kappel, editor of *Oceanography* magazine, had accumulated, including asking all of the women authors of articles in this issue. There was no attempt to be systematic or comprehensive, no research on web sites to find more names, and only a very few screening rules applied. For example, I didn't include women who were currently graduate students or post-doctoral scholars in my initial solicitations, although we didn't turn these contributions away if they arrived. Because of the very idiosyncratic nature of the starting list and my desire to be as comprehensive as possible, I included a request in the invitation that each woman pass the invitation along to at least two other women oceanographers (the viral component), and I asked the article authors to contact an even larger number.

We asked contributors to provide an autobiographical sketch that covered both the professional and the personal, asking for a contribution roughly 400 words accompanied by one graphic, either a graphic or picture related to their research or a photo of the scientist in any setting. Although contributors were free to focus on any topics they wished in the broad sense of scientific autobiography, we asked them to think about a series of specific questions in framing their responses (see box).

We gave a relatively short timeline for contributions, and we watched with growing glee as they flowed in. We answered questions about contributors and contributions. We applied no strict limits other than length, and we offered no restrictions on how the invitation could be passed along. We allowed broad interpretation of the boundaries of oceanography. When asked, for example, whether someone who considered herself a marine biologist or a geologist could contribute, we said, yes, if she also considered herself an oceanographer. We assured women that the timing of an invitation's arrival did not reflect any assignment of status; there was no A-list or B-list of invitees. We addressed fears about seeming too negative or too explicit about concerns, finding that pieces were written in balanced fashion. We were impressed by the growing reach of our invitation as responses moved beyond our initial viral inoculation.

Some themes stand out in reading through the autobiographies. Mentors and mentoring play a major role in many careers, both in presence and absence at different career stages, and many women link this to the great joy they find in teaching about oceanography. Some women knew from an early age that they wanted to be oceanographers, others decided later, and some didn't address this issue. Liking a challenge, enjoying solving problems, and working out puzzles are all defined as rewarding and compelling. The

SUGGESTED TOPICS FOR AUTOBIOGRAPHICAL SKETCHES

(1) What are your scientific and research interests?

(2) How did you choose your field of study?

(3) What have you found most rewarding about being an ocean scientist and why?

(4) What have been your greatest career challenges? How have you responded to these challenges?

(5) How have you balanced your career and personal life? How has this balance influenced your career choices and your personal life?

(6) Are the conditions for women in your area of the field different now than when you began your career? If so, how has that affected your work?

(7) What other topics or issues would you like to address?

interdisciplinary nature of oceanography is important to many. Love of their work and their careers shines through in many autobiographies, with their greatest joy often found at sea or in the field, regardless of harsh conditions. The interactions, relationships, and collaborations with colleagues and students are mentioned as being fulfilling. Research funding comes through as a significant and growing challenge, specifically for those on "soft money." Career paths were sometimes mentioned as non-conventional or circuitous, with some contributors acknowledging obligations to family and/or children as a contributing cause to what they perceived as slow progress. A significant proportion of sketches acknowledge the difficulties and challenges of balancing career and family life. A number mention the effects of overt or implied discrimination, and some women refer to the combined and added challenges of representing a minority ethnic or racial group.

Because of the nature of the "viral communication" used to solicit autobiographies, there is a lot missing. The autobiographies focus most heavily in academic research oceanography, with more limited representation of women in mission-oriented agencies, government agencies, non-profit agencies, and other non-academic career paths in oceanography. There were worries expressed as autobiographies were composed and edited about seeming too negative or about offending potential employers, collaborators, and colleagues. Some women may have chosen not to participate or not to be as forthcoming as they might have been otherwise as a result. There are a suspiciously large number of scientists whose career paths at one time intersected with UCSC over the past two decades, my time on the faculty here, or with the MIT/WHOI Joint Program in the late 1970s and early 1980s (my graduate school days). In closing, I hope you find these stories as interesting as I do, and I thank all of the contributors for their generosity.

Acknowledgements. I would like to thank Lisa Borok, Visitor Programs Manager at the UCSC Seymour Marine Discovery Center for organizing the Fall 2004 public seminar series "Women Who Turn the Tides: Setting New Benchmarks in Marine Science," and for inviting me to design and host a panel discussion in that series about "Women in Marine Science: Discussing Careers and Inspirations." I would like to thank the panelists at that discussion for allowing me to "test drive" these questions on them in a very public setting. I would like to thank Alison Trybom, UCSC, for her able summary notes about the autobiographies. I would especially like to beg the indulgence of all those I missed in the viral campaign; omissions were not deliberate.

Peggy Delaney
Guest Editor

Fatima Abrantes

Principal Researcher, Instituto Nacional de Engenharia, Tecnologia e Inovação, Lisbon, Portugal, fatima.abrantes@ineti.pt

Although always fascinated by the ocean, since my early years in Angola, a career studying history was my high school dream. The lack of a history degree at the University of Luanda, however, turned me toward geology. After starting my studies (1974), the civil war in Angola forced my family to move to Portugal where I finished my degree at the University of Lisbon. Oceanography wasn't part of the degree syllabus, but I developed my final-year research project with the Marine Geology Group (MGG) of the Portuguese Geological Survey (PGS); I had been working in the PGS library part-time for four years.

Research jobs weren't available and graduate studies didn't exist at Portuguese universities. But, I decided to keep working and learning with the MGG for free while searching for a research position. Months later, PGS was asked to evaluate the industrial potential of the diatomite layers of a lignite/diatomite complex, and I got to do this study. That was how I learned about diatoms and their industrial potential. I was totally in love with these algae when I finally got a technical position at the MGG.

In 1982, the USA and Portuguese Science Foundations launched a program to promote the development of young Portuguese researchers in ocean sciences. I applied, was selected, and experienced what turned out to be an incredible and most enriching four-month training course at the great Lamont-Doherty Earth Observatory. I learned from great diatomists Constance Sancetta, Lloyd Burckle, and Julianne Fenner, loved the working environment, and decided to return to the United States as a graduate student.

Back home I searched for funds and prepared applications to American oceanographic institutions. Accepted at two universities, I was awarded a NATO scholarship in 1985. The University of Rhode Island's Graduate School of Oceanography (GSO) and Jim Kennett (whose *Marine Geology* book had impressed me) were my choice. Five years of intense, but fulfilling, work and great professional and personal learning experiences followed. Already married when I entered GSO, I became pregnant after taking my comprehensive exams. With a lot of effort through the latter part of graduate school, I was very proud to prove that I could be a mom and still do my research. I defended my thesis when my son was nine months old.

It was then time to come back to PGS and pay back to my country for the help I had received. Although there were difficulties in adapting to Portuguese working methods, and the system was highly bureaucratic, I decided to develop a paleoceanography group. Success in getting funds from the European Union and joining international programs helped in my quest. I was the second female geologist joining PGS. Presently, the Marine Geology Department has an equal number of men and women, and the Paleoceanography Group is majority female.

I love my research and all the involved activities give me pleasure. But the most rewarding event of my career was organizing the big 6th International Conference on Paleoceanography in Lisbon (1998). Its great success gave me a fantastic feeling.

In a country where by tradition and culture house chores and children's education is still mainly a female job, accomplishing career goals demands a lot of coordination and an internal driving force. I have certainly not achieved the scientific level that I would have liked. My administrative obligations have also increased to a level that leaves no space to both pursue my own scientific interests and enjoy my family and friends, and has forced me to make difficult choices. But, what is life other than a sequence of choices that at any time determines our future?

A visit to the R/V *Mestre Costeiro's* steering room on my first cruise (1981). Current research interests include oceanic paleoproductivity, Cenozoic marine diatoms, taxonomy, biostratigraphy, and paleoceanography, among others. Photo by L. Gaspar.

Vera Alexander

Professor Emeritus, School of Fisheries and Ocean Sciences, and Assistant to the Provost for Fisheries and Ocean Science Policy, University of Alaska Fairbanks, Fairbanks, AK, USA, vera@sfos.uaf.edu

I recently stepped down from the position of Dean of the School of Fisheries and Ocean Sciences at the University of Alaska Fairbanks (UAF), after serving in the position since the formation of the School in 1987. Prior to that, I had served as Director of the Institute of Marine Science and Professor of Marine Science. Now, I serve as Assistant to the Provost for Fisheries and Oceans Policy, but on a half-time basis, being semi-retired. I direct the MMS/UAF Coastal Marine Institute and the Pollock Conservation Cooperative Research Center, supported by the Pollock Conservation Cooperative.

I was born in Budapest, Hungary, and raised in England, and came into oceanography via a circuitous route. As an undergraduate, I thought I wanted to go into agriculture, but upon arriving at the University of Wisconsin, I was persuaded to change first to a chemistry major, then to biochemistry, and finally to zoology—the latter because I had become involved in the very active limnology program. I ended up taking a master's degree in zoology there as well, pioneering the use of ^{15}N in to measure nitrogen fixation in lakes. I had my first marine experience at Sapelo Island in Georgia, and also at the Bermuda Biological Station. I received my Ph.D. in marine science at the University of Alaska, the first woman ever to receive a doctorate there. I was fortunate, in that the first director of the fledgling marine institute at the University of Alaska invited me to be his Ph.D. student, and once finished, I found that I enjoyed the challenge and freedom of working and living in Alaska, and elected to stay. My subsequent research in Arctic limnology and biological oceanography included fieldwork in the Arctic, Antarctic, northern Canada (Ellesmere Island and Devon Island), and Finnish Lapland, and my most recent work was on the biological productivity of the seasonal marginal sea ice zone in the Bering Sea. I have served as visiting Professor at the National Institute of Polar Research, Tokyo, and at the University of Turku, Finland, and still make frequent visits to northern Japan.

This photograph was taken in February, 2002, during the Symposium on the Okhotsk Sea and Sea Ice, in Mombetsu, northern Japan. This annual event offers the opportunity to compare northern sea ice dominated marine systems.

Since diverting into administrative roles, I have become more active in national and international arenas. For example, I served on the Science Advisory Board to the National Oceanic and Atmospheric Administration, and on the ocean Research Advisory Panel to the National Ocean Research Leadership Council. I currently serve as a US Marine Mammal Commissioner, as Chairman of the North Pacific Marine Science Organization (PICES), and President of the Arctic Research Consortium of the United States (ARCUS). I also serve on the Scientific Steering Committee for the Census of Marine Life, a very exciting and innovative global program designed to assess the biodiversity of the world oceans.

When I started my career, there were very few women involved, especially at high latitudes. I was one of the first to use the Naval Arctic Research Laboratory, and the environment there was not totally welcoming, although it became more so by the 1970s. I was the first director of an oceanographic group, and became quite used to being the only woman at various meetings. Fortunately, it is very different now! I was fortunate in being able to indulge my interest in horses and classical piano, and enjoyed raising my two children. Maintaining a personal life, while pursuing a scientific career, is made easy in Alaska because the availability of land close to the university and the lack of traffic totally eliminates commuting time.

Alice L. Alldredge

Professor and Chair, Department of Ecology, Evolution, and Marine Biology, University of California, Santa Barbara, CA, USA, alldredg@lifesci.ucsb.edu

Alice Alldredge and her son, Reno King, in their favorite habitat.

While growing up in Colorado I became mesmerized by stories of oceans I had never seen, and decided to become a marine biologist when I was 11 years old. After getting a B.A. in biology from Carleton College, I spent my first year in graduate school studying gelatinous zooplankton in their natural habitat while blue-water diving in the Gulf Stream with my advisor, Bill Hamner. This new approach to pelagic research allowed me to quickly find a unique niche of my own investigating the ecological role of marine snow. Upon receiving my Ph.D. from the University of California, Davis in 1975, I took a NATO postdoc on the Great Barrier Reef before coming to Santa Barbara where I have been happily ever since.

My career has been an exciting, fascinating, all-engrossing adventure. While diving among exquisite plankton I have been scrutinized by oceanic sunfish, dolphins, marlin, sailfish, cormorants, sea lions, and many, many kinds of sharks, including a Great White. I have huddled behind boulders in makeshift field camps during hurricanes, helped rescue 600-foot freighters sinking far out at sea, studied marine snow in the deep abyss from *Alvin* and *Sea Link*, and conducted research in everything from homemade outrigger canoes and ships to one-person submersibles. I have received several awards, including the Henry Bryant Bigelow Gold Medal in Oceanography. But the most satisfaction in my career still comes from making truly new discoveries, from mentoring my many wonderful students, and from deep friendships developed with colleagues around the world.

A 30-year marriage to my highly supportive, non-scientist husband has added stability and humor to my life, but it was the birth of my son that changed my whole perspective on my work, bringing into sharp focus what really matters. On our deathbeds I doubt that any of us will be thinking back on the thrill of some discovery we made, or the admiration of some colleague, or some grant proposal we're still angry didn't get funded. Instead, we will be asking bigger questions. How well were we loved? Did we live well? Did we really make a difference? I have come to see my career as a kind of backdrop against which these larger issues of my life are revealed. My career has provided wondrous and, at times, painful opportunities to grow in wisdom and compassion and to learn not to take myself too seriously. It has kept me ever at my edge, always growing, always challenged, and forever grateful.

Ahuva Almogi-Labin

Senior Scientist, Head, Stratigraphy and Oil Division, Geological Survey of Israel, Jerusalem, Israel, almogi@mail.gsi.gov.il

Already as an undergraduate, I knew that I would specialize in marine sciences using mainly calcareous microorganisms. Scientifically, my main interest is to better understand low-latitude marine environments of marginal seas in shallow and deeper water. This naturally results from the local geography of Israel, but it also reflects the fact that marginal seas are, in general, reliable amplifiers of oceanic processes. In my studies I often used the present as a key to understanding and reconstructing the past. This was the case in my work on the Red Sea, when I reconstructed its paleoceanography based on a detailed study of the population dynamic of pteropods and planktonic foraminifera. Also, in the eastern Mediterranean, I combined data from the present and past to reconstruct past conditions of shallow-water environments, mainly along the distal parts of the Nile delta. Lately I have become more involved in the study of foraminifera from brackish habitats where conditions are marginal for their existence. Here, past records show the range of salinities that this group can tolerate. I am also interested in an ongoing project concerning anthropogenic eutrophication in the eastern Mediterranean. In this extremely oligotrophic sea, anthropogenic eutrophication is causing large changes in the characteristics of the living benthic foraminifera's population.

One of the projects that I am currently studying is the brackish ecosystem of the Timsah ponds, Israel, which has ~3‰ salinity, and where calcareous foraminifera thrive. The ponds are monitored on a monthly basis for their water properties and their calcareous microfauna. The area is the healthiest wetland along the coastal plain of Israel and is frequently visited by water fowl that seems to repeatedly introduce foraminifera into these water bodies.

As a married woman with children, I had to find my way in science trying to balance my career and personal life. At an early stage in my career, I had to make my choice, deciding to do my Ph.D. in Israel and not go abroad. Later on I worked for several years on soft money trying to find my way before finally settling on the Geological Survey of Israel. Most of my students are women and I continuously see that they still have the same difficulties that I had years ago, though the awareness of their needs is increasing today. It is especially difficult caring for children when they are young, while at the same time, needing to make progress in science. Helpful and tolerant spouses seem to make a lot of difference, making it easier for women to proceed in their scientific careers.

Finally, I have to admit that, although I continuously encountered difficulties in my work as a woman in oceanography, I highly enjoy all that I did and that I am still doing.

Belén Alonso

Head, Departamento de Geología Marina y Oceanografia Física, Instituto de Ciencias del Mar (CSIC), Barcelona, Spain, belen@icm.csic.es

I was born in Tudela, Spain. I began studying geology in 1975 at Barcelona University (Spain), and completed a Ph.D. in 1986 at the University of Barcelona, entitled "The Ebro Deep Sea Fan (Western Mediterranean Sea)."

I joined the Instituto de Ciencias del Mar of the CSIC in 1988. I have 20 years of research experience in seismic stratigraphy, sedimentology, and morphology, with a specialization in deep-marine sedimentary systems. In 1992, I was named Spanish delegate of the Science Committee of ESCO (Ocean Drilling Program), and this year I received Honorable Mention by the Society for Sedimentary Geology (SEPM) for my contribution in the Poster Session. Since 1997 I have cooperated with the oil industry (Repsol-YPF, Norsk Hydro, Medgaz) in various research projects concerning turbidite systems in the Northwest Mediterranean (the Ebro), the Southwest Mediterranean (Almeria, Guadalfeo, and Guadiaro), and the Atlantic Ocean (Agadir, Magdalena, Orinoco). In 2004, I was appointed Professor of the CSIC. I have co-authored over 120 published papers and books (national/international), and I am co-editor of a textbook on "Submarine Valleys and Modern Turbidite Systems" edited by CSIC. I have participated in 60 congresses as speaker and chairperson, and in 35 national and international research projects.

My research interest ranges from morphology of the seafloor, particularly submarine valleys, to the evolution and sedimentary architecture of continental margins, to deep-water sedimentary processes and deposits. In the summer of 1979, at the end of my university course, I participated in a research cruise on board the *Catherine Lawrence*. This experience stimulated my passion for marine geology. The main challenges during my research career have been to better understand the origin, formation, and sedimentary evolution of turbidite systems;

Belén Alonso at her office at the Instituto de Ciencias del Mar, CSIC, Barcelona.

I discovered and first described some of these turbidite systems. I enjoy my work and I could say that the balance of my career and personal life is very satisfactory. I am married and have two sons of 20 and 7 years old. I remember that when I began to work in marine geology, I was the only woman on board geological cruises, but this situation has changed. My work, in general, has not been affected by this mostly male environment; however, I remember some unpleasant behavior towards women. At present, I would like to work on 3-D modeling projects, including geological modeling of continental margins.

Pallavi Anand

Research Scientist, Department of Palaeoecology and Paleoclimatology, Free University, Amsterdam, The Netherlands, palj@geo.vu.nl

I started my research in the field of ocean sciences with a short M.Sc. project in micropaleontology after finishing my B.Sc. degree in geology. My M.Sc. supervisor, Prof. M. S. Srinivasan, at the Banaras Hindu University, India, introduced me to the studies of marine calcifying organism, foraminifera, and its importance in ocean sciences. During those early days, he almost convinced me that benthic foraminifers were very important to study, whereas I was more inclined towards studying planktonic foraminifera! Eventually, I carried on with my interest and studied planktonic foraminiferal chemistry during my Ph.D. at the University of Cambridge, UK. I am really thankful to Harry (Prof. Harry Elderfield) for giving me freedom to explore the field of geochemical proxies. During my postdoctoral research at the University of Cambridge and the Free University, I decided to work on both planktonic and benthic foraminiferal chemistry and I am really happy with my decision because the preliminary results have been very exciting and encouraging.

My main research includes development, understanding, and application of the geochemical and isotopic proxies to evaluate climate change on geologically short (glacial-interglacial) and long (100 million year) time scales. I have been involved with studying Mg/Ca, Sr/Ca, $\delta^{18}O$ and $\delta^{13}O$ in foraminifera and their application to understanding past sea-surface temperature, bottom-water temperature, and $\delta^{18}O$ of sea water (salinity). I find it very interesting and rewarding to deal with major fields of science (biology, chemistry, and physics) in order to develop, understand, and use proxies for studying the evolution of past oceans, which is impossible to know without the help of proxies. The greatest challenge of my career so far has been to convince a small group of scientists who do not believe in "proxies," especially the recently developed ones. I am continuously doing my bit to overcome this challenge and I can sense that it has finally started to work.

Life as a woman scientist has been very challenging on the personal front. Even after marriage, my husband and I have been living in two different places and have been keeping a long-distance relationship. It has been a constant struggle for us to find academic jobs in one place, one in ocean sciences and other in planetary sciences. Now that we are expecting the arrival of a new member in our family, more challenging times are yet to come. Undoubtedly, this will require significant changes in my personal life and we will be making some major decisions in the near future, which may even lead to a change in career. However, it is still early to predict how things will be, but I am certain that my broad scientific education will guide me in finding a good balance between family responsibilities and professional obligations.

Sibel Bargu Ates

Associate Project Researcher, Institute of Marine Sciences, University of California, Santa Cruz, CA, USA, sibelbargu@hotmail.com

Sibel in San Francisco looking at the sea lions and this time not thinking about domoic acid (just having fun!).

I chose to be an oceanographer, even though I get totally seasick, to discover this part of the world. The ocean scares me, but I love it all the same. My advanced training began as a biologist. I graduated from the biology department at Istanbul University. After graduating, I was awarded a scholarship from the Turkish government to pursue a master's and doctoral degree at an institution of my choice; I chose to attend the graduate program at the University of California, Santa Cruz (UCSC) in the U.S., which is very strong in marine biology and ocean science. At that campus I completed my master's degree with Dr. Ken Bruland, working on marine diatoms and their trace metal affinities, and then switched directions slightly to work with Dr. Mary Silver on the ecology of toxic algal blooms for my Ph.D.. For my doctoral research, I focused mainly on how the diatom toxin, domoic acid (DA), is vectored through the food chain via herbivorous vectors, such as krill, in a coastal upwelling system. My field and lab findings very strongly support the hypothesis that DA can be transferred through krill to higher trophic levels in the marine food web. Given the central role of krill in transferring phytoplankton carbon to large pelagic predators, it is obvious that an understanding of the responses of these crustaceans to toxic food is critical in predicting the exposure the entire pelagic ecosystem to the neurotoxin, domoic acid.

After completing my doctoral degree at UCSC in December 2001, I returned to Turkey to a permanent position as assistant professor at Mustafa Kemal University on the coast of the eastern Mediterranean. Because I was broadly educated as a biologist, marine biologist, and oceanographer, I was given assignments to teach a variety of classes. I also supervised three master's degree student projects. I love to teach and mentor a wide variety of students, but my teaching load there was extremely heavy. I felt that I was not afforded the time necessary to provide the level of mentorship my students deserved. In addition, I could not devote the time needed for my own research in order to sustain myself as an educator and scholar in marine biology, at least at the level that I desire. Hence, I am now beginning to work again with Dr. Mary Silver at University of California, Santa Cruz as associate project researcher. I believe that I could now have the balance to contribute to academic community as an instructor and a researcher in applied marine biology. One of the other challenges through my career was to balance my work time and the time I spent for my loved ones. But, I like challenges, and by spending my daily life completely full and joyful with doing both is making my life completely satisfied.

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Dorothea Bauch

Research Scientist, IFM-GEOMAR Leibniz Institute of Marine Sciences, Kiel, Germany, dbauch@ifm-geomar.de

Understanding Earth's climate and the processes linking paleoceanographic archives and modern oceanography have been my major interests for the past ten years. I love being an oceanographer. I would even say that I love my job too much because I also wish I had a job more easily compatible with family life with children! Administrative laws in Germany make it extremely hard for a person in academia who does not fit into a "standard path of life." Stipends and positions are distributed not only by a person's achievements, but also by his or her age. After a certain number of years in academia (currently five years after Ph.D., but probably soon switching to 12 years including the Ph.D. period), receiving a soft-money position is prohibited by German administrative law! This rule definitely helps to exclude women who are going slower in their careers because they raise children. This is why I say I love my job too much, because I have three wonderful children and I nevertheless try to follow up my scientific quest in a part-time position.

As a student in the physics departments, I was mostly interested in theoretical physics and its philosophical consequences. Only when I had to join an institute for my master's thesis did I reconsider my original aims in life, and in science in general. In 1987, I finally joined the Institute of Environmental Physics, a highly "eccentric" field in the Heidelberg Physics Department. This was a major career decision, which finally led me to the field of isotope oceanography. I did my Ph.D. in this field at the Lamont-Doherty Earth Observatory some years later.

When I returned from the United States back to good old Germany in 1994, I had a Ph.D. and a husband, and I was pregnant. In a new city and new academic surroundings, I started to work on stipend money at GEOMAR in Kiel. In the following years, I developed a project at the interface between marine geology and modern oceanography. Now I am 41 years old and our kids are 7, 9, and 11 years old. I successfully publish my work in high-standard journals and I am proud of my publication record. But, in the eyes of the German academic system, this does not count. I have not reached a permanent position after a fixed number of years, which will exclude me from soft money in due course... if the laws do not change very soon again. As I have stated before: I love my job too much. "Hope dies last," doesn't it?

It is fun to present results. I enjoy public presentations at conferences and writing for journals, but I also enjoy speaking to interested laypersons. Presenting results definitely feeds one's vanity, but there is more involved: What is it all good for? Why am I doing my specific little piece of science? These are the challenging questions especially when I speak to someone not involved in science and try to connect them with oceanography and the details of my research.

Robin E. Bell

Doherty-Senior Research Scientist, Lamont-Doherty Earth Observatory of Columbia University, Palisades, NY, USA, robinb@ldeo.columbia.edu

I am a marine geophysicist studying rivers and estuaries, ice sheet stability, and life in Lake Vostok. I spent my youth dreaming of being a marine biologist, but in studying at my all girls' high school I became fascinated with the physics of slinkies and waves. When I realized that you could use physics to understand the Earth, I was hooked and enrolled in Middlebury College to study geology. After graduation, my boyfriend, Karl, and I built a 24-foot dory that we sailed and rowed down the Hudson River past Lamont and Columbia. Arriving in Woods Hole by boat, I secured a job at the U.S. Geological Survey where I first spent many months at sea collecting marine seismic data. Realizing I wanted to be designing the experiments, I entered Columbia University to study marine geophysics. Twenty-three years later I am still at Lamont enjoying the thrill of deciphering Earth's puzzles.

Robin with her husband, Karl, and their two children, Justin and Beryl, atop a Rocky Mountain Pass.

I have conducted research on seven continents, and am very intrigued by problems at the edges of the disciplines. Adapting technology developed for marine geology and geophysics, I have used aircraft to study inaccessible regions in Antarctica. Recently, I have been able to peer under the water of the river that flows past my office, leading the first high-resolution mapping of the Hudson, providing new insights into the transport of contaminants and the sustainability of benthic habitats. Becoming an expert on the local environment has added a new flavor to my work—connecting science with the interests of my local community. I am at a stage where I am building on the connections and collaborations developed over the years. Presently, I am playing a leadership role in launching a major international initiative, the International Polar Year (IPY) 2007/2008, involving over 35 nations. Bringing together the international, interdisciplinary scientific community to systematically study the polar regions of our planet, the International Polar Year will explore new frontiers, and deepen our understanding of the rapidly changing poles. I hope to use this opportunity to explore the subglacial environment of the lakes and volcanoes of Antarctica.

Winning the ADVANCE grant has become a unique opportunity to systematically study women in science. Presently, a career in science is like a monopoly game. Men play with a pair of normal dice while women are missing the six on one die. Subsequently, women often do not progress as far forward as men. These smaller returns are not the result of evil intentions, but rather the construct of universities and subtle biases both men and women harbor. Through the ADVANCE grant we are aiming to change the return women get for their investment in the pursuit of science, ensuring that women move toward Boardwalk at an equitable pace.

I believe a job at Lamont is one of the best for scientists raising families. In business, the women who are most satisfied are those who run their own companies The Lamont research career, similar to jobs at other major oceanographic institutions, is vetted through a rigorous tenure process, is supported by university endowment funds, and is flexible. Both of my children spent the first six months of their lives in my office and know the Lamont campus like their own backyard. My daughter has a sign in the Oceanography Building ladies' room advertising baby gerbils for sale while my son spent the summer working with Suzanne Carbotte and Bill Haxby programming JAVA applications for Geo-MapAP. The flexibility provided by a research-focused job is an ideal venue for pursuing one's passion for science and raising a family.

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Claudia Benitez-Nelson

Assistant Professor, Department of Geological Sciences/Marine Science Program, University of South Carolina, Columbia, SC, USA, cbnelson@geol.sc.edu

I'd never really planned on being an oceanographer. Having grown up in Seattle, I always loved the sea, but a career in studying the ocean had never occurred to me. It wasn't until college that I saw the possibilities. At the University of Washington, I was majoring in chemistry, and on a whim, took an oceanography course. That course, and a little encouragement from a very convincing advisor, hooked me for life. My specialty is marine geochemistry. I use naturally occurring radionuclides to study processes ranging from atmospheric mixing to upper ocean particle export and sediment accumulation on the seafloor. More recently, I have been involved in studying the composition and bioavailability of phosphorus. I love the excitement of testing new ideas and finding the unexpected. My favorite quote is by Isaac Asimov and I think it reflects the scientific process most appropriately, "The most exciting phrase to hear in science, the one that heralds new discoveries, is not 'Eureka!' (I found it!) but 'That's funny'...."

This picture was taken after we successfully deployed a particle interceptor trap in the lee of the Hawaiian Islands as part of the E-Flux cruises (where Dr. Benitez-Nelson (right in picture) is the lead principal investigator and chief scientist). Yoshimi Rii (left) and Patricia McAndrew (middle) are two graduate students in oceanography.

One of the best things about being a marine scientist is that I get to travel the world to do my research and yet have a flexible work schedule (in between cruises and teaching classes, that is). I am married with a wonderful husband and two great kids, Noah (five) and Julia (one). At first I was concerned that having two children before tenure would hurt me professionally. However, I have found that this is not the case due to an incredibly supportive workplace where many of my colleagues have young children as well. I think this is a dramatic change from what the work place used to be like and is probably still not as common as it should be in the sciences. It was a factor in ultimately choosing the university at which I now work. Although flexibility in my job has been wonderful, I do go to sea quite a bit. My biggest challenge over the past year is that I have been the lead principal investigator on a multi-institutional grant to study eddy formation. As chief scientist, this has required me to go on two 18-day cruises separated by only six weeks. My daughter is less than a year old, so missing this time with her has been especially difficult. Having said that, we are conducting some incredible science and getting fantastic results.

As a female oceanographer, I want young scientists to realize that it is possible to become a successful research scientist and have a family (even before tenure).

Kelly Benoit-Bird

Assistant Professor, College of Oceanic and Atmospheric Sciences, Oregon State University, Corvallis, OR, USA, kbenoit@coas.oregonstate.edu

My research focuses on the importance of spatial and temporal structure in driving interactions between pelagic animals. My work combines acoustics, oceanography, applied fisheries research, animal behavior, and ecology. Recently, I have worked in Hawaii looking at spinner dolphins foraging on a deep, sound-scattering layer of small fish, shrimp, and squid; in New Zealand with dusky dolphins and their prey; in the Netherlands with harbor porpoises and many species of fish; and soon in the Gulf of Mexico with sperm whales and their prey and Monterey Bay with small fish and the zooplankton they eat. While traveling to these beautiful places is very exciting, I most enjoy the problem solving that goes into science. My work often involves developing new ways to measure animals beneath the water's surface. Sometimes that's high-tech and sometimes it means devising creative ways to use parts from the hardware store.

I think that I first became interested in aquatic life on the many fishing trips I took with my father in the waters off New England as a child. As an undergraduate majoring in ecology at Brown University, I was fortunate to work in a research lab with two scientists who studied animal sounds both in air and underwater. It didn't take long for me to combine my excitement about ecological problems underwater with my new skills in acoustics as a graduate student at the University of Hawaii. Because my background is different from many acoustical and fisheries oceanographers, I have been able to make progress in both studying the ocean's ecology and in applying and developing acoustic approaches.

The two distinct fields that I work in have given me a broad group of exciting colleagues to work with. Learning the language of two different fields and trying to convince each of the other's strengths has also been challenging. I think the best way to solve that problem is by showing the acousticians exciting new problems and the biologists exciting new answers. Another challenge I faced was overcoming my own sense of intimidation in working with my nearly all-male colleagues in acoustics. Attending my first meeting at a graduate student to find that I was the only woman presenting in a room with over a hundred people was pretty overwhelming! My apprehension was dispelled through the encouragement of colleagues who have since become mentors and friends. However, the most difficult challenge in my career has been geography. My husband, who is also a scientist, and I have had some difficulties coordinating our career timing. Compromise and an incredibly supportive husband have made it workable.

Kelly Benoit-Bird deploying acoustic moorings off Oahu, Hawaii.

Dorothy Eden Bergamaschi (1934-2005)

Foreign Affairs Officer, Office of Ocean Affairs, U.S. Department of State, Washington, DC, USA
Submitted on Dorothy's behalf by Brian Bergamaschi (her oceanographer son), bbergama@usgs.gov

Oceanography thrives on data: data collection and open data dissemination. Many oceanographers take for granted free passage for ships to collect data, and open availability of oceanographic data once it is collected. But nations are reticent to permit free access to data that may have strategic, military, or economic value, as much oceanographic data does. Dorothy had a clear understanding of both the needs of oceanographers and the global benefits of oceanographic research. She translated this understanding into terms that convinced the United States and other nations that the benefits of cooperative research were greater than the potential value of the data.

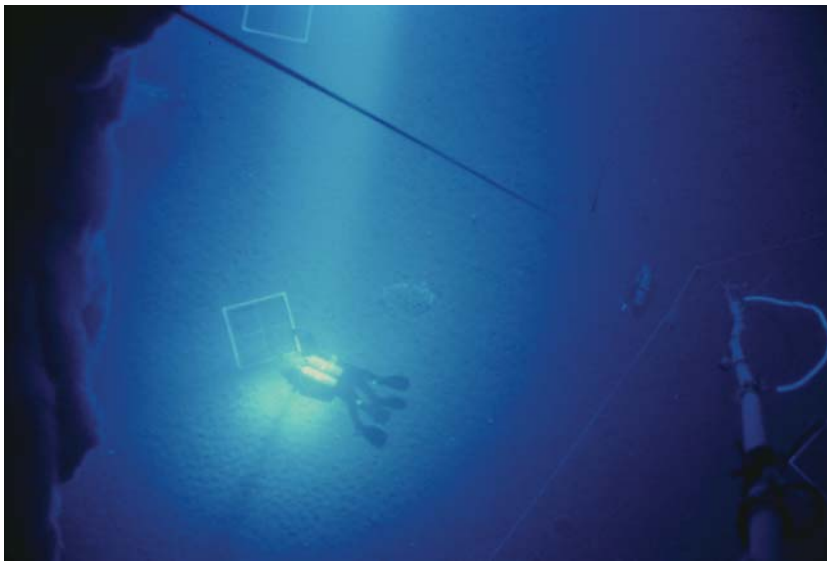
As a young woman, Dorothy was focused primarily on her family of three boys, completing her education and launching her career after the boys were grown. She was educated as a geographer and urban planner, receiving her B.S. in 1973 and her M.S. in 1981. Her early career was devoted to inserting the findings of environmental scientists into the process of coastal zone planning. In addition to several reports, she coauthored a book, *Environmental Quality by Design*.

Dorothy started working for the U.S. Department of State when she was 44 years old. For more than 20 years, as a Foreign Affairs Officer, Dorothy was an articulate advocate for global science and oceanography, helping to convince the United States and other nations to share meteorological and oceanographic data, and to permit free passage of research ships through national waters. She advocated passionately for oceanographic science in several international arenas. Dorothy was instrumental in the success of several scientific programs, negotiating transit of research ships through foreign waters to gather data critical for understanding global change, ocean circulation, and carbon dioxide uptake by the oceans. Dorothy's vision was for the free exchange of scientific data to advance global environmental research. The position of the United States and many other countries during the time Dorothy engaged this debate was that such data was costly to acquire, and thus should be sold rather than shared freely. Dorothy pursued her vision of free data exchange by serving on several international committees on data exchange, by representing the United States at international negotiations, and by serving on a National Academy of Sciences panel advising the administration on appropriate data-exchange policy. Her efforts helped change the U.S. position, permitting free exchange of oceanographic data, and helped lead to the formation of the World Data Center for Oceanography.

Dorothy as head of the U.S. delegation at a UNESCO conference in Paris (1989). In addition to leading negotiations, she took great pride in skippering the all-female crew of the racing sloop *Gorilla* to win the inaugural Chesapeake Women's Skippers Race.

Joan M. Bernhard

Associate Scientist, Woods Hole Oceanographic Institution, Woods Hole, MA, USA, jbernhard@whoi.edu



Bernhard during a SCUBA dive in Explorers Cove, Antarctica. The image was taken in a hut built over the dive hole; note the edge of the 2-m-thick ice in the left foreground. The ray of light is sunshine penetrating to the ~23-m-deep seafloor through another dive hole. Bernhard is preparing to harvest a 1-m^2 quadrat to determine densities of *Astrammina rara*, a giant agglutinated foraminifer that has been studied by Bernhard, Sam Bowser (Wadsworth Center), and others for its bioadhesive and mechanisms of shell formation. Photo copyright S.P. Alexander.

Raised near Buffalo, New York, I spent summers in lakes and winters on ski slopes, thereby developing a curiosity about aquatic environments, especially in high latitudes. My academic background, with a geology bachelor's degree from Colgate University, geology master's degree from the University of California, Davis, biological oceanography Ph.D. from Scripps Institution of Oceanography (University of California, San Diego), and cell biology postdoc at the Wadsworth Center (New York State Department of Health), is diverse and seemingly bizarre until it's realized that I have always studied foraminifera, which are protists with a long fossil record.

These studies have taken me to many regions of the world. Over nine field seasons, I have amassed nearly two years' work in Antarctica, including almost 200 SCUBA dives through 1- to 3-m-thick ice. Even though some dives ended near hypothermia, each was truly awesome due to water clarity and the faunal diversity and abundance. Other highlights have been a Fulbright scholarship in Norway, leading ten cruises as chief scientist, and four *Alvin* dives at cold seeps. These dives were equally awesome considering this submersible's history, its technological abilities, and the sighting of a giant squid!

Early on, I decided to devote all energy to research rather than pursue a professorship. Raising full salary for 15 years has been challenging, especially with today's limited resources, but the establishment of "boutique" programs to support truly multidisciplinary projects is a most welcomed addition to the funding smorgasbord.

Much of my current work involves emerging disciplines. While it has long been known that certain foraminifers have photosynthetic symbionts, I first described putative non-photosynthetic symbionts in benthic foraminifers. Colleagues and I have also documented both endo- and ectobionts in deep-sea foraminifers. Additionally, we identified the "chloroplast conundrum," an enigmatic phenomenon where benthic foraminifers living far below the photic zone sequester intact chloroplasts, whose role remains under investigation. My laboratory also studies the physiological role of peroxisomes in microaerophilic and facultatively anaerobic foraminifers. Recently, efforts focus on unraveling the complex fine-scale prokaryotic and eukaryotic microbial interactions in sulfide-enriched sediments. With colleagues, I developed a method to preserve microorganisms in life position, revealing that sulfidic, laminated sediments have highly complex juxtapositions of aerobes and anaerobes living within a few nanoliters. Observations provide impetus for reinterpretations of supposedly post-depositionally pristine laminites typically used in paleoceanographic reconstructions. After six years at the University of South Carolina, I was thrilled to return to the Northeast in 2004, joining WHOI's Geology and Geophysics Department as a tenured associate scientist.

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Katharina Billups

Assistant Professor, Graduate College of Marine Studies, University of Delaware, Lewes, DE, USA, kbillups@udel.edu

I use light stable isotopes and other geochemical tools to investigate paleoclimates and ocean history as recorded in deep-sea sediments. My research primarily involves the application of stable isotopes in planktonic and benthic foraminifera to extract paleoenvironmental information about the surface and deep ocean. I am interested in the processes behind the climate record necessitating the comparison of proxies on millennial and tectonic time scales.

I first became interested in this area of research as a senior undergraduate student at the University of California at Davis. I had the opportunity to earn some extra cash picking foraminifera. I enjoyed the work and stayed for a master's degree. Hooked on foraminifera, I decided to pursue a Ph.D. (at the University of California, Santa Cruz), and later a postdoc at Harvard University. The postdoc experience enabled me to solidify my understanding of stable isotope mass spectrometry and to learn new analytical tools. For the past four and a half years I have been an assistant professor at the Graduate College of Marine Studies, University of Delaware (UD). I have a light stable isotope mass spectrometer, which is the heart of my laboratory (see figure).

It is no surprise that the past four years have been both challenging and gratifying. I enjoyed designing the geochemical aspects of a geological oceanography course that I team-teach at UD, and I particularly like my own course that introduces students to paleoceanography. As we are a graduate college, I miss interacting with undergraduate students in the classroom, but I have had a number of undergraduate intern students working on projects during the summer. What I find particularly attractive about being an ocean scientist is its interdisciplinary nature. It seems that as a paleoceanographer I need to know a little bit about everything—geological, chemical, physical, and biological processes. I find it rewarding to be able to choose research projects of interest, and to see them through until they appear in print.

One issue that remains unresolved is my wish to participate on a cruise of the Integrated Ocean Drilling Program. I dread the time away from my two-year old daughter. Beyond that, I have not found it particularly difficult to balance life in the lab and classroom with Play-Doh and Legos.

Light stable isotope ratio mass spectrometer housed at the University of Delaware, Graduate College of Marine Studies. The instrument is a GV Instruments IsoPrime mass spectrometer equipped with a dual inlet and a MultiPrep autosampler for the analysis of 60 calcium carbonate or water samples.

Deborah A. Bronk

Associate Professor, Department of Physical Sciences, The College of William and Mary/Virginia Institute of Marine Science, Gloucester Point, VA, USA, bronk@vims.edu

I can honestly say that I am an oceanographer today because of Jacques Cousteau. I grew up in Nashville, Tennessee and spent every summer in northern Wisconsin—both a far cry from anything maritime. Books and TV were my introduction to the ocean. I took my naïve ambitions to the University of Miami where I found a wonderful mentor, Kathleen Sullivan; in many respects I have worked under the wing of one great lady after another ever since. I did my Ph.D. at the University of Maryland with Patricia Glibert and discovered I have a bizarre love of anything nitrogenous. I went on to do postdoctoral work with Bess Ward at the University of California, Santa Cruz. I then joined the faculty of the University of Georgia and, later, the Virginia Institute of Marine Science (VIMS), and was fortunate to find wonderful female colleagues and mentors at both institutions.

My research focuses on nitrogen biogeochemistry, specifically the sources and sinks of dissolved organic nitrogen, in environments ranging from Chesapeake Bay to Antarctica. By necessity I find myself doing a lot of methods development, which means I spend a fair bit of time in the trough on the wave of success. It is a great way to learn, however, and it is something I strongly encourage students to undertake.

What do I love about my career? I have the satisfaction of making a difference, I am my own boss, each day is different, I am constantly learning, and I get to travel the world. I will admit that balancing my career with my personal life has been trying at times. A recovering work-a-holic, it took a concerted effort to make time in my life for other passions. I was also a poster child for putting career before relationships. It took a while, but I finally found a sweet guy who I don't intimidate, who is incredibly supportive of my work, and who brings me much-needed balance.

Debbie Bronk on a research cruise aboard the RVIB *Nathaniel Palmer* in the Ross Sea, Antarctica.

What I love most about my career, however, is the people—the camaraderie of cruises, the enthusiasm of each new class, the lifelong friendships from graduate school, the joy of seeing old friends at meetings and learning what new things they've discovered, solving that data conundrum while lunching with the ladies, watching your student give a great talk! Being in academia can be very challenging at times but it is a life that is easy to love.

Lisa Campbell

Associate Professor of Oceanography and Biology, Texas A&M University, College Station, TX, USA,
lcampbell@ocean.tamu.edu

I am a biological oceanographer with research interests in phytoplankton ecology. Currently, research in my laboratory centers on the toxic dinoflagellate *Karenia brevis.* We find considerable variation in growth rate and toxin production among clones of *K. brevis* and are developing markers to link population and physiological diversity to better understand bloom formation and dynamics. I am also working with the Texas Automated Buoy System program to develop a buoy-based imaging system to detect *K. brevis in situ.* Once deployed, cells can be counted, and data recorded and telemetered back to the lab to provide the basis of a real-time early warning system for harmful algae blooms. Ultimately, our results will contribute to development of models for predicting the origin and maintenance of blooms.

Lisa Campbell is a phytoplankton ecologist studying *Karenia brevis*, the dinoflagellate responsible for harmful algal blooms in the Gulf of Mexico. A large collection of clonal isolates of *K. brevis* has been established for studies of population genetics using hypervariable DNA markers (known as microsatellites) to "fingerprint" isolates and elucidate population structure of blooms. Ultimately, the goal is to link population diversity and structure with causal factors of significant and ecologically harmful algal blooms.

Why did I decide to become an oceanographer? Growing up in California along the coast, I was intrigued by bioluminescence of the "red tides." Although the path my career has taken a number of turns, I have remained fascinated by phytoplankton. Many of the choices in my career were influenced by teachers and mentors. In high school I chose biology as my field of study following an exciting advanced biology course. Subsequently, at the University of California, Santa Cruz, I was inspired by the faculty in marine sciences to pursue my research interests. Working at Scripps Institution of Oceanography after graduation provided an experience that was fundamental to my continuing study of phytoplankton diversity and trophic dynamics. As a graduate student at SUNY Stony Brook, I was encouraged to try new approaches and benefited from interactions with numerous scientists.

Over my career, I have noted an increasing number of women in oceanography. The number of female faculty in my department has doubled in the past five years. I hope this trend will continue as universities place a strong emphasis on diversity. Institutions will need to be more responsive to dual-career couples; many merely acknowledge this is an issue, but really do not do enough to accommodate a spouse.

How do I "balance" my professional and personal life is a frequent question. It is impossible to "balance"—my life is more of a "see-saw." As different demands pop up, I just have to re-adjust and use my time as efficiently as possible. Fortunately, my husband is also a scientist and so is understanding of my time constraints. My sons understood at a young age that I had to work—classes, proposals, tenure. Obviously, my family has been influenced by the demands of my career, but we frequently manage to combine family holidays following travel, so it is not all negative. Nothing can match the joy my children give to me, and I have made some career decisions based on family concerns. What keeps me going are the constant opportunities to learn new things, work with new colleagues from other disciplines (engineering to molecular biology), see the spark of enthusiasm in my students, travel to interesting places, but also finding time to relax at home.

Elizabeth A. Canuel

Associate Professor, Department of Physical Sciences, Virginia Institute of Marine Science, The College of William and Mary, Gloucester Point, VA, USA, ecanuel@vims.edu

My research program focuses on the sources and fate of organic matter in marine and estuarine environments. I arrived at my current position in marine organic geochemistry through an entirely circuitous route. Although I was always interested in the oceans and spent many summers at the beach as a child, I entered the field via my training in chemistry. As an undergraduate, I majored in chemistry at Stonehille College, a small liberal arts college in Massachusetts. Shortly after graduating with a B.S., I responded to a job ad for a research technician position in the Chemistry Department at the Woods Hole Oceanographic Institution (WHOI). This experience was life-changing.

The time I spent at WHOI (1982-1986) was a revolutionary period in oceanography. At weekly department seminars, and through interactions with faculty and visitors, I was introduced to numerous breakthroughs from newly discovered hydrothermal systems, the identification of previously unknown groups of marine organisms, and the first characterizations of the small-scale physical environment in which zooplankton move and feed. I participated in two oceanographic cruises and discovered that I loved being at sea. After crossing the California Current and entering the calm, deep blue of the North Central Pacific, I was hooked and decided to pursue graduate studies in oceanography. I then began my graduate school on a part-time basis taking courses through the WHOI-MIT joint program and at the University of Massachusetts, Boston. Subsequently, I enrolled in the Ph.D. program at the University of North Carolina-Chapel Hill and received my degree in 1992. Following completion of my degree, I did a National Research Council postdoctoral fellowship with the U.S. Geological Survey in Menlo Park, California and joined the faculty at the Virginia Institute of Marine Science/College of William & Mary (VIMS) in 1994.

Along the way, I have had a number of outstanding mentors and remarkable opportunities. Stuart Wakeham was a generous supervisor and mentor while I worked at WHOI. He encouraged me to attend seminars, read, take courses, and brought me along on my first oceanographic cruises. He took a big gamble on my ability to be transformed from a chemist to a chemical oceanographer. Chris Martens, my advisor at UNC, was always enthusiastic and supportive and prepared me to become an independent scientist. Lastly, Jim Cloern, my postdoc advisor, introduced me to the complexities of estuarine systems and broadened my thinking to include ecological perspectives.

In addition, I am extremely fortunate to have the support of my husband, the fresh perspectives and sense of priorities my seven-year-old son provides, and the opportunity to develop close relationships with students and faculty colleagues at VIMS and around the world.

Suzanne Carbotte

Doherty Research Scientist, Lamont-Doherty Earth Observatory of Columbia University, Palisades, NY, USA, Carbotte@ldeo.columbia.edu

My primary research interests concern the formation of oceanic crust at the global mid-ocean ridge. I make use of a variety of marine geophysical techniques, including reflection seismic studies to image the interior of oceanic crust and acoustic methods to image the seafloor surface. My ridge studies have focused in two areas: extensional failure of newly formed crust and the cause and significance of non-transform segmentation of ridges. In recent years I have become involved in marine geophysical studies of sedimentary processes within estuarine systems. With this work I have had the opportunity to learn about new research problems with the added advantage of staying closer to home while my children are young.

It's surprising to me that I ended up as an oceanographer with the career I have had. Looking back it seems to be a route defined by following opportunities rather than making conscious, long-term choices. Both of my parents are scientists and this must have contributed to my decisions in some way. Growing up, I knew little about the kinds of science that my father did, but I was very aware of the great pleasure he derived from his work and the freedom it provided him. My mother was also a scientist who pursued a Ph.D. after her children were born and who had the benefit of a highly supportive spouse, as I now have, who gave her the ample time, free from cooking and child care, to develop her career. In high school I wanted to be a painter, but I was good at math and science and decided to pursue a science degree at university thinking this would provide more job opportunities. I had several good summer jobs doing fieldwork and saved enough money to go to an art college after completing my undergraduate degree at the University of Toronto. This was a terrific experience, which in interesting ways is connected to my later choices. It was during this time that I learned about the excitement of developing and pursuing my own ideas and following my own interests. After art school, I enrolled in a master's program at Queen's University to work on a thesis project in plate tectonics, which involved an opportunity to go to sea. This hooked me and led to a Ph.D. at the University of California, Santa Barbara with lots of sea experience and the beginning of a varied and interesting research career.

Suzanne Carbotte with daughter Odette and son Max, enjoying the California sun.

The greatest challenge I have experienced as a woman in science continues to be raising a family while I meet the demands of my work. Travel and fieldwork are always difficult. How will we get the children to school when I am away? Who can pick them up when my husband has to stay later for a faculty meeting? But it also has provided considerable flexibility in my work hours that have let me participate in activities at the children's school, like teaching art as part of a parent-run program and talking about my science to classrooms of young students.

Paola Cessi

Professor, Scripps Institution of Oceanography, University of California, San Diego, La Jolla, CA, USA, pcessi@ucsd.edu

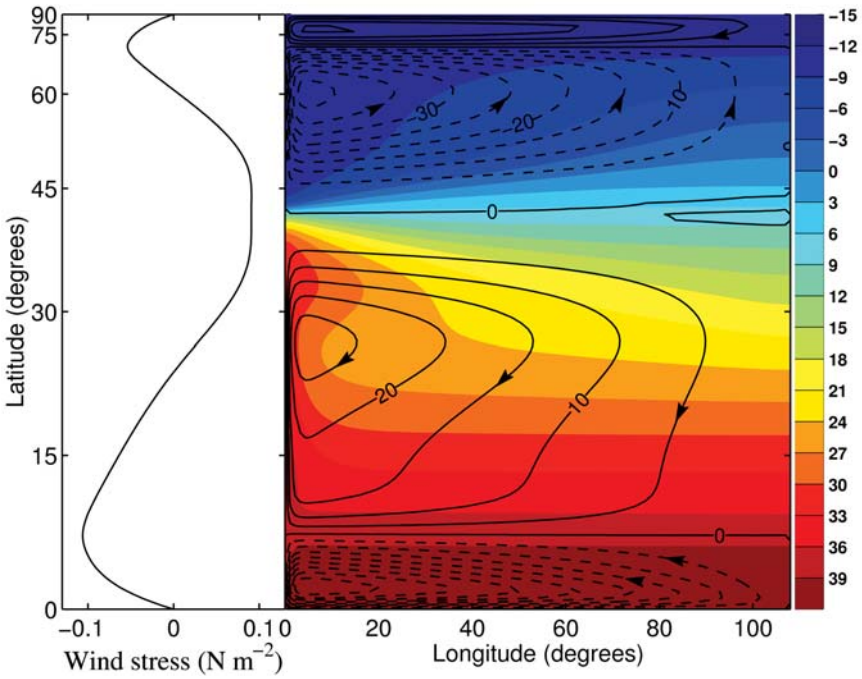
My research focuses on the large-scale circulation of the ocean and its role in Earth's climate. My approach is to formulate and analyze idealized fluid dynamical models of the ocean-atmosphere system that isolate specific processes.

For example, I constructed a minimal description of the large-scale interaction between the upper ocean wind-driven circulation and the mid-latitude atmospheric flows, based on the conservation principles of heat and momentum, to show how the oceanic heat transport can influence the wind. The figure exemplifies one such model.

The "theoretician's view" of the oceanic currents offered by these simplified descriptions lacks the realism of nature and the complexity of large numerical simulations. However, I find it very satisfying to obtain mathematical solutions either by hand or by small numerical integrations because both methods allow the complete exploration of the external parameters controlling the solution. For me this view is necessary to achieve the full understanding of the physical mechanisms involved.

Indeed, the possibility of conceiving and solving mathematical models of physical processes, and evaluating theoretical explanations against observations, is what initially attracted me to physical oceanography. As a physics undergraduate during the early eighties in Bologna (Italy), I was not interested in becoming a small part of a big high-energy physics experiment that would test someone else's theory. Instead, I was attracted to a field where the constant improvements in observations allows opportunistic theories to sprout, be modified, or be revived every few years. Thus, I can keep my interests perked up by changing the topic of research every two or three years.

Fortunately, oceanography is a relatively young science, and it is easy to find many fundamental problems that are still unsolved. At the moment, I am intrigued by the processes that transfer the surface temperature differences imposed by differential insolation to the deep ocean. The hope is that a comprehensive theory accounting for the deep structure of temperature and salinity in the ocean will clarify the dynamics of the thermohaline circulation, providing clues to the fate of the oceanic component of the poleward heat transport under changing climate scenarios. My current goal is to contribute to the unraveling of this problem.



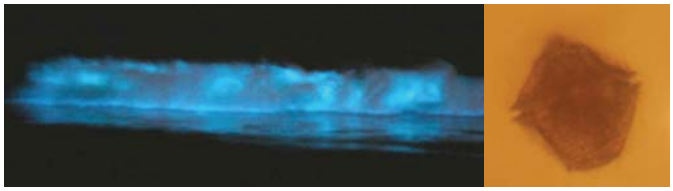
Left: Time- and longitudinally averaged wind stress as a function of latitude. Right: Contours of oceanic mass transport (in Sverdrups, black lines) and contours of sea surface temperatures (in Centigrade, colors). The transport of sea surface temperatures by the oceanic currents creates a thermal front beneath the westerlies' maximum, which contributes to the local intensity of the surface winds.

Grace C. Chang

Associate Researcher, Ocean Physics Laboratory/University of California, Santa Barbara, CA, USA,
grace.chang@opl.ucsb.edu

I am often asked how someone who grew up in the landlocked state of Minnesota became an oceanographer. Was it because of the mysteries associated with the infamous Scandinavian dish, Lutefisk, which is fish soaked in lye? Or was it an excuse to escape from a region where oftentimes, an increase in air temperature of 100°F would result in a cold index that is still below freezing?

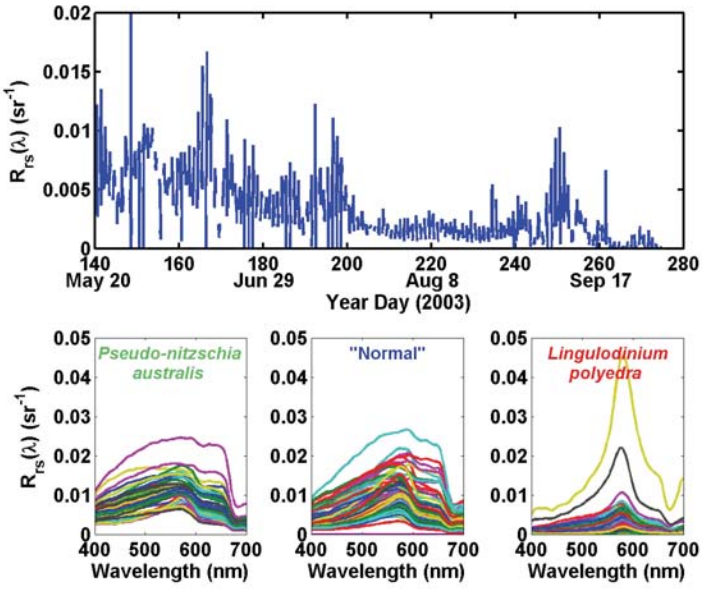
The answer is the latter (although I am curious about Lutefisk). I began my scientific career as a geological engineer/geologist, studying environmental issues associated with freshwater systems. Twenty-two years of Minnesota winters prompted my research shift from freshwater to saltwater and I fled to southern California. My research interest is interdisciplinary coastal oceanography, primarily the study of physical processes coupled with bio-optical responses. This research establishes an understanding of particulate movement and distribution in the water column and along the ocean bottom. The results have value for assessing various aspects of the global carbon budget, environmental impacts, and ultimately the role of the coastal ocean in global climate change.



(Left): Digital photograph of a breaking wave illuminated by bioluminescent dinoflagellates, *Lingulodinium polyedra*, from La Conchita, CA in October 2003 (photographer Rosalba Dominguez). (Right): *L. polyedra* image (provided by Cristina Orrico).

One of the major career challenges I have experienced as a scientist in academia was getting that first proposal funded. Generating funding can at times seem like a Catch-22: we need to prove feasibility and success of proposed research to be approved for funding yet a young scientist is unable to conduct research without financial support. Persistence is key to overcoming this challenge as well as broadening research interests and working closely with established colleagues. Interdisciplinary ocean research affords many valuable and rewarding opportunities for collaborative projects.

I find that the most gratifying aspect of being an oceanographer is the ability to generate enthusiasm for ocean research for non-scientists, particularly students. Residents living in or near coastal communities like Santa Barbara tend to spend much of their time staring out at the sea, forming questions in their minds such as: Why is the ocean blue? Where do waves come from? What causes a red tide and why does it glow? Many of them have extensive experiences above or below the sea surface as fishermen, divers, and/or surfers but lack the formal education necessary for understanding the oceanographic system as a whole. I enjoy conversing with these "recreational oceanographers," whether offering informal lessons on oceanographic processes or learning about their experiences at sea. Interest in and knowledge of ocean science can promote conservation and environmental awareness of global processes.



Top: Time series of hourly averaged (8 AM and 6 PM, local time) remote-sensing reflectance at 412 nm, collected by hyperspectral radiometers in 25 m water depth off La Conchita, CA. Bottom: Hyperspectral remote-sensing reflectance spectra during (left) a *Pseudo-nitzschia australis* bloom (Year Day 140-150), (center) "normal" conditions (Year Day 195-205), and (right) the *L. polyedra* bloom (Year Day 260-270).

Zanna Chase

Assistant Professor, College of Oceanic and Atmospheric Sciences, Oregon State University, Corvallis, OR, USA, zanna@coas.oregonstate.edu

My research interests are in the marine carbon cycle, past and present. More specifically, my research interests are in trace metal biogeochemistry and paleo-productivity. I'm interested in the impact of trace metals such as iron and copper on biological productivity and ecosystem structure. I'm also interested in reconstructing past changes in productivity using radionuclide proxies such as ^{230}Th and ^{231}Pa.

Zanna with her father Ronald at Parc d'Oka, near her home town of Montreal. Ronald Chase is a neurobiologist specializing in terrestrial snails.

I started university as a math major, primarily because I had no idea what I wanted to study. I quickly became frustrated with math because I felt I wasn't actually learning how the world works. I switched to biology, because I had always been interested in ecology. My interest in oceanography, and specifically in trace metals, came when I met Neil Price at McGill University, and began a master's thesis under his supervision. In two years, I learned an enormous amount of biological and chemical oceanography, and very little was from courses. I was working on iron, and became interested in Martin's Iron Hypothesis, the idea that lower levels of atmospheric CO_2 during glacial times may have been caused by enhanced productivity of the glacial ocean in response to greater dust (iron) fluxes. This was such a beautiful idea to me, and I was drawn in by the fact that these very large changes in atmospheric CO_2 could not be accounted for. This is how I became interested in paleo-productivity, in radionuclides, and a student of Bob Anderson and Lex van Geen at Lamont.

I love being an oceanographer. I find it deeply satisfying to study such an important part of the Earth system. I love that I get to think about things like climate feedbacks, as well as things like the speciation of thorium. I love going to sea, seeing different parts of the world, and getting to know so many wonderful colleagues. I love playing with gadgets in the lab.

Still, this is a challenging field. I'm just starting out, and I wonder at times if I'll be able to get enough grants, write enough papers, teach well, supervise students well, and stay sane. Long separations for cruises, and long hours in general are a challenge to any relationship. My husband is also an oceanographer, and finding a solution to the "two-body problem" was a challenge. He's also my greatest source of support, as well a good sounding board for ideas.

Overall, I can't think of a better way to make a living, for men or women.

Teresa Chereskin

Research Oceanographer, Scripps Institution of Oceanography, University of California-San Diego, CA, USA, tchereskin@ucsd.edu

The ocean is an equal if not dominant partner with the atmosphere in determining global climate. It modulates climate through heat storage and transport and through water mass modifications. Quantification of the ocean's role in climate through these processes requires a characterization of the complete spectrum of ocean velocity—from large-scale mean flows that transport heat to small-scale intermittent turbulence that is the agent for mixed layer entrainment. Until quite recently, our picture of ocean currents came from the geostrophic calculation—an indirect method that infers currents from density as well as from a handful of measurements by direct techniques: current meters, surface drifters, and subsurface floats.

The last decade has been an exciting period for the development of direct current measurement technology. In particular, the widespread use of acoustic Doppler current profilers (ADCPs) represents a breakthrough in the measurement of ocean currents and a major advance in our capability to test hypotheses of dynamic processes occurring in the ocean. ADCPs have revolutionized the field of ocean current measurement in much the same way that CTDs (conductivity-temperature-depth sensors) revolutionized hydrography; instead of point samples, one obtains profiles of ocean currents. The shipboard ADCP measures profiles in the upper ocean from a ship underway; the lowered ADCP (LADCP) descends on the CTD package for a full ocean depth profile. This unique coverage in space and time, together with the vast dataset begun under the auspices of the World Ocean Circulation Experiment (WOCE) and continued under the Climate Variability (CLIVAR) Program, means that there is now an unprecedented and growing database of ocean velocity measurements.

How will these measurements change our view of ocean circulation? What can we learn about flows not described by geostrophy: frictional boundary currents, internal waves, the wind-driven surface layer? Addressing these questions is the long-term goal of my research, and the ADCP is my primary tool.

Although I do not develop instruments, I enjoy the technical aspects of observational oceanography, and I find that a detailed understanding of the instrumentation is essential in interpreting the observations. The key challenge in making ocean observations is to design experiments for an extreme environment with only limited resources. For me, exploiting both ocean physics and measurement techniques in order to formulate an experiment that can address a scientific hypothesis is both the most challenging and most rewarding aspect of being a sea-going physical oceanographer.

Visit to Petermann Island, Antarctica during a 2004 cruise on the ARSV *Laurence M. Gould* as part of my National Science Foundation project to study Southern Ocean currents from U.S. Antarctic icebreakers.

Sanae Chiba

Research Scientist, Frontier Research Center for Global Change (FRCGC), Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Yokohama, Japan, chibas@jamstec.go.jp

As a marine biologist, my interest is physical-biological coupling. The major question I seek to answer is how, and to what extent, environmental forcing affects local plankton community structure and thus the food web, both spatially and temporally. I have joined research cruises off Japan, and in the Gulf of Maine, equatorial Pacific Ocean, Arctic Ocean and Antarctic Ocean. Especially unforgettable was my cruise to the Antarctic Ocean where I conducted research for my doctoral thesis.

Since I joined the Ecosystem Change Research Program of FRCGC in 2000, my task has been to elucidate the link between climate change and marine ecosystem variation using the historically collected data sets/samples for the past several decades. It was known that biomass of many fish species varied in a globally synchronous manner. Also, significant correlations between decadal- to multi-decadal scale climatic variations and plankton/fish biomass were recently reported everywhere. Yet, we don't know what processes linked the climate and ecosystem, and we wanted to find out the mechanisms of variations rather than merely correlations.

The story behind my scientific career is not short. I grew up in a coastal town feeling quite familiar with the ocean and native wildlife, and I naturally wanted to be a biologist when I was a kid. But I chose a secretarial job for my first career after finishing college just because it seemed the only way to earn good money and I had no idea how to be a specialist. The turning point came when I was working at an ocean research institute where my job was to help visiting scientists from overseas settle into Japanese society. Through friendship, they gave me lots of encouragement for doing marine science with a bit of optimism: "You, too, can do it." I decided to go back to school to study marine biology after nine years of secretarial work. Today, I recognize that being scientist is not always fun: fewer holidays, pressure to get funding, struggling to write papers, and hard work on a rough ocean combined with leaving family for months. But, all of these things are worth doing because I know

Sanae on the R/V *Umitaka-maru* holding a sea urchin that was sampled. The photo was taken during her first voyage to the Antarctic Ocean in 1996 when she was working for her doctoral thesis at the Tokyo University of Fisheries.

"marine science is to do what others dream." These are words I saw the other day on screensaver of someone's PC, which also included a magnificent photo of an iceberg and sunset.

When I joined in the Australian Antarctic research cruise in 1998, about half of the scientific team consisted of women, while there were only two women scientists among 60 on the Japanese icebreaker. It is shame that women are still minority in the Japanese marine science society. A good sign is that the government has started encouraging university and research institutes to hire woman scientists, though it will take some time to change the situation. This will bring a big chance for us, and I hope many young women scientists come to join—agitate and rock the community.

Penny Chisholm

Professor, Department of Civil and Environmental Engineering, and Biology, Massachusetts Institute of Technology, Cambridge, MA, USA, chisholm@mit.edu

I am a biological oceanographer and microbial ecologist. What motivates me is the magnificent complexity of microbial processes in the oceans. In an attempt to simplify the problem I have focused my lab on a single group of microbes, *Prochlorococcus*, for the past 15 years. As the smallest, simplest, and most abundant phytoplankter in the sea, this group offers a beautiful model system. Our goal is to understand the structure and function of *Prochlorococcus* populations at all levels of organization—from the genome to the ecosystem. The challenge is to understand how processes at the cellular level scale up to shape global biogeochemical processes. I have been privileged to work with an extraordinarily talented group of students and postdocs over the years. They have shaped my career.

Here I am with my partner, Don Sisson. Don is in real estate development, but he has an uncanny understanding of what my professional world is like. He has been very supportive of my career, and helps me keep it all in perspective. We have no children (my only real regret in life), but we are the companions of two very spoiled cats, Jack and Gus, who were reluctant to sit for this family portrait.

What path led me here? I grew up in a small town in Upper Michigan. When I was asked, "What do you want to do when you grow up?" I never had an answer. I knew I liked science, but I had no idea how one could translate this into a job. I went off to Skidmore College (all women at the time) and majored in biology and chemistry—not knowing what I would do with it. One day my advisor said off-handedly, "You could get a Ph.D., you know." This had never occurred to me, but it sounded much more interesting than getting a job so I went on to graduate school. It was during a postdoc at Scripps that I discovered oceanography, and two years later I joined MIT's Civil and Environmental Engineering Department as an assistant professor. I have been here ever since. Though I did not set out to be who I am, and there have been challenges, I am very grateful that I found the path that put me here.

Looking back, I think the biggest challenge for me was trying to remain authentic while participating in a profession designed by men, for men. Thirty-five years of adapting to such an environment has to shape one's persona to some degree. I sometimes wonder who I would be had I chosen a profession in which women were more well represented. Then I am reminded that my mother, a dissatisfied homemaker, always wondered who she would have been if she had had the opportunities open to me. Generation by generation, we continue to make progress. On a good day, I can see equity just around the corner.

Gail Christeson

Research Scientist, Institute for Geophysics, Jackson School of Geosciences, University of Texas, Austin, TX, USA, gail@ig.utexas.edu

I am a marine seismologist currently employed as a research scientist at the University of Texas at Austin Institute for Geophysics (UTIG). I grew up in Maryland, received my B.S. from Texas A&M University, and received my Ph.D. from the MIT/WHOI Joint Program. My recent field projects include studies of the Chicxulub impact crater, backarc spreading at Bransfield Strait offshore the Antarctic Peninsula, the accretion of the Southeast Caribbean margin, and a comparison between the seismic structure and observed geologic stratigraphy at the Hess Deep Rift and the Blanco Transform Fault.

As an undergraduate, the two courses I enjoyed most were plate tectonics and oceanography, and so it was natural to focus on marine geophysics for my graduate studies. I have now participated in more than 10 geophysical cruises, including three as chief scientist. Living and working with a small number of people for 24 hours a day, seven days a week is a challenge, but can also result in very good friendships. I also enjoy the chance to follow a project through from planning to data acquisition and analysis to publication.

I am sometimes asked about conditions as a female chief scientist. I can honestly say that the three captains I have sailed with have all treated me with the same respect as that shown to my male colleagues. The major difference I have noticed on board research ships in the past ten years is an increase in the number of female crew members—I have now met female mates, engineers, stewards, and deck hands.

I receive tremendous support from my husband, John Goff, and my parents. John is also a marine geophysicist at UTIG and we have two children, Megan and Cameron. Both John and I participate in research cruises and may be away from home for many weeks at a time. Fortunately, my parents live nearby and stay with the kids on the rare occasions when both John and I are away from home. Having children has meant that I sometimes have to forego a cruise or a meeting, but overall John and I have been able to work things out. I try not to work more than 40 hours a week so that I can spend time with my family. This past fall I coached my son's and daughter's soccer teams, and also joined a women's over-30 recreational soccer team.

Cameron, Gail, and Megan all played soccer in Fall 2004.

The need to constantly pursue new funding is the most daunting challenge that I face as a research scientist. I am always not only working on existing projects, but also proposing new ideas for possible funding. I try not to get too stressed out about the future, and figure I can always change careers if need be. Fortunately I haven't had to yet!

Maria Bianca Cita

Professor Emeritus, University of Milan, Milan, Italy

My early scientific education was in sedimentary geology and stratigraphy, and included mapping and fieldwork. Later on I specialized in the field of micropaleontology, which was just starting to develop when I was young. My investigations centered on Cretaceous and Paleogene successions from the Southern Alps in pelagic facies; on Jurassic, Cretaceous, and Tertiary microfacies; and on Miocene and Pliocene hemipelagic formations from various regions.

In 1968 when I was invited to be shipboard micropaleontologist on Deep Sea Drilling Project (DSDP) Leg 2, I was happy to have the opportunity to see for the first time deep-sea sediments that had always been buried beneath the ocean bottom and thus had not undergone subaerial weathering.

In the early days of DSDP, planning was very preliminary and there were still many unknowns and problems to be solved. Continuous coring was considered a waste of time and stratigraphy was conceived basically as a means to date seismic reflection horizons. Chief scientists were very disappointed to find so many barren, undatable sediments; the importance of carbonate dissolution at depth was underestimated.

From left to right: Kim Kastens, Maria Bianca Cita, First Officer Patanè, Massimo Giambastiani, Cesare Corselli (in the background) on R/V *Bannock* in 1984.

Finally, at Site 10 (Leg 2) on the western flank of the Mid-Atlantic Ridge, we succeeded in recovering a pure pelagic carbonate succession of Late Cretaceous age on top of the mid-ocean ridge basalts. I was amazed by the extraordinary preservation of the foraminiferal tests. This first experience was so important that it changed my life. I quickly shifted my professional interests towards marine geology and paleoceanography.

Shortly thereafter, in 1970, I was again at sea on the *Glomar Challenger* for the legendary Leg 13. On this leg we discovered that a small ocean basin, the Mediterranean, if disconnected by the open ocean can be filled by salts and dry up. This was a real cultural shock and most shipboard scientists did not accept and share what is now considered the "classic" model for the Messinian Salinity Crisis. The deep basin desiccation model was based on three different and completely independent arguments: sedimentary (Ken Hsu and the tidal nature of the evaporites); geophysical (Bill Ryan, and the nature and areal extent of horizon M, calibrated at various drill sites as the top of the evaporites); stratigraphy/paleoceanography (myself); and the open marine nature of the earliest Pliocene (Zanclean) pelagic sediments directly overlying the Messinian evaporites (the catastrophic deluge).

In the following years, I contributed to discoveries that became more and more interesting: the spectacular evidence of submarine erosion along the passive margin of North America observed in Alvin dives in the Bahamas escarpment and in submarine canyons off Georges Bank; the exhumation and submarine dissolution of Messinian evaporites, which created hypersaline, anoxic brine lakes at the bottom of collapsed basins along the active margin of Europe; the discovery of mud volcanoes and shale diapirs on the Mediterranean Ridge; the finding of deep-sea tsunamiites, which were formed by the collapse of the Santorini volcanic island after the destructive eruption of the Bronze Age. Throughout my career I have been fortunate to participate in such exciting and highly innovative science.

Cornelia Class

Doherty Associate Research Scientist, Lamont-Doherty Earth Observatory of Columbia University, Palisades, NY, USA, class@ldeo.columbia.edu

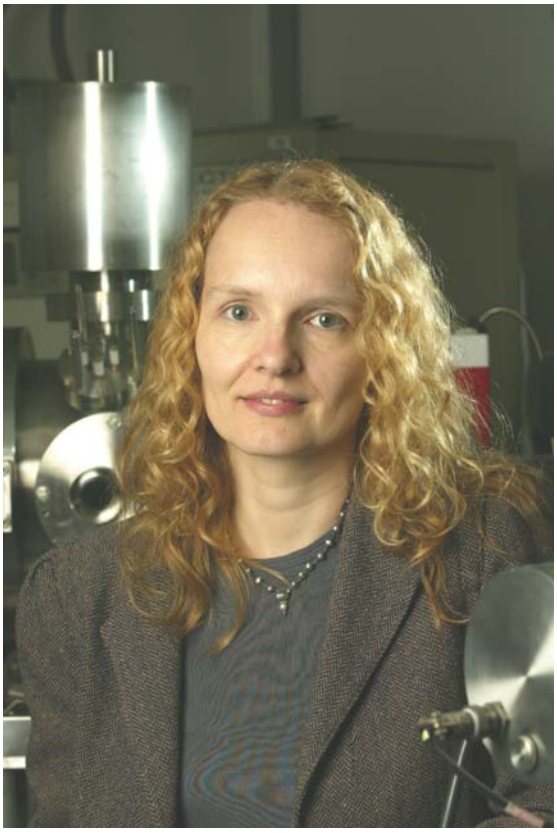


Photo by Bruce Gilbert.

As a student I became fascinated by the ability of geochemical tools to "look" into the otherwise inaccessible Earth's mantle and constrain its heterogeneity and temporal evolution. Combined with the stunning beauty of volcanoes, which provide such "windows" into Earth's interior, mantle geochemistry became my passion. I have been studying mostly volcanic rocks from oceanic islands related to mantle plumes and subduction zones, as well as submarine volcanic samples from both of those settings. Attempting integrated major, trace element, and Sr-Nd-Pb-Os-Hf-He isotope studies, my research focuses on the following main topics: (1) processes of plume-lithosphere interaction, (2) the significance of detached subcontinental lithosphere in the source regions of oceanic basalts and processes of detachment, (3) the origin of primordial ^{3}He in oceanic basalts and evolution of helium isotopes in Earth's mantle, (4) element flux from subducting slabs to the sub-arc mantle, and (5) the role of the subcontinental lithosphere in the formation of flood basalts.

Balancing career and personal life remains a challenge. The situation for women at the Lamont-Doherty Earth Observatory of Columbia University has improved tremendously in recent years through a stop of the promotion clock for up to two years with the possibility of parental leave, partial or full, for up to one year per child. I have two children as a junior scientist, hence a total of 1.5 years of pregnancy, two years of parental leave, almost 5 years without uninterrupted sleep... With the biologic clock and tenure clock coinciding, these same years are when I have been working to build my publication and funding records. My sense is that institutions that wish to include women must be even more flexible, with the possibility of further slowing the promotion clocks to accommodate different situations, such as difficult pregnancies and the frequent illness of young children. Elder care and care of a sick family member are also major issues for women. I think we should be brave enough to admit that childcare and elder care are still mainly in the hands of women. Though as academia and the rest of the workforce becomes more gender diverse, societal roles regarding family responsibilities will likely change so that the burdens are shared. To further this process, we should adjust to the current situation by allowing for more-flexible career paths for women. In this way, they can continue to accommodate these important social responsibilities, but the flexibility can be provided in a way that permits women to stay on career paths leading to senior positions. Research positions, such as mine at Lamont, have few fixed time constraints, and should be able to provide the full flexibility needed by women to balance their intellectual fascination and their social responsibilities.

Paula Coble

Associate Professor, College of Marine Science, University of South Florida, St. Petersburg, FL, USA, pcoble@hq.nasa.gov

My career has not followed what you might consider to be a traditional pathway, so I think perhaps my greatest challenge has been to continue to learn and grow as new opportunities have come along. I feel that my career as an oceanographer has been so rewarding because I have the freedom to choose what I work on every day. It just keeps changing and it never gets boring.

My dream to become an oceanographer was born in my sixth-grade year, the result of a career assignment. I had never seen the ocean and I thought that scientists mostly worked alone in laboratories studying how the natural world works. I sure had a lot to learn! I would never have dreamed all the places I would go, the people I would meet, or what I would be doing today.

My goal hasn't changed since I was 12, but what I actually work on has changed a lot over the years. My personal life began to influence my career as early as graduate school, when I chose a program that also accepted my husband. It wasn't the best place for either of us, but we were together and we both finished our M.S. degrees.

One of the advantages of working in Earth Science education is that many workshops and conferences are held in Boulder, CO, with it's proximity to the Rocky Mountains. This picture shows how happy I am to have climbed my first "Fourteener," a mountain with elevation greater than 14,000 feet.

We went to work at Bigelow Lab, and I had the opportunity to meet and learn from some of the best minds in the field. I participated in major research cruises as part of a large science program and wrote my first papers and proposals. It was a very exciting stage in my career and motivated me to go back to graduate school to get my Ph.D. (so I could be my own boss).

My second time in graduate school remains the hardest part of my life so far. Ten years after graduating from college, I found myself back in math and chemistry classes at MIT. My chemistry homework required math that I wouldn't learn for another 3 weeks, so I was never able to complete an assignment. The first semester was so hard, but second semester was even harder! At this point, my husband and I were living apart and I had a three-year old son. I have told myself ever since that if I could survive those years, I can survive anything.

I emerged from my Ph.D. program to a career studying the chemistry of compounds that give the yellowish color to rivers and streams. I actually measure the color of water from all over the world, including the oceans, to better understand mixing between rivers and oceans, and the carbon cycle in natural waters.

Shortly after I started my first faculty position, I began to get involved with marine science education for middle school students and teachers. I started an educational TV program that produced 150 programs of Project Oceanography, which were distributed free to thousands of schools around the world. I learned so much about people AND oceanography.

I now spend as much of my time promoting marine science education as doing my own research, and while I still occasionally go to sea, I almost never work alone. My biggest career surprise is how much I enjoy working with people and helping others meet their goals. I am very happy that I haven't spent the last 30 years of my life alone in a lab. Real scientists are real people, just like you!

Maureen Conte

Associate Research Scientist, Bermuda Biological Station for Research, St. George's, Bermuda, mconte@bbsr.edu

I am an organic geochemist who uses organic compounds ("biomarkers") as molecular tools to explain the fundamental ecological interactions that control biogeochemical cycles. A current focus is to explore how variability in physical, chemical, and biological processes in the surface ocean affects fluxes of material and energy through the ocean, and how processes operating within the ocean's interior modulate these fluxes. The downward flux of particles in the ocean controls the geochemical cycling of many elements, the energy available for life below the euphotic zone, and the removal rates of many ocean constituents. These are fundamental constraints to climate models and paleoceanographic interpretation of sediments.

Maureen Conte (center) deploys a sediment trap at the Oceanic Flux Program time-series site off Bermuda. The OFP has produced a nearly thirty-year continuous record of sedimentation patterns in the deep ocean. Recent studies have shown the important role of transient upper ocean physical and biological forcing and of midwater biological processes on the magnitude and composition of particle fluxes.

I work on the principle that understanding how the ocean functions requires coordinated study of the system components as a whole. So, I have many interdisciplinary projects and collaborate with scientists having diverse specialities from many institutions.

My studies have taken me from the murky Chesapeake Bay to the subarctic North Atlantic and now to Bermuda, where I have been Principal Investigator of the Oceanic Flux Program (OFP) time series since 1995. My career began at Johns Hopkins' Chesapeake Bay Institute where I studied the interplay between estuarine circulation and anadromous fish and zooplankton distributions. I chose Lamont-Doherty Earth Observatory for graduate studies to conduct research as part of multidisciplinary Warm-Core Rings project. At Lamont I became excited about molecular tracers and embarked on new directions as an organic geochemist. At the University of Bristol I participated in British Joint Global Ocean Flux Study before joining the Woods Hole Oceanographic Institution to head up the OFP time-series.

Since an early age, the natural world and its interactions have been a continuing source of inspiration and fascination. I can't remember a time when I did not want to be "An Ecologist." This certainty has sustained me through the challenges, hard work and several unpleasant obstacles that I've faced as a woman scientist. Over my thirty-year career, the status of women in science has changed greatly, but the glass ceiling isn't yet broken. The day will come when we'll see representative numbers of women at the helm of important large ocean science initiatives that increasingly control funding directions.

I'm a "hands-on," sea-going oceanographer. I love working "the back deck," putting an instrument that I've participated in developing overboard in order to collect the tiny, precious sample that, upon analysis back in the lab, will give up its secrets. That moment of discovery—when all your efforts come together to reveal new, lasting information about the world we live in—that moment is immensely rewarding.

This article has been published in *Oceanography*, Volume 18, Number 1, a quarterly journal of The Oceanography Society.

Penelope Cooke

Gary Comer Foundation Postdoc in Abrupt Climate Change, Department of Earth Sciences, University of Waikato, Hamilton, New Zealand, p.cooke@waikato.ac.nz

My research interests have tended to focus on deep-sea marine sediments and their geochemical contents. However, in an ideal world, I would have really like to have been a vertebrate palaeontologist! The reality is that there are few jobs in this field, especially in New Zealand. For my undergraduate and master's degrees, I double-majored in biology and Earth sciences at the University of Waikato, then travelled and worked overseas for six years. Once I returned home, I started work on my Ph.D., which took slightly longer to finish than I would have liked. Some of the time, I worked on my degree part-time; for the rest of the time, I worked as a tutor for undergraduate courses. I very much enjoyed the teaching and it is lovely to see those students that I taught is their first year at university, now completing their degrees.

Penny sampling water from a CTD (conductivity, temperature, depth sensor) on a recent research voyage in New Zealand waters.

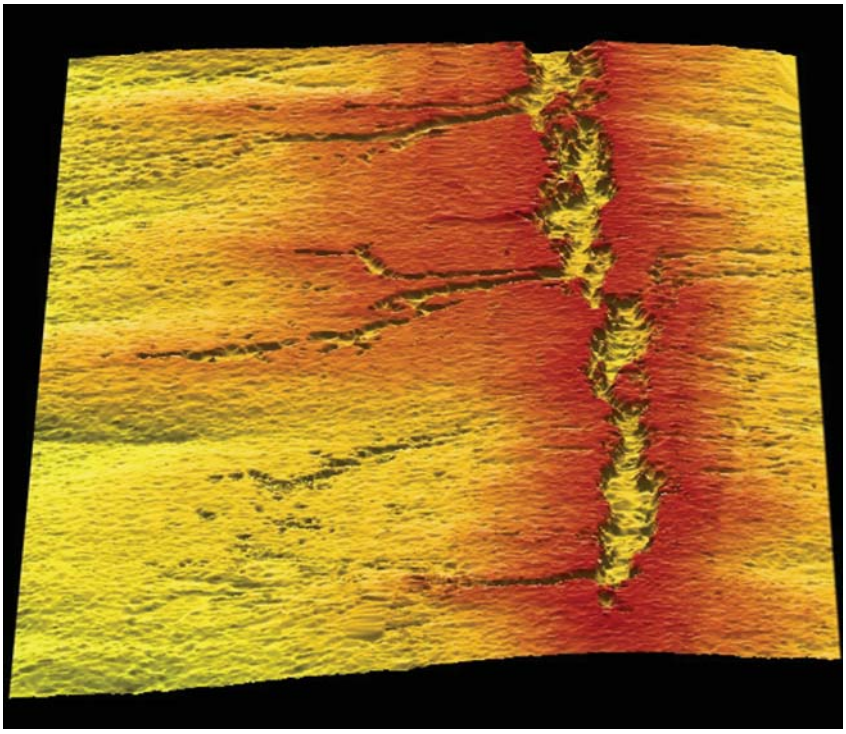
My Ph.D. research focused on Neogene carbonate sediments and their palaeoclimatic records over the past 19 million years. While doing my postdoctoral research, this focus has changed to terrigenous sediments. I am now investigating how palaeoclimatic changes have affected the supply of terrigenous material to the New Zealand offshore region. I feel very fortunate that I have postdoctoral funding and very grateful to have received my funding though the Gary Comer Science and Education Foundation in the United States for work on abrupt climate change.

It is very unsettling not to know what I will be doing once my postdoctoral work is finished. The lack of certainty in science funding and career options saddens me, as the reality is that my options are limited if I want to (and I do want to) stay in science. If I have the opportunity, I would really like to work on carbonate reefs and on the organisms that produce them. It concerns me greatly that people are (or appear to be) making suggestions to pump "waste" CO_2 into the deep ocean, but they don't appear to really understand carbonate systems and that lowering the pH with the CO_2 will have dramatic effects on the ocean chemistry. If carbon dioxide sequestration in the ocean does occur, it could be our next big environmental impact. It would be nice if those who work with carbonates (and not just me) were consulted, and the research conclusion of the scientists working on this issue were listened to.

Marie-Helene Cormier

Doherty Associate Research Scientist, Lamont-Doherty Earth Observatory of Columbia University, Palisades, NY, USA, cormier@ldeo.columbia.edu

I have long been interested in the geological processes that shape our planet. The ocean floor carries a particular appeal to me because it uniquely exposes the effects of plate tectonics, and because it remains one of the last frontiers for exploration. As a marine geophysicist, initially trained in France and then in the US, I enjoy mapping new territory and developing methodologies to investigate processes at the seafloor. Oceanography is a multidisciplinary science, and I also appreciate collaborating with colleagues who have different expertise. Through it all, accommodating family life and career has been a permanent (and rewarding) challenge.



Microbathymetric data we collected along the 2600 m-deep East Pacific Rise with the AUV "ABE" reveal volcanic features with unprecedented resolution. This perspective view of the ridge axis is 2000 m long and 600 m wide, and the vertical relief is less than 50 m. The narrow trough at the center is a system of drained lava lakes that developed above an eruptive fissure. The channels visible on the left side mark the pathways of the lavas out of the eruptive fissure.

One of my interests is the study of mid-ocean ridges. Using shipboard geophysical data, I document their changing geometries and investigate possible causes for these changes. I am also exploring new approaches for characterizing underwater volcanic eruptions with several colleagues. Using an autonomous underwater vehicle (AUV), we produced microbathymetric maps of the ridge axis that highlight individual eruptive vents, lava flow boundaries, fissures, and minor faults. Combined with detailed maps of the magnetic field, photomosaics, and submersible dives, this approach reveals lava pathways in the shallow subsurface and at the seafloor. In another project, we assessed the timing of eruptions along the ridge axis by measuring the magnetic paleointensity recorded in basalt samples. This emerging method should eventually achieve a precision sufficient to date successive eruptive cycles. We are also applying underwater geodetics to help discriminate between magma transport models. To that effect, we will deploy pressure sensors along a section of the mid-ocean ridge and measure vertical motions resulting from magma intrusion, and develop models for surface deformations.

More recently, I became interested in plate boundaries other than mid-ocean ridges, such as the submarine extension of continental transform faults. Using a combination of bathymetric and seismic data as well as sediment samples, I am coordinating a project to evaluate the recurrence interval and rupture length of large earthquakes along the North Anatolian Fault beneath the Marmara Sea near Istanbul. Other applications for marine geophysics in coastal environments concern gas and fluid seepages. Venting seems to be widespread along continental margins and may have profound climatic, geotechnical, hazards, and resource significance. My first study along these lines focuses on characterizing large gas blowouts along the US Atlantic shelf using an AUV as well as sediment and water samples.

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Kathleen Crane

Program Manager, Arctic Research Office, National Oceanic and Atmospheric Administration, Silver Spring, MD, USA, Kathy.Crane@noaa.gov

My pathway through oceanography has not been a random walk nor has it been direct. I inherited a sense of adventure and a love of the outdoors, although most of my early adventures were from books. Regardless, I really wanted to have the chance to see the world.

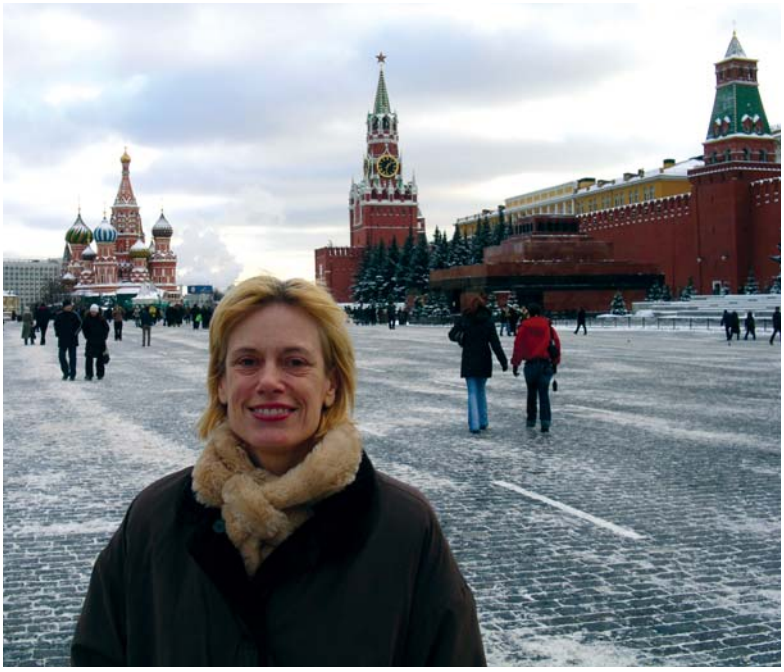
After graduating from Oregon State University in 1973, I opted to go to Scripps Institution of Oceanography because they had the most ships that sailed to the South Pacific Ocean. Once there, I joined the Deep-Tow Group, which Dr. Fred Spiess ran like a combined military and pirate organization. At times I really loved this deep-ocean exploration. It was also a pretty hard life, but at least graduate students had the run of the Deep-Tow operations at sea.

I moved to Woods Hole in 1977. I was the youngest person on the research staff and as a woman, I was rather isolated. This situation eased somewhat when I took a position at Lamont-Doherty Earth Observatory. In 1985, out of frustration with social isolation in part brought about by many years at sea, I moved to California Institute of the Arts to study live-action film and video. Although I loved this new adventure, I realized that I no longer had the energy to start over in a new field. Consequently, I accepted a position as a professor at Hunter College of the City University of New York. This position gave me the stability to explore new pathways in science. Collaboration with my Lamont colleagues opened up my eyes to a new world of international science. I soon began collaboration with Scandinavian oceanographers and added the Arctic to my portfolio of research sites.

Through the Office of Naval Research, I expanded my international network, culminating with the first USSR-US deep-diving expeditions to the Reykjanes Ridge. I still am amazed about the rapid response of the Office of Naval Research to the changing world order at the demise of the Cold War. ONR led the way by funding many Russian researchers, and by endorsing Russian-U.S. oceanographic expeditions.

The end of the Cold War signaled an opportunity for women in science. Old scientific kingdoms were being dismantled with the crumbling of the political tensions, leaving the doors wide open for those who wanted to pass through. I took advantage of these opening doors, one more time. In the early 1990s, information was released to the world about the environmental contamination that had accumulated in Eastern Europe and the Former Soviet Union. Drs. Peter Vogt and David Nagel from the Naval Research Laboratory in Washington, D.C. asked me to move to the NRL to head an Arctic environmental security geographic information systems program.

In 1996, I adopted my daughter from Siberia. This commitment totally redefined my personal and my scientific life. In 2002, I left Hunter College and a full-professorship to join the Arctic Research Office of NOAA where I am very active in U.S.–Russian Federation and Pacific Arctic Research programs.



Kathleen Crane in Red Square, Moscow, Russia, December 2004. Photo by Aleksey Ostrovskiy.

Kendra L. Daly

Assistant Professor, College of Marine Science, University of South Florida, St. Petersburg, FL, USA, kdaly@marine.usf.edu

My research interests focus on the ecology and physiology of planktonic organisms, particularly crustacean zooplankton, such as euphausiids, copepods, and mysiids. My research has spanned a variety of topics, including understanding the physical and biological factors that control the abundance and distribution of zooplankton and the role of zooplankton in marine food webs and biogeochemical cycles. I have been fortunate to have had the opportunity to work in a number of marine environments, such as the Arctic, the Antarctic, the Bering Sea, the Greenland Sea, SE Alaskan coastal waters, Puget Sound, the tropical Pacific Ocean, the Gulf of Mexico, and coastal Atlantic regions. Currently, I am participating in the Southern Ocean GLOBEC program, which aims to understand the influence of climate change and physical forcing on variability in marine secondary production. As part of this project, we are investigating the role of interannual sea ice extent on the overwintering behavioral strategies and recruitment of the Antarctic krill, *Euphausia superba*. I also am interested in the implementation of ocean observatories and the development of marine sensors. One project we are working on is transitioning a patented approach for characterizing microorganisms developed for optical spectroscopy to acoustics.

Kendra Daly at Port Lockroy on the Antarctic Peninsula, May 2002.

I knew early on in my life that I wanted to be an oceanographer. I grew up on the Pacific and later the Atlantic Ocean, racing sailboats as a teenager. I even worked nights as a waitress so that I could sail during the day. The ocean was an ever-changing landscape that fascinated me. One year during a family vacation, we visited the Woods Hole Oceanographic Institution. They had set up a large tent with microscopes to view plankton. Once I realized that people were actually paid to spend time on the ocean I was hooked.

Although I have always been an active sea-going scientist, for personal reasons I followed an alternative career path and did not pursue a Ph.D. until later in my career. This path has had both positive and negative consequences. Certainly, I spent much more time at sea than I probably would have otherwise, which I loved. I suspect most women in oceanography from my generation faced obstacles, particularly on ships. Going out to sea for weeks to months at a time also often creates difficulties with families. For me, however, some of the obstacles had surprisingly positive outcomes. Overall, the rewards of being an oceanographer have far outweighed the challenges. I have been able to work in places and experience nature in ways that few people will have the opportunity to do. I have had extraordinary experiences over the 27 years that I have worked in polar regions. Other rewards are the interdisciplinary aspect of our science, the close collaborative relationships oceanographers develop after spending weeks to months together at sea, and the opportunities to work with scientists from other countries. Currently I have six graduate students, five of whom are woman. It is a joy to have more women in oceanography.

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Kate Darling

NERC Advanced Research Fellow, Grant Institute of Earth Science/Institute of Evolutionary Biology, University of Edinburgh, UK, kate.darling@ed.ac.uk

My oceanographic career path was totally unconventional. As a child I was an avid shell and fossil collector, combing the beaches of North Yorkshire where Jurassic/Cretaceous sediments erode and spill their treasures onto the shore. This area was home to my hero Captain Cook, and I spent many happy hours in the Whitby Museum viewing artifacts from his fantastic voyages. Little did I know that I was later to follow in his wake around the global ocean. Initially, my teenage equine interests led me astray, as I majored in animal science, leading to a Ph.D. in animal physiology. Not the classical start for an oceanographer! Leaving science for 12 years to raise two children changed my perspectives and led me to revert to my first love. Swallowing my pride, as I was a relic from the pre-computer age, I retrained in the Grant Institute of Earth Science at Edinburgh, facilitated by free-thinking faculty staff.

The magical microfossil assemblages recovered by the Ocean Drilling Program inspired me. Drawing on the multidisciplinary nature of my training, I naively suggested that we attempt a new genetic approach to unravel the problems encountered in interpreting diversity and adaptation in the planktonic foraminiferal fossil record. Bizarrely, I found a home in the Centre for HIV Research at Edinburgh, where staff and graduate student alike bravely taught me the basics of molecular biology sufficient to attempt the project. Sponsored by the Carnegie Trust for the Universities of Scotland, I collected my first specimens of living tropical planktonic forams in the Caribbean in 1993. I could not have chosen a more problematic organism, but with my Yorkshire doggedness, I rode the funding roller coaster until I was on the correct trail.

In combination with their fossil record, living planktonic forams provide a unique and ideal tool for addressing mechanisms of speciation and evolution in the plankton. Their diversity is greater than predicted from morphological analyses and often the distinct types have different adaptations. For past climate reconstructions, researchers are often unknowingly pooling together several genetic types with different distributions and environmental preferences, imposing noise in data and uncertainty in interpretation. Now funded by the Natural Environment Research Council in the UK, I have set myself the daunting task of sampling the global ocean to determine the extent of foram diversity and adaptations to enhance resolution for paleoceanographic interpretation.

My work has taken me on challenging cruises to the most remote regions of the Arctic and Antarctic, a privilege I shall always treasure with bipolar sea sickness long forgotten. I did not choose my oceanographic career: it chose me and I love it. I have at last found my forte supported by my long suffering, if not shell shocked, husband Ian. My career path was certainly atypical, but its success reflects the benefits of an interdisciplinary approach mixed with supportive colleagues.

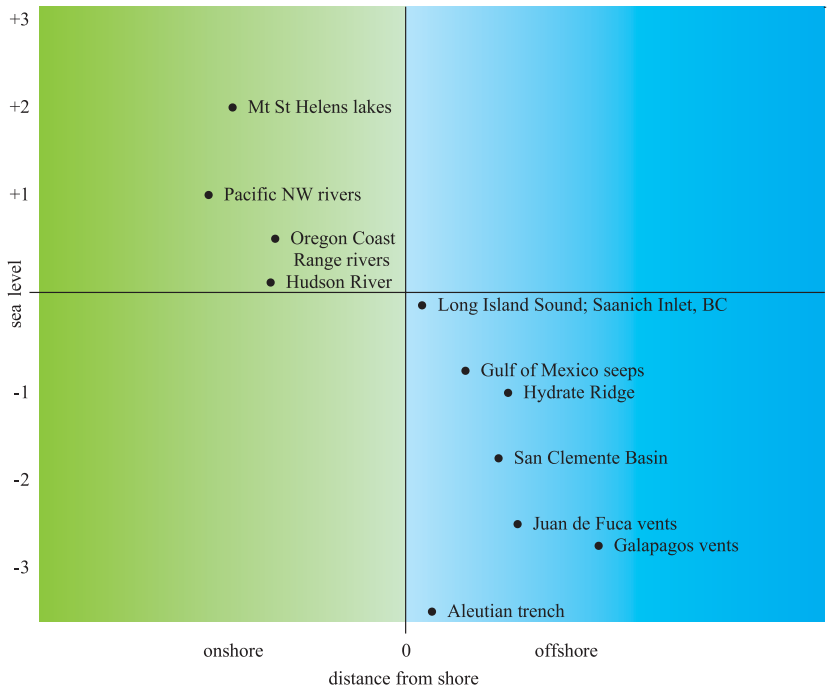
Standing on an ice flow at 79°N in the Fram Strait off Spitzbergen in front of FS *Polarstern* (Alfred Wegener Institute) looking towards the North Pole. Within eight months I was to find myself in the Antarctic on RRS *James Clark Ross* (British Antarctic Survey) looking out over the chaotic remnants of the shattered northern Peninsula ice shelves.

Marie de Angelis

Associate Professor, SUNY Maritime College, Throggs Neck, NY, USA, mdeangelis@sunymaritime.edu

I am a chemical oceanographer with an interest in reduced trace gases. In recent years, I have focused on understanding the key parameters that control the rate of methane oxidation in various marine environments.

I majored in chemistry as an undergraduate and attended graduate school in physical chemistry where I realized that I was not going to be happy working in such a highly specialized field. Then I discovered the multidisciplinary joys of oceanography. My research in methane biogeochemistry includes not only chemistry, but also microbiology, because methane is produced and consumed by microorganisms. Methane production requires the absence of oxygen; in the marine environment such conditions are found in marine sediments, hydrothermal vents, cold seeps, and hydrate fields, adding a geological field component that involves visiting and sampling strange and wonderful places.



Locations I have sampled and/or visited over the course of my oceanographic career as a function of distance from shore and altitude or depth in km using a variety of vehicles including ships, small boats, helicopters, and submersibles.

Initially, the most rewarding part of being an ocean scientist was the breadth of knowledge and skills needed to be successful. However, about 12 years ago, I accepted a position at an undergraduate teaching institution, expecting it to be an intermediate stage in a research career. Instead, I discovered a gift and love for teaching at the undergraduate level. Although I continue to conduct and love research, teaching is now the most rewarding part of my career. My greatest challenge has been to do high-quality research as a professor at a teaching institution. I found a combination of collaborating with colleagues at research institutions and setting up a lab that could function as both a research and undergraduate teaching facility has worked well.

I have chosen to emphasize my career over commitment to a personal relationship without regret. However, recently for personal reasons, I have made the move to another, very different, teaching situation at SUNY Maritime College. This move involves new challenges, including developing a new curriculum, new oceanographic labs, and relationships between an undergraduate institution and both graduate and K-12 programs. While I hope to continue to conduct oceanographic research via collaborations both new and old, I am looking forward to writing educational grants to strengthen an undergraduate program in marine environmental science and oceanography.

I have been involved in a number of initiatives encouraging females to consider a career in science, including Expanding Your Horizons and a self-initiated local effort with other female faculty to visit K-6 classes to give science presentations to both boys and girls (the subconscious message being that women can be scientists). I make a special effort to mentor female undergraduate students because I recognize the self-confidence crises many of these students endure as well as some of the societal pressures faced by women considering a career in science.

In conclusion, I bless the day I stumbled into oceanography. It has been a gift that has introduced me to a world of wonder.

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Christina De La Rocha

Senior Scientist, Alfred-Wegener-Institut für Polar und Meeresforschung, Bremerhaven, Germany,
crocha@awi-bremerhaven.de

When I was young, the ocean was a vast, tantalizing expanse to me. It was grey, frothing, green, and cold, with spray that flew at you in the wind. The wrack that rolled up, dead and rotting, on the beach—piles of tiny vertebrae, broken crabs, tangled kelp, mottled jellyfish, headless seals, and, once, a whale, hinted at some fantastic subaquatic world. I would have given anything to breathe water and explore the deep.

Today the ocean still captivates me and I have grown up to be a biogeochemist and oceanographer. I strive gamely to know the 1,370,000,000,000,000,000 cubic meters of the sea through pinpoint cores of mud, nets full of mangled goop, and bottles of water filled up blindly from icy depths. I love the rhythms of the phytoplankton: primary production and decay, nutrient uptake and remineralization, upwelling and sedimentation. And I am awed by the interactions of climate and biogeochemical cycles that have kept Earth's surface temperate and habitable for billions of years.

A few years ago I would have told you only that I study biogeochemical cycles by measuring the stable isotopic composition of somewhat ignored elements (Si, Ca, Ge) in silica, calcium carbonate, and seawater. I would have said these isotopes shed light on how the biological pump shuffles carbon between atmosphere and abyss today and over glacial-interglacial cycles. I would have emphasized that the isotopes help us reconstruct, over geologic time, sea salt concentrations and their ties to climate, rock weathering, evolutionary events (e.g., invasion of the land by plants, the emergence of the diatoms), and tectonics.

Now I also want to emphasize the human framework of science. Alone I am but a silent brain floating in a dark tank of isotonic fluid, working slowly and accomplishing little. But conversations with other people spawn into my head ideas and understanding and then hone robustness into them. Within partnerships and consortia, experiments I could not do on my own or would have never thought of, produce excellent results. And as I grow older and am expected to do greater things, the hands of colleagues ahead of me (all over the world but now especially at the Alfred-Wegener-Institute) reach back to work with me, and to help me expand my expertise and sophistication, and build up a laboratory and a group with which to make a big dent in that great ocean of things that we do not yet know.

Oceanography takes you everywhere. One year, Antarctica, the tropical Pacific the next. Here I am working even in the Himalayas, a bit above a river that in a few miles will become the Ganges. I'm inspecting a hydrothermal mound of silica that is a favorite of Mike Bickle's, a geologist who wonders about CO_2 from metamorphic decarbonation reactions escaping through hot springs to the atmosphere. I like silica, but really I was there for water samples from the rivers to help settle the Si-isotope budget of the ocean.

Peggy Delaney

Professor of Ocean Sciences, University of California, Santa Cruz, CA, USA, delaney@ucsc.edu

My research interests focus on marine geochemistry and specifically in the application of geochemical tools to paleoceanography. Because my position as a faculty member has had me teach undergraduate and graduate classes over two decades time, my scientific interests encompass marine geology more broadly and global-change issues on all time scales. I was an undergraduate majoring in chemistry at Yale University when I found the opportunity to work in a marine geochemistry lab for Professor Karl Turekian starting the summer after my sophomore year and continuing for two years. I was intrigued by the challenges of applying chemical techniques to natural systems, I enjoyed the lab work in radionuclide systems I did, and I found the raging enthusiasm of the people working there contagious and compelling.

After some doubts in my senior year about "what next?," I took a year away from school before enrolling in graduate school in chemical oceanography in the MIT/WHOI Joint Program. Again, it was the enormous enthusiasm and dedication to finding things out about the ocean by using geochemistry that I found in people there—my advisor, Ed Boyle, my fellow graduate students, other faculty and researchers—that helped me find my way through graduate school. I was fortunate enough to land a faculty position at UC Santa Cruz; after a brief stop at Scripps Institution of Oceanography right after graduate school, I have spent my faculty career at UCSC, with supportive and interesting colleagues. I became involved with the larger oceanographic community through participation in advisory activities related to scientific ocean drilling and to paleoceanography. This introduced me to an international set of colleagues, and it was complemented by my participation in three two-month long Ocean Drilling Program cruises (1990, 1996, 2002), as well as my graduate students' participation in a number more.

I think my biggest career challenges have been in defining "what is enough?" and in struggling with my own self-confidence and worries about my abilities. This has been heightened by the much more challenging situation for research funding that has evolved over the years. I have two kids (spending the 1990 cruise in the very early stages of one pregnancy!), and I have a wonderful, supportive spouse who redefined his career path for us to be in Santa Cruz. It's hard to define exactly how things would have been different without kids—I had to focus more in the time I had, I probably went to sea fewer times, and I worried about not having the single-minded commitment I thought might be necessary. I tried to keep what I think of as the work-home arrow pointed to the right place on the scale, and I wouldn't make different decisions than I did, but often thought both were being short-changed.

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Send all correspondence to: info@tos.org or The Oceanography Society, PO Box 1931, Rockville, MD 20849-1931, USA.

Amanda W.J. Demopoulos

Postdoctoral Scholar, Integrative Oceanography Division, Scripps Institution of Oceanography, La Jolla, CA, USA, amandad@ucsd.edu

My desire to be an oceanographer began at the early age of four, as illustrated in this photograph. Living in the Midwest, my family made it a priority to visit the ocean every summer. In addition to swimming, I spent hours digging in the sand, examining the small bivalves and crustaceans. These early diggings during my formative years expanded into studying sediment-associated organisms and the field of benthic ecology. As an undergraduate, I participated in a tropical marine biology course in the Bahamas. This course, which included daily coastal explorations, opened my eyes to the diverse marine life present in coastal communities. My first snorkeling experience among mangrove prop roots was breathtaking; I observed dense clusters of organisms that encrust these finger-like projections from the tree. This experience heightened my intrigue for mangroves and led me to pursue my current research in the ecology of mangrove and deep-sea benthic communities.

Being an oceanographer has been very rewarding and I have enjoyed the extensive exploration and travel experiences. My research has taken me to field sites spanning the globe, from Puget Sound to the Antarctic Peninsula and from Micronesia to Puerto Rico. The work has involved using research vessels, submersibles, and benthic sampling equipment. I have worked with people from around the world, affording me the opportunity to learn new languages and techniques. These experiences have opened my eyes to the rich natural and cultural environments that exist around us.

When I began my undergraduate work at the University of Washington in 1992, there were few women oceanographers. These women greatly influenced my early career development by providing positive examples of what could be achieved with hard work and focus. The generations of women oceanographers before me had to make great personal sacrifices in order to pave the way for future women in oceanography. As a result, we have made significant progress in the field and I am optimistic that we women oceanographers will continue to make great strides onward and upward.

Amanda W.J. Demopoulos, age 4, digging in the sand for critters at Ocean City, New Jersey. Photo taken by M. Jones.

To date, my career challenges have focused on the academic path no matter what obstacles came my way. Graduate school was an endurance test of sorts, much like a marathon, and it helped to have stamina and a steady focus. This approach enabled me to navigate around any barriers to success. In truth, I believe that my greatest career challenges lie ahead, including being a positive mentor for future women oceanographers. Identifying female mentors is an important factor in the success of women scientists. I have been fortunate to have found supportive role models throughout my career. To be as good an influence on future oceanographers is one of my major career aspirations.

Heidi Dierssen

Assistant Professor in Residence, Department of Marine Sciences, University of Connecticut, Groton, CT, USA, heidi.dierssen@uconn.edu

As I close the newspaper this morning, I am reeling. The president of Harvard was apologizing for making a speech that suggested innate differences might make women less capable of succeeding at math and science than men. He argued that women might be less inclined to advance to top levels in science because they are unwilling to work long, grueling hours once they have children. This statement comes in today's supposedly enlightened times from one of the top academic leaders.

I start to ponder whether I have an innate difference that makes me less capable of science than men. I feel like I work long, grueling hours, but it is true that many of them are now filled with the joys and travails of raising two young girls. And, I start to think about how to raise my girls in such a way that will counteract the stereotypes that will surely follow them. You see, I am the daughter of immigrants. My parents came here from Denmark before I was born. When I look at the pool of women colleagues in oceanography, there is a disproportionate number of us—foreign born or born of immigrants to the United States. I had the pleasure of attending Complex Systems Summer School in Santa Fe several years ago. Approximately 10 of the 80 attendees were women and of those, only two of us were born in the United States. And, both of us had parents who immigrated to the United States. Maybe it isn't so much a lack of innate math and science skills, but the "American" societal pressures that somehow prevent women from achieving in those fields.

Here are some facts about me. For the past year and a half, I have been an Assistant Professor in Residence at the University of Connecticut. The "in Residence" part means that I am not tenure track and bring in my own salary with grants (i.e., "soft money"). The "Professor" part means that I can advise and mentor graduate students, teach, and participate in faculty meetings. I am an interdisciplinary oceanographer who uses optics and remote sensing to address biological and physical processes in the oceans. I work on a variety of ecosystems from tropical seagrasses to glacial meltwater. Some advantages of my field are that I collaborate with a wide variety of scientists and have useful skills that make it easier for me to be a soft money scientist. The biggest disadvantage is that I don't fit easily into a standard discipline.

I left my postdoctoral position at the Monterey Bay Aquarium Research Institute one year early and moved out to Rhode Island when my husband started a tenure track position. Although we moved for his position, I feel like he envies the freedom that I have from administrative burdens, not to mention the ocean view from my office. However, I know how hard it is to make a lifetime of soft money and I don't like being a statistic. In my department and at many other marine departments, women comprise a much larger share of the soft money faculty than the tenure track faculty. Moreover, most of my female colleagues from graduate school have opted out of the academic world. The long hours, stress, and lack of financial reward make academia challenging even without the additional pressures of raising a family. Now, I feel like I can't give up. I want to be an example for other female scientists and my daughters, in particular. I want to show them that they can have both a rewarding career and a family. I don't doubt that women may be innately different from men, but perhaps this gives us unique insights into science and the natural world. As a society, we need to look towards building a culture of women who are strong, confident and able to tackle the problems that the future holds. So, now I will head home to throw out all of the pink princess books.

Ellen R.M. Druffel

Professor and Advance Chair, Department of Earth System Science, University of California at Irvine, CA, USA, edruffel@uci.edu

Chemistry has been my passion since high school, precipitated by talented teachers, Rosie Spitt and Bill Cain. Loyola Marymount University (B.S. chemistry) and U.C. San Diego (Ph. D.) are my alma maters. In the chemistry department at the Woods Hole Oceanographic Institution (now Marine Chemistry and Geochemistry), Sheila Griffin and I built a high-precision radiocarbon lab that housed a 37-ton steel shield (painted robin's egg blue) with numerous quartz counters each named for beloved family and friends. In 1993, we bought homes on the U.C. Irvine campus (spitting distance apart) and joined the newly established Department of Earth System Science. Three years ago, with John Southon, Sue Trumbore, and colleagues, we helped set up the Keck Carbon Cycle Accelerator Mass Spectrometry Laboratory. We reconstruct ancient El Niño events, and study the cycling of dissolved and particulate organic carbon in the open ocean and coastal regions affected by small mountainous rivers.

Sheila and I have been very fortunate to work with each other for twenty five years and with our excellent students and postdocs. We get paid for pursuing our passion. How lucky is that?

Sheila Griffin and Ellen Druffel in a salt-water hot tub aboard the R/V *Melville* on the Boomerang cruise in the Southern Ocean (54°S, 176°W) in December 1995.

Life as a chemical oceanographer gives me freedom to: bring my kids to work, wear shorts to work (and slippers at night), change priorities daily, decorate the many freezers in the lab, view the Newport skyline from my office and the green flash from numerous ships, and last, but certainly not least, shop with Cindy Lee in cities around the world.

How have I balanced my career and personal life? By relying on Steve Rodriguez, my college sweetheart, who tolerates my travels and eccentricities. Together (the emphasis on together), we have raised two great kids. Kevin is a sophomore at Loyola Marymount. He rows varsity crew, enjoys chemistry, acting, and biking. Rachel is a freshman at University High. She enjoys science, plays water polo, drums, and is a teacher's aide.

My major challenge of late is funding. Since science budgets continue to decrease this will continue to be a challenge. I would also like more time to enjoy my hobbies: glass fusion, guitar, gardening and dining with Steve.

My mother Ann's curiosity about eclectic topics taught me to pursue my passions, and she encouraged me to persist, despite the dearth of women scientists in the 1960s. Thanks, Mom.

We've made some progress since the late 1970s, a time when being different was a liability. Now we can talk more openly about the issues that matter. With the benefit of hindsight, my advice for having a life as a scientist (female or male) would be:

- Find an excellent mentor (mine have been Cindy Lee and Pete Williams).
- Ask for what you need, and work hard to attain your goals. Publish!
- Say no to things you really do not want to do.
- Put family first.
- Keep a sense of humor.
- Help the junior people in your field.
- Listen to your gut.
- Take vacations, and eat plenty of chocolate.

Henrietta N. Edmonds

Assistant Professor, The University of Texas at Austin, Marine Science Institute, Port Aransas, TX, USA,
edmonds@utmsi.utexas.edu

On rare occasions Hedy Edmonds does like to get away from the ocean, in this case to her family's former homestead west of the Adirondacks. She tries to stay near water, though.

I am a marine geochemist specializing in the distribution and geochemistry of submarine hydrothermal vents and plumes, and the use of uranium series radionuclides as tracers of physical and biogeochemical processes. I first became interested in oceanography as a child, knowing that my father's uncle and cousin had both been marine geologists at Woods Hole. As an undergraduate at Yale, I majored in chemistry and raced with the varsity sailing team, and started wondering if I could somehow do chemistry outdoors or even in the ocean. After taking a math course from a physical oceanographer, I asked for his help in making this transition, and spent the following summer as an undergraduate Summer Student Fellow at the Woods Hole Oceanographic Institution. A year later I enrolled in the MIT-WHOI Joint Program and have never looked back, except perhaps to wonder why I don't seem to have time to sail anymore.

In my first week at MIT, I had a conversation with Professor John Edmond about his research. He mentioned that he was going on an *Alvin* cruise the next month and "could always use some help." Four weeks later I was on the seafloor at the Juan de Fuca Ridge, wondering what else there could possibly be to do in my life except perhaps go to space. I went on four more vent-related cruises as a graduate student, although my Ph.D. thesis involved the use of anthropogenic iodine-129 (released from nuclear fuel reprocessing plants in Europe) as a circulation tracer in the North Atlantic. With graduation looming in 1996, I applied for postdocs in the fields of both tracer oceanography and hydrothermal chemistry, and ended up doing both. As a postdoc at the University of Rhode Island and the Southampton Oceanography Centre, I learned radiochemical techniques and applied them to studies of particle cycling in hydrothermal plumes, and also began to apply mass spectrometric methods to studies of relatively long-lived nuclides such as ^{230}Th and ^{231}Pa. All of this helped me land a job at the University of Texas in 1999. Beginning this fall, I will be an associate professor with tenure, and my first Ph.D. student expects to graduate this winter.

I feel that I have had a relatively easy time balancing career and personal choices compared to a lot of folks. My husband of nine and a half years has been able to telecommute ever since I graduated. Many people think our year in the UK was the most remarkable in this respect, but moving to Port Aransas, Texas may have been more of a stretch in terms of distance from the "information superhighway." Also, taking the job at UT put me close to my mother and my oldest sister's family in Austin, which was particularly helpful when my mother was terminally ill. The one choice that never seemed easy was when to have children and how to balance doing so with work. That decision was taken out of my hands last summer (just in time to miss a big research cruise out of Fiji), and I am expecting my first child in February 2005. Stay tuned!

Margo Edwards

Research Scientist and Director, Hawaii Mapping Research Group, Hawaii Institute of Geophysics and Planetology, University of Hawaii, Honolulu, HI, USA, margo@soest.hawaii.edu

I really enjoy the outreach aspect of my job and talking about my adventures in the Arctic or undersea. Like many women scientists, I especially like to accept speaking invitations to tell girls about my experiences so that I can encourage young women to pursue careers in science. At these sessions someone invariably asks me why I think I've had a successful scientific career, and I always flash back to the moment when my fellow graduate student and good friend, Michelle Kominz, told me that "life is just a series of opportunities taken and opportunities lost."

Until that moment in graduate school, my career had followed an unconventional path that I later realized could be described as a series of opportunities taken. I started college at Washington University in St. Louis as an engineering student, but thanks to meeting Ray Arvidson, found myself developing software for planetary satellite data. That led me to Rodey Batiza who asked me to turn my attention to sonar data. Almost before I knew it, I was working on my Ph.D. under Bill Ryan and Dan Fornari at the (then) Lamont-Doherty Geological Observatory and having this conversation with Michelle. The conversation took place at a point many graduate students reach, when details bog down your research and you wonder whether you can ever possibly finish, graduate, and go on to other things.

Margo Edwards aboard the *USS Hawkbill* during the SCICEX-99 field program, which used nuclear-powered submarines to investigate the Arctic Ocean.

As the wisdom of Michelle's words became clear, I began to recast the tasks in front of me as opportunities instead of challenges. This perspective was liberating, providing me with the outlook to shape my own career and the confidence to follow difficult paths. Those words led me to accept the opportunity to become Director of the Hawaii Mapping Research Group just two years after I completed my dissertation although I was universally advised against taking the job. The words helped me to expand my research from mid-ocean ridges to the Arctic Ocean even though it meant starting from scratch. And those words flashed bright and clear in my mind on the morning that I got the phone call inviting me to become the first woman in U.S. history to ride on a nuclear-powered submarine. Although each of these opportunities was challenging, I've never regretted taking any of them. That's why, whenever one of the young women I meet asks me for advice I tell her, "Remember, life is just a series of opportunities taken..."

Elisabetta Erba

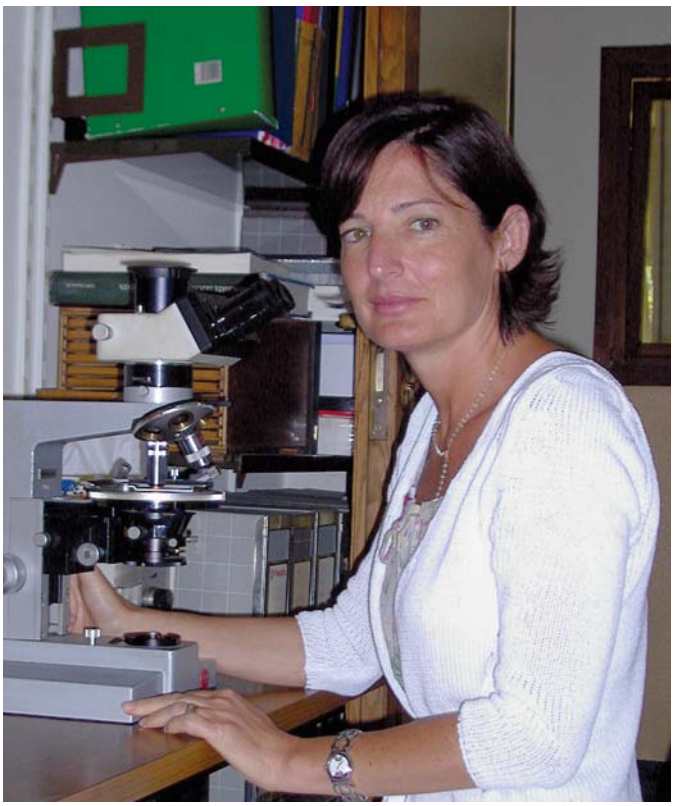
Professor of Paleontology, Department of Earth Sciences, University of Milan, Italy, Elisabetta.Erba@unimi.it

I was trained as a sedimentary geologist and spent most of my time in the field working in the Southern Alps and in Central Italy. At the Earth Sciences Department in Milan, I was the first to work on calcareous nannofossils, the tiny fossil remains of coccolithophores, mainly to obtain biostratigraphy of Mesozoic successions. Soon I realized that coccoliths treasure a lot of information regarding physical, chemical, and trophic characteristics of the oceans and, consequently, I got deeper and deeper into (paleo)oceanography.

In the very early phase of my training, I also had the luck to live two experiences that directed the rest of my life. As undergraduate I was involved in a coring project in central Italy, and as graduate student I participated in various cruises in the Mediterranean. Coring on land introduced me to technical aspects and research benefits, and during cruises I felt like an explorer: in a few years we discovered deep anoxic basins and mud diapirs, and found peculiar sediments that later on were determined as microbial mats. Since then, my research has been devoted to Jurassic-Cretaceous pelagic successions and paleoceanographic evolution of the Mediterranean in the Quaternary. In both cases, the leading character is the ocean and I use nannofloras to reconstruct the dynamics of the ocean/atmosphere system. Research on extant coccolithophores is crucial to characterizing biological processes in surface waters of the largest Earth ecosystem. The study of past oceans is essential to introduce time and obtain a four-dimensional picture of modes and tempos of environmental changes.

I sailed on Ocean Drilling Program (ODP) Legs 129 and 144. Both legs were fantastic experiences for science as well as for human relationships. I still remember the lively days and nights spent on board with people coming from very different countries, cultures, traditions: a few of them became by best friends.

After my daughter Bianca and my son Andrea were born, I haven't been on a ship again. In Italy it is still unusual for a mamma to work away from home for weeks, especially if drilling in the middle of the ocean. My kids are the most exciting and amazing adventure of my life, and lately my family has become my first priority; when they are older, I'll certainly go to sea again. In the meantime, I often tell Bianca and Andrea



Elisabetta sitting at her microscope in Milan.

my sea adventures, and I have never ceased to be involved in ODP and (paleo)oceanography in general. I continue to be active on panels, study Deep See Drilling Project (DSDP)-ODP samples, participate as a researcher in European marine science programs, write and review drilling proposals, and teach paleoceanography.

In Milan, I represent the third generation of women in marine geology-paleoceanography: a unique case in Italy where geology is still mainly a man's job. I never felt discriminated against as a woman, although I admit my personal background and family situation played a key role. Many of my students are women: they have the talents to promote innovative science and keep paleoceanography as an exciting opportunity for research and cultural exchanges.

Gemma Ercilla

Scientific Researcher, Marine Geology and Physical Oceanography Department, Instituto de Ciencias del Mar, CMIMA-CSIC, Barcelona, Spain, gemma@icm.csic.es

I received my B.S. (1987) in geology from the Basc Country University, Ph.D. (1992) in Marine Geology from the Catalonian Polytechnical University, and was a Postdoctoral Fellow at Institute of Oceanographic Sciences, U.K., specializing in seismic stratigraphy, sedimentology, and geotechnics and their application to paleoceanography, geological hazards, and hydrocarbon exploration. In the summer of 1987, at the end of my university course, I participated in a research cruise on board the R/V *García del Cid*. This experience stimulated my passion for marine geology, and shortly afterwards I enrolled as a Ph.D. student in the Instituto Ciencias del Mar, CSIC, in Barcelona where I am a Scientific Researcher in the Department of Marine Geology.

My research interests are wide-ranging, and include shallow to deep-marine environments and different seas and oceans, such as the Mediterranean Sea, Atlantic Ocean, Caribbean Sea, Black Sea, and Antarctic Sea. I have an enthusiastic interest in determining the morphologic, stratigraphic, sedimentological, and tectonic features that define the varied and complex set of environmental conditions of the continental margins and deep-sea areas. This oceanographic work is very rewarding because I have discovered and explained geological features in unknown areas of the seafloor, participated in sea trials and research cruises on board different oceanographic vessels, and have collaborated with scientists around the world and with graduate students and postdocs, and have sponsored Ph.D. students.

Throughout my career I have had an enthusiastic interest in the Antarctic Ocean, coordinating and organizing research and extending these interests to glacio-marine processes. Likewise, I have developed an interest in mud volcanism, gas in marine sediments, submarine valleys, and submarine instabilities. I relish working on these new and different topics because they provide me with an opportunity to apply my experiences in completely different geological contexts and oceans. I have numerous scientific publications, have been co-editor of a textbook and journal, and have participated in multiple congresses and scientific projects. I have been an active member of AAPG, IAS, and SEPM, and I have worked with the hydrocarbon industry.

Striking a balance between my career and personal life has not always been easy. It has been sacrifice for me to leave my home and the village where I was born, spend long intervals far from loved ones, especially my daughter, in response to frequent career challenges. But these negative aspects of my career choice are diminished because I enjoy my work and my colleagues. In fact, I want to emphasize that my condition as a woman has never represented a problem for discussion and debate in the scientific forum.

Carlota Escutia

Científico Titular, Consejo Superior de Investigaciones Científicas-CSIC, Granada, Spain, cescutia@ugr.es

For the past twenty years I have been working as an ocean scientist focusing on seismic stratigraphic and sedimentological studies of continental margins, analyzing paleoclimatic change, geologic hazards, and hydrocarbon resources.

I did not really choose the field of marine geology. In fact, I started as a field structural geologist studying the Paleozoic nappes (faulted, overturned folds) near Barcelona (Spain). As I was measuring folds and figuring out the deformation phases in the low-grade metamorphic rocks, I was given the opportunity to sail on an oceanographic cruise to study the turbidite systems off the Ebro margin (Spain). That was it! I was hooked! And I was lucky to get a job offer a few months later to work with the Marine Branch of the Spanish Research Institution (Consejo Superior de Investigaciones Científicas-CSIC). Twenty years later, I am still working as an ocean scientist, with its rewards and challenges.

The rewards from working in ocean sciences are many and of different nature. A main research-related reward for me has been to work on one of Earth's last frontiers, the oceans. This work has such great impact on society: the oceans basins contain many of our resources, they are areas of geologic risk where many of the geologic hazards affecting human activities are generated (e.g., the Sumatra tsunami), and they are a key element in driving climate. Personal rewards include many friends and traveling the globe. Work on research vessels calls for long weeks and months at sea, sharing both your work and your free time with the same people. There is nothing else to distract you (until not so long ago, not even e-mail!) so you can meet very interesting people and get to know them well.

The challenges in ocean sciences are also many. A main work-related challenge in marine geology is the cost of the expeditions. There are usually few government funds budgeted for them. It has been frustrating for ocean scientists to see how much money is spent in exploring the universe—not that it should not be done—compared to how little is spent in exploring our still-unknown Earth's oceans. In any case, to carry on research at sea is very competitive, but this is the nature of the job.

I think the main challenge for a woman ocean scientist is balancing a career and personal life, especially when children are involved. As with everything, one has to make choices. The field of ocean sciences is not easy to drop out of for few years and then come back, and it sometimes requires long hours at work and travel. In my case, my choice was to continue with science doing the bare minimum when my children were small (no sea expeditions for 10 years, few meetings...), and it worked mainly because I had a very supportive environment at home. It is not always like this, and many woman scientists are faced with the decision of continuing or dropping their careers for children. This is no doubt one of the reasons why there is such a big difference in the percentage of women professors in our profession.

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Marta Estrada

Research Professor, Institut de Ciències del Mar, CMIMA (CSIC), Barcelona, Spain, marta@icm.csic.es

My interest in research started as a child, due to the influence of my parents. My father was accountant, but he devoted all the time he could to investigating the archeology of my town and the surrounding region, where he made important discoveries. My mother worked together with him and also developed a strong interest in local history. With this background, I thought that looking for scientific challenges and discovering new things was what I wanted to do in my life. I was lucky, and I was encouraged to go to the university at a time when many families considered that girls did not need a formal education because their basic destiny was getting married. This attitude has changed in the last decades, and I must say that in all my professional life, I have never witnessed any action of direct discrimination against women. The problems exist, but they are far more subtle. For example, there is a social pressure for women to sacrifice their career options in favor of those of their husbands or boyfriends. I obtained a tenured position a few years after graduation, so that pressure for a job was not a direct factor in my personal life choices.

In an Antarctic cruise, on board the BIO *Hespérides* research vessel (I am the one with the red hood). From a scientific point of view, I enjoy oceanography because of its intrinsic interdisciplinarity. I also like the feeling of openness derived from the worldwide distribution of the oceans and the irrelevance of artificial frontiers in them.

After completing high school, I had a hard time choosing what to study. I was sure that it had to be a scientific career, but I was attracted by many subjects, including mathematics and biology. At that time (early 1960s), there were no interdisciplinary options, and I went on to study biology and medicine with the idea of focussing on biochemistry. In one of the last courses of biology, I had Dr. Ramon Margalef as professor of ecology. He was a person of extraordinary intellectual and human qualities. I was fascinated by his ability to integrate concepts from different disciplines to build a coherent ecological theory. I asked Margalef to be my Ph.D. adviser, and started a thesis on marine phytoplankton at the Institut d'Investigacions Pesqueres (Institute of Fisheries Research) of Barcelona, where he was a part-time scientist. Thus, what I appreciated in my choice of research topic was the interdisciplinarity of Margalef's approach, rather than whether the particular object of my future investigation was going to be the sea or another ecosystem. A few years after I entered the Institute, the commissioning of the B/O *Cornide de Saavedra*, perhaps the first proper research vessel in Spain, opened a suite of exciting possibilities for Spanish oceanography. From these beginnings, I continued my line of research in biological oceanography, with particular interest in the distribution and dynamics of phytoplankton assemblages and in the interactions between physical and biological factors in marine ecosystems.

Kelly Kenison Falkner

Associate Professor, College of Oceanic & Atmospheric Sciences, Oregon State University, Corvallis, OR, USA, kfalkner@coas.oregonstate.edu

As an associate professor of chemical oceanography in the College of Oceanic and Atmospheric Sciences at Oregon State University, I apply state-of-the-art inorganic elemental and isotopic measurements to the understanding of aqueous geochemical issues. My research group has explored topics ranging from the recent history of lead pollution in the atmosphere, to factors controlling the chemical composition of the world's largest lake (Baikal), to large-scale perturbations to chemical cycling in the Black Sea. Much of my present effort is directed toward Arctic Ocean circulation issues.

My path to a career in oceanography was somewhat circuitous. While mid-way through undergraduate studies at Reed College and following a year of intensive organic chemistry, I found my enthusiasm waning for a career tied to laboratory science. I enrolled at UNH for a year where as a resident I could reconnoiter financially and take classes that Reed did not offer. A last-minute decision to take what proved to be an excellent course in chemical oceanography lead to a rewarding summer student fellowship with Mike Bacon at Woods Hole. With sights set on eventually combining science and policy, I returned to Reed to major in chemistry with a minor in Russian. I completed an ocean-related senior thesis under the guidance of Bob Collier, now my colleague at OSU. After Reed I attended the MIT-Woods Hole Joint Program and obtained my Ph.D. in John Edmond's lab. Postdoctoral positions, first at MIT, and then under a NATO Fellowship with Jean-François Minster in Toulouse, France, followed. From France, I came to OSU where I have been since 1992.

Early in my career at OSU, an Office of Naval Research Young Investigator Award allowed me to explore naturally occurring tracers for their potential to distinguish river water contributions within the Arctic Ocean. Success in this endeavor has lead to over a decade of ground-breaking research in the Arctic just as the region has shown signs of unprecedented change. Over this time, I have enjoyed conducting and leading tough, but exciting, interdisciplinary fieldwork from aircraft and ships throughout the Arctic. Along the way, I also made use of US Navy nuclear submarines for my research during the SCICEX program. However, not until the very last year of the program, and under restricted circumstances, were women allowed to sail on the submarine. This experience was a jolting reminder that the playing field for men and women in science can be far from even.

Kelly Falkner keeping her ice skills honed with daughter Perrin, age 9 and son Elliot, age 5. Photo by James A. Falkner.

I feel fortunate to have had an extremely supportive husband. My job demands travel for field work and meetings and odd hours for research and teaching duties. My husband's flexibility and dedication as a stay-at-home parent of our two children has helped make it possible for me to enjoy combining work with raising a family. Being a mom with a full-time career is challenging, of course, but it has added positive dimensions to my endeavors and has markedly boosted my efficiency!

Kristina Faul

Assistant Professor, Environmental Sciences, Mills College, Oakland, CA, USA, kfaul@mills.edu

My scientific and research interests are in paleoceanography and marine geochemistry. I apply chemical techniques to understanding nutrient (e.g., phosphorus) dynamics and oceanic productivity in the past oceans, with the goal of understanding how they might affect global biogeochemical cycles throughout Earth history. I am particularly interested in the operation of feedbacks among nutrient cycles, productivity, the carbon cycle, and climate, as these interactions in the past may provide us with clues to future global change. Recently, I have also become interested in particulate phosphorus cycling in the modern ocean.

While I was an undergraduate at the Massachusetts Institute of Technology (MIT), I learned about the relatively new field of global change science. During my senior year, I answered a job ad for an undergraduate research opportunities program (UROP) project to work in Maureen Raymo's lab. I spent a semester looking down a microscope at foraminifera, and I was hooked. I was fascinated by the possibility of reconstructing the history of the oceans by using information locked in material produced by one-celled marine creatures recovered from cores deep below the bottom of the ocean. What was even more fascinating to me was that understanding the past oceans and climate could potentially help us understand future climate change. After graduation, I spent a year working as a research assistant for Bill Curry at the Woods Hole Oceanographic Institution, where I became more interested in paleoceanography. Subsequently, I traveled west to the University of California, Santa Cruz, to work on a Ph.D. with Peggy Delaney and Christina Ravelo.

The most rewarding aspect about being an ocean scientist for me has been the experience of going to sea. I sailed on Ocean Drilling Program (ODP) Leg 171b to the western equatorial Atlantic and ODP Leg 199 to the eastern equatorial Pacific. Participating in these cruises was rewarding because it was something none of us could have done alone as independent

scientists—this work was a collaborative effort among people from many different countries and backgrounds, all working toward the same goal. In my mind, the excitement of hearing the announcement of "Core on deck!" couldn't be matched, particularly when the core may be a record of such events as the extinction of the dinosaurs or the warmest known climate interval of the Cenozoic. I feel privileged to then take some of these precious samples home and try to "unlock their secrets" about the past oceans.

Rana A. Fine

Professor, Marine and Atmospheric Chemistry, Rosenstiel School, University of Miami, Miami, FL, USA,
rfine@rsmas.miami.edu

My research uses tracers to investigate physical processes that affect the capacity of the oceans to take up atmospheric constituents. Over the years I have been involved in several international global change programs, using measurements of chlorofluorocarbons to deduce rates of climate-altering processes. This research has contributed to estimates of the age of oceanic layers, their transportation pathways, and their renewal rates, as well as rates of biogeochemical processes.

I take great pleasure in discovering new things, working with interesting colleagues from diverse disciplines and backgrounds, and doing field work in the world's oceans. Guiding the development of graduate students is especially rewarding. I chaired the Division of Marine and Atmospheric Chemistry at the University of Miami, and served on, and chaired, numerous advisory committees. I actively participate in several professional societies having served as section officers in AGU and AAAS, and on the Council of the AMS. I am deeply gratified to have been named a Fellow of each of those societies.

Growing up in New York City and Miami, I have loved water sports from SCUBA diving, to sailing dinghies, to big-game fishing. Admission to the Bronx High School of Science started me on a career path involving science and mathematics. I received a B.A. in mathematics from New York University, then an M.A. in mathematics from the University of Miami. In 1971, I enrolled at the Rosenstiel School wanting to apply mathematics to oceanic processes. When I completed my Ph.D., for personal reasons, I did not want to leave Miami, and that was fortuitous. I received a postdoctoral appointment at the Rosenstiel School's Tritium Laboratory. From that beginning, I have become a proponent of applying chemical tracers to climate relevant problems.

As a young woman it was difficult to overcome the macho, nearly 100 percent male, environment on research vessels; and at professional meetings I was often the only woman scientist. Over time, with the support of my husband, friends, and some men colleagues, I became more comfortable. The working environment has also changed substantially. The turning point in my career came while serving as a program manager at the National Science Foundation. At NSF, I gained an appreciation for how my interests fit into the bigger picture of Earth science, and the importance of networking at meetings. I learned that not only did women scientists have insecurities, but men were also insecure, they just compensated in a different way. This had a huge affect on my ability to work in a male-dominated environment. On returning to the University of Miami, I was offered a tenure-track position, which I enjoy today.

When I went to work at NSF in 1981, I was one of four women physical oceanographers at an academic institution in the United States. It is gratifying to see a much larger and hopefully expanding proportion of women colleagues today. Though there is still more work to do, the attitudes and ideals of my young women, and men, colleagues are having a positive impact on oceanography. I certainly enjoy being part of this continuing evolution.

Tracy D. Frank

Assistant Professor, Department of Geosciences, University of Nebraska-Lincoln, NE, USA, tfrank2@unl.edu

My research sits at the interface between oceanography and geology, and uses the chemical compositions of ancient marine sediments and rocks to understand how Earth's oceans have evolved through time. I am particularly interested in carbonate rocks such as limestone and chalk, which are composed of calcium carbonate minerals. The value of carbonate rocks in interpreting ocean history lies in their formation from a combination of biological and chemical processes. Not only are they rich in the fossils of marine organisms, but a record of the ambient marine environment is also preserved in the chemistry of the fossil shells and skeletons.

My research combines field and laboratory work. Field work involves the collection of samples from outcrops of marine deposits exposed on land and from cores of sediment obtained from the deep sea. Observing the physical relationships of strata provides insight into the original environment of deposition. Geochemical data obtained in the laboratory are interpreted within the framework provided by field observations. My research has taken me to such diverse locations as the Great Barrier Reef, the Canadian Arctic, and the Australian outback. I have also sailed on research excursions to the Bahamas and central Pacific with the Ocean Drilling Program, an international initiative to study the history of Earth's ocean basins.

A few years into my first academic job, I met my husband, who is also a geologist. Together we've struggled with the difficulties of being a dual-career couple. At one point, we faced the prospect of one of us giving up a tenure-track position so that the other could accept a job offer at another university. We agreed to move, and I spent the next two years as a soft-money researcher. Fortunately, a permanent tenure-track position was ultimately organized for me. As dual-career couples become more common, I hope that more employers begin to make it possible for both members of academic couples to pursue satisfying careers.

I am a native Midwesterner, born and raised in Iowa. Given that much of Iowa's geology lies buried beneath glacial till, I attribute my interest in the geosciences to having parents who enjoy the outdoors. We took family vacations to US National Parks and spent two years in Kenya, where I had a first-hand look at lakes and volcanoes of the Great Rift Valley and snorkeled over reefs in the Indian Ocean. It wasn't until I had the opportunity to take geosciences courses in college, however, that I recognized geoscience as a viable, not to mention immensely satisfying, career option.

Tracy at low tide on the reef crest of Heron Reef during a recent field trip to the Great Barrier Reef, Australia. Heron reef is home to the Heron Island Research Station, Australia's largest university-owned marine station.

Joan M. Gardner

Marine Geologist, U.S. Naval Research Laboratory, Marine Geosciences Division, Washington, DC, USA,
joan.gardner@nrl.navy.mil

I've been a marine geologist for 20 years. I have a B.S. in geology from New Mexico State University, an M.S. in marine science from Moss Landing Marine Laboratories (San Jose State), and a Ph.D. in geology from George Washington University. My love for marine geology began when I was accepted into the graduate program at the Hawaii Institute of Geophysics (HIG) as a research assistant working with one of the first interferometric side-scan sonar and bathymetric mapping instruments. I spent months at sea working long hours, but I found the work interesting, challenging, and rewarding. I didn't realize until many years later how fortunate I was to have started my career with the research group at HIG, which was equally composed of women and men. We were all treated equally and expected to take part in all aspects of the work both on deck and in the lab. This was unique then and still is to a great extent.

I've been a civilian research scientist with the U.S. Naval Research Laboratory (NRL) for more than half of my career. My primary area of expertise is seafloor mapping and characterization. I rarely get to pick the projects or geographic areas that I work in since my role is to support the needs of the ocean-going military as they arise. Most of my career at NRL has been spent working with foreign military and research scientists, which has presented me with some interesting challenges in terms of my credibility as a scientist and my role as a mother.

When I was offered my present position at NRL, I was told I would need a Ph.D. in order to be promoted. I worked on my Ph.D. while simultaneously continuing to work full-time at NRL and starting a family. I finished my Ph.D. in five very hectic years during which time I learned a lot about being organized, being flexible, and setting priorities appropriately. It's a constant juggling act that I alternately fail and succeed at on a daily basis. I still find it to be very much a man's world in my area of marine geologic and oceanographic research, but it is slowly changing. It's still common for me to be questioned, by both men and women, about how I can leave my children for extended periods of time to go to sea. While I still become defensive at the notion that I am shirking my responsibilities as a mother by doing a job that I love and am good at, I've come to realize that resenting the question or the questioner is not going to help me get the job done at sea, in the office, or at home. I will continue to fight the battles until I lose my love for what has been a challenging and rewarding career.

Top: Navy nuclear research submarine *NR1* preparing for a cruise off the coast of Spain. I am standing on the port side conning tower wing. *NR1* is equipped with a high-frequency side-scan sonar, high-resolution still and video cameras plus a large viewport, which makes it ideal for doing seafloor mapping and characterization. She is currently the only U.S. Naval nuclear submarine that allows female scientists on board to conduct oceanographic research. She carries an active duty military crew of 10-11 and can accommodate a maximum of two scientists at one time. Bottom: Glamour shot. The author inside *NR1* manning the side-scan sonar controls. This picture was taken after 36 sleepless hours.

Ann Gargett

Professor, Department of Ocean, Earth and Atmospheric Sciences, Old Dominion University, Norfolk, VA, USA, gargett@ccpo.odu.edu

It's been nearly 40 years since I started graduate school in physical oceanography, aiming towards a career in physics that wouldn't see me stuck in a windowless basement laboratory all my life. In the course of those years, some things about the life of women in oceanography have improved, some have stayed the same, and some have markedly deteriorated.

What's improved? Well, now there ***are*** women in physical oceanography. In the mid-1960s, as far as I know, there were only three women: myself, Barbara Hickey, and Jane Huyer (all, oddly enough, Canadian by birth). Now there are many more. It is also now a given that women have as much right to go to sea as men, with shipboard facilities evolving in response.No more hanging a sign on the (only) bathroom on the ship and trying to be super-fast in the shower so as not to restrict access to everybody (male) else. No more (I hope, though I'm actually not sure) being told that you can't overnight (!) on a U.S. Navy research submarine, despite being a principal investigator on the project.

What's unchanged? An adequate and assured supply of worksite daycare still hasn't become the norm, in either academic or research settings. In the coming wave of baby-boom retirements and the ensuing struggle for qualified faculty/researchers (believe it), organizations that have failed to deliver work-site child care will rue the day that "economic" decision was made—or worse, not even considered as the institutional imperative that it will be. In the meantime, women (and their partners) still have to stress over child care arrangements.

What's gotten worse? The pace (due to modern communications) and the pressures of a research career, particularly when exacerbated by the addition of academic responsibilities, have increased steadily. While this is a cross-gender issue—many men would also prefer more time for family and life other than science—it affects women scientists disproportionately: they frequently have alternatives and often take them, dropping out entirely or identifying and moving into less-stressful roles. If we are not to continue losing the research contributions of highly educated women oceanographers, institutional structures must change.

The paucity of women in the early stages of my career meant that most of my colleagues and mentors were male. I'm grateful for this opportunity to thank those who gave freely of their encouragement and support, and in the earliest days fought for my participation in cruises and meetings: one of the greatest rewards of my career has been the friendships thus forged. My professional life was additionally blessed by a job situation that allowed me room to raise a beloved daughter as well as indulge a love of oceanography. While I slightly regret that my attention span for any particular topic has never allowed me to become "the" expert on anything, I've never been bored.

The opportunity and privilege of going to sea, whether on long ocean cruises or (as here) on a day trip to install an instrument on a cabled coastal observatory, has always been the best part of my oceanographic career—but it hasn't always been a given.

Silvia L. Garzoli

Director, Physical Oceanography Division, Atlantic Oceanographic and Meteorological Laboratory, National Oceanic and Atmospheric Administration, Miami, FL, USA, Silvia.Garzoli@noaa.gov

I am a sea-going observationalist in the field of physical oceanography. I conduct and direct field programs concerning ocean circulation and climate, with a focus on the South Atlantic. My specific interest has been using observations to quantify and understand the dynamics of heat and mass exchange. Oceanography was not my first choice of study. I grew up in Buenos Aires, Argentina, and my first degree was in physics from the university of Buenos Aires. After that I obtained a doctorate in physics from a joint program between the La Plata and Maryland universities, and the subject of my dissertation was a model of the galactic structure. The first years of my scientific career were in the field of radioastronomy. I loved the subject, but at the same time I was interested in doing research in subjects more directly relevant to society. I started to interact with physical oceanographers and meteorologists. This is how, when I arrived in Paris in the mid 1970s, I was fortunate to obtain a position at the Laboratoire d'Oceanographye Phisique with Professor Henry Lacombe, who was my mentor.

In 1980, we left Europe for the United States looking for a place where both my husband (also a physicist), myself and our six-year-old daughter could work and live in the same city. For 18 years I worked at the Lamont Doherty Earth Observatory of Columbia University where I attained the level of Senior Scientist. I thoroughly enjoyed the academic life. Yet it was a struggle to balance my life as a mother, a woman, and a scientist. At no time was this an easy task, and certainly not back then. I always tell young women scientists that the number one element to succeed in achieving a balance in life is to choose as the father of your children a supporting partner, someone who respects and supports your career. I have been fortunate to have that. Life at LDEO, as the only woman scientist was difficult, and I experienced several instances of blunt discrimination affecting my advancement and salary. This was in spite of my consistent ability to raise funds for my research and support staff. Another challenge was that most of the time captains of the research vessels had difficulties in accepting a woman as the Chief Scientist. Fortunately, not everyone was like that. Some of my colleagues were excellent men whose friendship and support I value to this day. And there were always the other "isolated women" miles away from Lamont with whom we shared experiences when at national or international meetings.

Deployment of a RAFOS float from the R/V *Seward Johnson*, Benguela Current Experiment, September 1997.

When women started to fill up the laboratories as graduate students and young scientists it was a pleasure to see how the working conditions had evolved positively for them, and to realize that I was able to play a role in making those changes happen. Accepting my current position as Director of Physical Oceanography at NOAA/AOML was the ultimate stage in both working on applied science and supporting the role of women in science. I take great pleasure in being a mentor, a guide, a supporter, and a friend to the young women in my division and in the field.

Deidre M. Gibson

Assistant Professor of Marine Science and Biology, Hampton University, Hampton, VA, USA, deidre.gibson@hamptonu.edu

As an assistant professor at Hampton University, I am doing exactly what I planned almost 20 years ago. I am continuing my research and managing several programs to enhance the marine science research and education for underrepresented undergraduate and graduate students.

I was born and raised in New Orleans, LA., and I always had some connection to the water. But the one thing I never realized was that people actually studied the water for a living. I became excited about marine science after taking a SCUBA class, which by the way, was one of the only courses I passed that semester while goofing off at the University of New Orleans. I finally decided to get serious about my studies, so I packed my bags and headed to Seattle Washington.

My first experience was at Shoreline Community College, in a program focusing on marine biology and oceanography technology. The professors exposed our class to hands-on research that extended the boundaries of the classroom to the Puget Sound, and I knew I wanted to recreate that atmosphere of learning when I became a scientist. I continued my education and received a B.S. in oceanography at the University of Washington, where I was surrounded by leading oceanographers who inspired me to continue in the field.

I decided to explore science as a research technician in a zooplankton and phytoplankton laboratory at the Louisiana University Marine Consortium. Although I gained valuable experience and developed my research skills, it was the only place where I was discouraged and told that I was not good enough to go to graduate school.

Then, I met a scientist from University of Georgia and Skidaway Institute of Oceanography on a cruise, and decided to become his student. For my research, I would quantify the feeding, growth, and reproduction rates of the tunicate *Doliolletta gegenbauri*. I was fortunate to continue my work with the tunicate *Salpa aspera* for my postdoc at the University of Connecticut, Avery Point. Both tunicates are unique members of the zooplankton community responsible for rapid colonization of neritic environments. My goal is to investigate the role that gelatinous zooplankton fecal pellets play in the vertical flux of carbon and as a possible food source to other zooplankton and bacteria in the coastal ocean, and to determine their role in the neritic environment.

As I think back on my life in the field, I am so happy that I passed that SCUBA class. I enjoy my life as an oceanographer—from the people I have met and who have changed my life to the interesting cruises, research, and places I have traveled. One thing I really enjoy now is the opportunity to go back to my community and schools to share my experiences with black students. It makes all the difference in the world to know that there are others out there.

Left: Deidre with the DREAMS scholars, a Hampton University/ Virginia Institute of Marine Science program for underrepresented students. Right: Deidre on her first cruise.

Kathryn Gillis

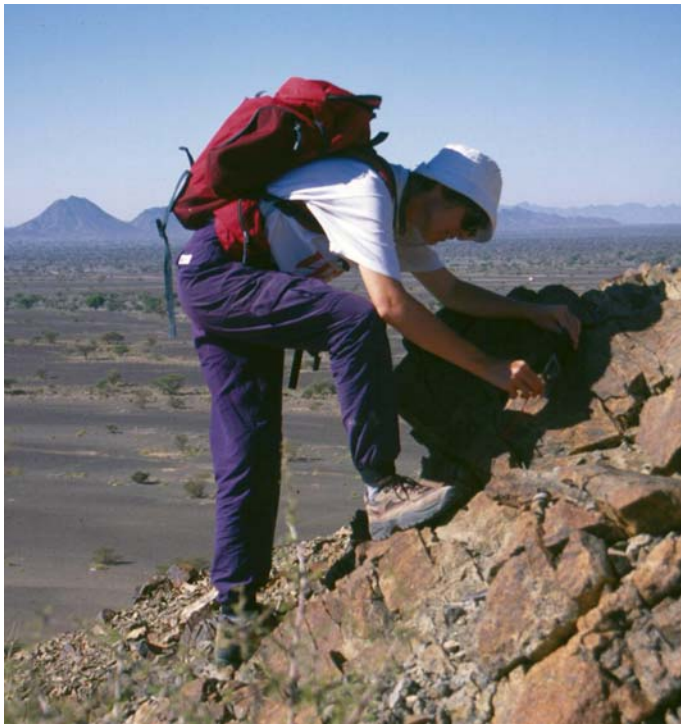
Professor and Director, School of Earth and Ocean Sciences, University of Victoria, Victoria, British Columbia, Canada, kgillis@uvic.ca.

My research is aimed at understanding the nature and consequences of ocean—lithosphere interactions throughout the life cycle of an oceanic plate. The story begins at mid-ocean ridges where we examine how the structure of the oceanic crust influences hydrothermal fluid flow and fluid-rock reactions, and nature of heat and mass exchange at the magma—hydrothermal interface. As an oceanic plate ages, we focus on understanding processes that contribute to the chemical evolution of the oceanic crust in order to quantify what controls global geochemical fluxes. This research involves seagoing and land-based fieldwork, petrological and geochemical analyses, and modeling.

I became interested in geology at an early age, after a family holiday to the western United States with a cousin who waxed poetic about the wonders of geomorphology and geology. I discovered years later that cousin Jack, who was a geophysicist, planned the route of our holiday as a geological tour. My interest in geology was solidified when I returned to school the next fall and had the good fortune to have a great science teacher who encouraged us to build volcanoes and think about the Earth. It wasn't until after I finished my undergraduate degree, however, that I realized that I could have a career that combined my curiosity about the ocean, developed growing up in Nova Scotia, with geology.

What I enjoy most about being a marine scientist is the potential for discovery each time I go to sea or travel to a new part of the world. It's a great thrill to dive to the seafloor or explore a hot vent with a remotely operated vehicle. It is equally gratifying to travel to a country such as Oman where ancient oceanic crust now exposed on land. These field approaches allow us to make fundamental observations and recover samples with critical spatial constraints. Another perk of this career is that I have worked with a colorful cross section of people over the years and have been exposed to new cultures.

A career in oceanography has many rewards and, like many professions, has some challenges. I started my career at the Woods Hole Oceanographic Institution. While it was an incredibly stimulating environment to conduct research, I decided after several years to lead a more balanced life and moved to the University of Victoria. Here my job is less self-focused and more rewarding as I spend my time conducting research and teaching undergraduate and graduate students. Gender is far less of an issue in my career now as the demographics of marine geology have changed significantly and women on board ship are no longer considered bad luck.



Kathy conducting fieldwork in the Sultanate of Oman where a Cretaceous aged fragment of oceanic crust is beautifully exposed. The goal of this field program was to map an area along the sheeted dike–gabbro contact in order to examine the nature of the transition between the magmatic and hydrothermal systems. So far this boundary has not been mapped in the modern ocean basins as it is difficult to identify from a submersible.

Patricia M. Glibert

Professor, University of Maryland Center for Environmental Science, Horn Point Laboratory, Cambridge, MD, USA, glibert@hpl.umces.edu

I am a phytoplankton ecologist, one-half of a dual-career couple, mother of three, professor, and advisor.

My graduate training at Harvard—over 20 years ago—was primarily centered on questions of nutrient dynamics and primary production in "blue water." I studied how algae could obtain sufficient nutrient for growth in waters that had depleted nutrients, leading to investigations on the regeneration rates of nitrogen in all forms. These questions now seem so simple—we even debated whether bacteria were important in the ocean! My work has become much more focused on the coastal realm, where the issue is one of nutrient saturation, not nutrient limitation. My current work is mainly examining the linkage between eutrophication and harmful bloom species, and how the form of nutrients, as well as the total amount of nutrients, may result in harmful algal outbreaks. Although most of my work is carried out in Chesapeake Bay, I have had recent projects in Australia, Brazil, Kuwait, and Florida.

In the early days of my career, it was not unusual for me to be the only woman on a cruise (60 days across the Indian Ocean, for example), the only woman at a national meeting, the only woman at a workshop. My daughter was born when I was on the faculty at Wood Hole Oceanographic Institution. She was (as I was often told) the first child to be born to a woman scientist at WHOI. Shortly thereafter my husband, Todd Kana, and I moved to the Horn Point Laboratory, as we were both offered academic jobs at the same institution—a rare opportunity! My son was born the following year, also the first child of a woman scientist at the Horn Point Laboratory. When my second son arrived three years later, there were so many kids appearing at Horn Point Laboratory that we were able to get a day care center started on campus, one that is a thriving to this day.

Todd and I have managed two careers and three kids somehow. We drove separate cars to work everyday for 15 years as we were on different pick-up schedules (eco-unfriendly, but necessary). We have rarely attended the same meeting or conference, but have managed a few collaborative projects. Our family stepped in to help when necessary and evolving institutional attitudes helped enormously.

Our children are now well beyond the years of child care (in high school and college now), but the balancing act continues. All are competitive sailors, with accomplishments that parents can rightly brag about. The days of scheduling play dates seem easy to us now; now we are scheduling weekend practices out of state, and arranging logistics for national and international competitions. I suppose the love of water is in their genes. I wouldn't want it any other way.

I look around now at our graduate students and see mostly female faces. What a change! These students will face many challenges, academically and personally. However, none of them should have to question whether they can have both a scientific career and a family.

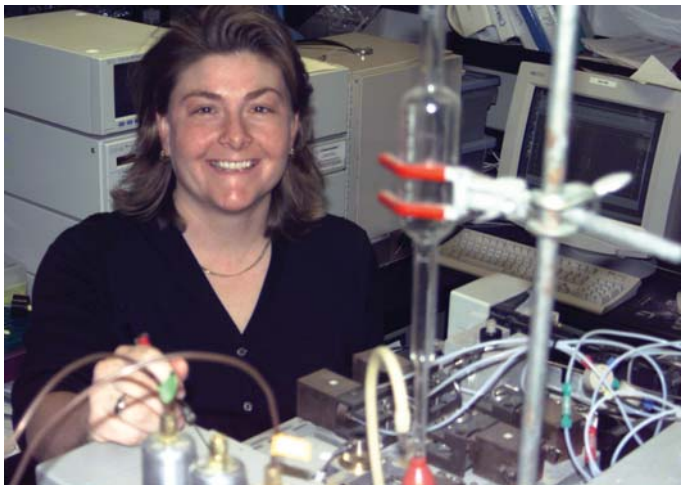
Shana K. Goffredi

Senior Research Fellow, California Institute of Technology, Pasadena, CA, USA, goffredi@caltech.edu

My primary research interests concern the ecological physiology of marine invertebrates. I am fascinated by the diversity of physiological solutions to environmental challenges and the potential limits to these adaptations. I consider "extreme" environments, like the deep-sea and sulfide-rich underwater volcanoes (or hydrothermal vents) ideal systems for observation. Animals in these environments typically push the limits of what we assume to be possible physiologically. Examining the range of adaptations used by these unique animals will broaden our understanding of how organisms function and evolve in a changing world.

I've always been interested in science. When I was a child, I was a "backyard biologist"—curious about all of the creatures that surround us in our every day lives. In junior high I had a very influential physical science teacher who inspired me from an early age. I became intrigued with marine biology after arriving at the University of San Diego. This small liberal arts college provided me with a hands-on experience in scientific research, first with a project in a lab on campus, and then through a joint internship at the San Diego Natural History Museum. At that point I was hooked on the wonders of aquatic science and later pursued a doctoral thesis in marine biology at the University of California, Santa Barbara and a postdoctoral position at the Monterey Bay Aquarium Research Institute.

The most rewarding experiences of my job as an ocean scientist are two-fold. Scientifically, I enjoy the spirit of discovery. Recently, colleagues and I have been involved in the discovery of animals that are new to science, many living in environments in which we previously thought animal life could not exist. These discoveries have emphasized the great need for continued ocean exploration to better understand the animal (and microbial) life on Earth. The second, and equally rewarding experience, has been outreach to the general public. I enjoy introducing young people, in particular, to the same phenomena that drew me into the field of marine biology. I have interacted with students from all age groups and stages in their careers, from college level classes to workshops for 8th grade girls interested in pursuing science and mathematics. This has been one of the true pleasures of my job.



Shana Goffredi at the bench measuring the characteristics of marine invertebrate body fluids using a gas chromatograph.

Many women before us have paved the way for our continuing representation within the many disciplines of oceanographic science. Certainly, they have created significant change, which is apparent to me even now at the early stages of my career. I think one of the most alarming facts is the disproportionate number of women involved in the sciences at the graduate student and postdoctoral level compared to those retained as faculty. There are still unique challenges to women pursuing professional careers in oceanography, however, I am hopeful that the continued success of women in marine sciences and increased awareness of the issues will enable us to focus on the important challenges in science and less of the challenges in the workplace.

Cheryl Greengrove

Associate Professor of Geoscience and Environmental Science Program Coordinator, University of Washington, Tacoma, WA, USA, cgreen@u.washington.edu

Over the course of my career as a physical oceanographer, my research focus has moved from "blue water" studies of the advection and diffusion processes that govern circulation in the South Atlantic Ocean, to coastal circulation studies off northern California, to investigating various marine environmental issues in estuarine systems in the Pacific Northwest. Currently, I am part of two interdisciplinary teams of marine scientists: one studying harmful algal blooms in Puget Sound, and the other exploring the physical, chemical, and biological oceanographic conditions in the fjords of Barkley and Clayoquot Sounds, British Columbia, Canada. My present areas of research also include local watershed studies and investigations into various science education pedagogical techniques particularly useful for hands-on, field-based activities in environmentally related courses.

I have always wanted to be a scientist and decided, at age ten, to combine my love of science, the ocean, exploration, and the outdoors and become an oceanographer. I received my B.S. in physics from Moravian College and went on to earn my doctorate from Lamont-Doherty Earth Observatory in physical oceanography. Since the completion of my degree in 1986, I have taught at a number of universities and colleges and worked in the consulting industry as a scientist and manager specializing in applied oceanographic and environmental research. My undergraduate education at a small liberal arts college, combined with graduate work at an institution that fostered international, interdisciplinary scientific research, have provided me with a strong academic foundation. Working in consulting gave me real-world, hands-on experience and the opportunity to do more applied coastal and estuarine oceanography. Each of these experiences has played a key role in shaping my professional development and has served me well in my present, somewhat unique, position of helping to build a new university.

In 1996, I was hired as one of the first two scientists at a new campus of the University of Washington in Tacoma. UWT, founded in 1990 as a two-year, upper-division public undergraduate institution, was established as an urban, commuter campus designed to increase access to four-year baccalaureate degrees for place-bound, time-bound students of the South Puget Sound region. My mission, along with my one scientific colleague, was to build an environmental science curriculum that would integrate all the natural sciences (non-existent to this point) into an interdisciplinary framework serving primarily non-traditional students on a campus growing at 15% a year. When we started as junior faculty members, the entire campus was in rented space; we had no equipment, labs, or scientific facilities. During the next nine years, we created an interdisciplinary environmental science curriculum built around student involvement in hands-on/field-based activities, undergraduate research and internships; forged relationships with potential outside collaborators for integrated research, education, and community service opportunities; established an Environmental Science B.S. degree; designed and built a science building; and hired three more science faculty and a lab coordinator. We now teach about 60 Environmental Science majors and 500 non-majors annually on a campus of 2000 upper-division undergraduates. This has been an extremely challenging, but exciting opportunity. One doesn't get to build a new university everyday.

All women scientific research cruise aboard the R/V *Barnes* in Clayoquot Sound, British Columbia, Canada , August 2004. Left to right: Lisa Faubion, undergraduate; Kate Hubbard, graduate student; Cheryl Greengrove , Chief Scientist (front with hat); Heather Tallis, graduate student; Kimberly Genther, undergraduate; Kathy Newell, marine technician. Research funded by NSF Grant OCE99-84163, Richard G. Keil , Principal Investigator.

Julie Hall

Group Manager Aquatic Ecology and Ecotoxicology, National Institute of Water and Atmosphere, Hamilton, New Zealand, j.hall@niwa.co.nz

I started my professional life as a limnologist in New Zealand and moved from there into the field of freshwater ecotoxicology for my Ph.D. in Canada. It was then back to New Zealand for a postdoc in marine ecosystems investigating the importance of picophytoplankton in the waters surrounding New Zealand. This move from freshwater to marine was dictated by the pragmatism of employment opportunities, but the transfer of knowledge between the two systems has worked out well. Over the past 15 years as a scientist and manager with the New Zealand National Institute of Water and Atmospheric Research, I have moved into the much broader field of microbial food web dynamics as my primary research interest. Of particular interest during this time was my involvement with two iron addition experiments and an iron budget experiment in iron-limited waters.

One of the advantages—and disadvantages—of working in New Zealand is the small size of the scientific community. Kiwi scientists often need to work beyond their immediate discipline interests. So, I have had excellent opportunities to broaden my science knowledge, including working with marine mesozooplankton and also working in the dry valleys of Antarctica. The small size of the community and the funding regime in New Zealand also promote multidisciplinary research that has been challenging and rewarding.

In terms of career challenges, these have come not only from my research, but also from my involvement in international science programs. I chaired the joint Joint Global Ocean Flux Study/Land-Ocean Interactions in the Coastal Zone Continental Margins Task Team and I have also been a member of the committees that have developed the design and implementation plans for the Coastal Global Ocean Observing System. The development and implementation of the Global Ocean Observing System is critical to future research and the management of the marine environment. More recently my biggest challenge has been chairing the development of the new SCOR/IGBP-sponsored project, Integrated Marine Biogeochemistry and Ecosystem Research (IMBER). The IMBER project is a ten-year oceanographic project to investigate marine biogeochemical cycles, ecosystems and their interactions, and the impacts of global change. Working together with the IMBER Transition Team and then the IMBER Scientific Steering Committee to bring together the scientific ideas, and melding them into a cohesive project, has been challenging and exciting as has working with other scientists from around the globe in the development of this project. The next challenge will be to start the implementation of the IMBER project.

They say the best form of relaxation is an alternate stress. Flying gliders is great fun and can be relaxing and enjoyable; at other times it can be very demanding and challenging, especially when you run out of "up"!!!!

Pamela Hallock Muller

Professor, College of Marine Science, University of South Florida, St. Petersburg, FL, USA, pmuller@marine.usf.edu

By studying modern and ancient coral reefs, my students and I gain insight not only into environments of the past and present, but also the potential effects of human activities on the future of Earth's ecosystems. Our work has implications from cell biology to global environmental change to hydrocarbon exploration.

Born on the prairies of South Dakota, I didn't see the ocean until my teens. As a child I wanted to be a teacher because my grade-school teacher and my aunt, also a teacher, were the only persons I knew who traveled. Being an ocean scientist has provided travel opportunities beyond my wildest childhood dreams. And as a child of the Sputnik era, I wanted to be an astronaut. Then, as an undergraduate at the University of Montana, field trips to Puget Sound hooked me on the ocean.

I applied to graduate school pre-Title IX. One program rejected my application because they didn't accept women. Recommendations were the avenue to the best graduate schools and my strengths were grades and GRE scores, so I was fortunate to be offered financial support by two universities. My boyfriend was also accepted with an assistantship at the University of Hawaii, so we married and went there together.

My first academic position out of graduate school was in the University of Texas system. In 1983, I joined the Department of Marine Science at the University of South Florida as an associate professor and was promoted to full professor in 1988.

My economic progress did not keep pace with my professional advancement. In 1989, I applied for a salary adjustment and was told that my low salary was my own fault for not being a better negotiator. In January 1998, I joined five other senior faculty women in a class action gender discrimination suit against the University of South Florida alleging salary inequities. I discovered that all senior women in the sciences at USF were paid 80 percent of the average for men, and subsequently analyzed and wrote a detailed report on gender-based salary disparities, their probable causes, and possible solutions. The lawsuit was settled in November 1998. I frequently speak on the value of role models and issues of gender equity in the sciences.

Women undertaking graduate degrees in the sciences today still face significant challenges. We often think integratively, and while men who think integratively are usually considered leaders and innovators, similar approaches by women are not as readily accepted. A leader in my field told me that, if I were male, my work would have stature comparable to his. This wasn't a sexist remark, but rather a lament that gender still determines the value too many place on individual contributions. In my opinion, the major challenge women scientists still face is the quest for respect.

Left: Pam in the lab. Below: Pam taking samples.

Roberta C. Hamme

Postdoctoral Scholar, Scripps Institution of Oceanography, University of California San Diego, La Jolla, CA, USA, rhamme@ucsd.edu

I am a chemical oceanographer interested in what drives the cycles of dissolved gases in the ocean. Both carbon dioxide and oxygen play important roles in climate change studies, but it is difficult to separate the effects that physical processes and photosynthesis/respiration have on setting the observed concentrations of these gases. By measuring dissolved inert gases like neon, argon, and xenon, I can predict how physical processes like rapid temperature change and air-sea gas exchange affect the biologically important gases. More generally, I am excited about the insights into ocean circulation, mixing and air-sea exchange that high-precision measurements of gases will provide us.

Roberta on a recent trip to Thailand.

Like many people in science, I hardly arrived at this point by the most direct means possible. As an undergraduate chemistry major, I was searching for a subject area that would combine field and lab work and discovered the summer Research Experiences for Undergraduates (REU) program at the School of Oceanography, University of Washington in my home town of Seattle. After a research project looking at the degradation of organic matter in shelf sediments, and especially after an amazing two-week research cruise from Seattle to Hawaii, I was hooked on oceanography.

My master's research topic focused on using Ba/Ca ratios in coral skeletons to investigate paleorecords of river discharge. Unfortunately, the observations were more influenced by the movement of the nearby river plume past our site than the river discharge we were interested in recording. Somewhat disillusioned with the project's failure to achieve our overall goals, I left graduate school and started a job in the quality-control lab of a company providing compressed gases to the semiconductor industry.

Routine analysis of contaminants in gases would win few awards for intellectual excitement, and I began to notice that I ironically enjoyed my job most when the instruments broke down. I realized that what excited me was the process of diagnosing a problem and finding the solution more than achieving a particular end result. This realization led me to reconsider academic science—after all, how different is grappling with a problem like a broken instrument and dealing with the myriad issues that arise along the way to completing any research project? In search of challenging problems to solve, I headed back to the University of Washington to finish a Ph.D. on the geochemistry of dissolved gases. Now a postdoctoral researcher, I am concentrating on developing methods to improve the temporal resolution and precision of measurements of dissolved and atmospheric gases. I look forward to combining my research interests with a commitment to innovative teaching in my future academic career.

Naomi Harada

Subleader, Institute of Observational Research for Global Change, Japan Agency for Marine-Earth Science and Technology, Yokosuka, Japan, haradan@jamstec.go.jp

Because rapid climate change occurred globally during glacial and interglacial periods, before human activity had a serious impact on climate, studies of those periods will help us to better understand the mechanism of natural climate changes. Using paleo-proxies such as biomarkers recorded in marine sediment, I am reconstructing past variation and changes in sea surface temperature, sea surface salinity, thermohaline circulation, and biogeochemical cycles. In addition, I am researching the characteristics of biomarkers in the modern ocean. An understanding of both modern and paleoceanographic characteristics is important for predicting future global climatic change. When I entered graduate school, my plan was to work in environmental assessment or to be a high school teacher after graduation. During my second year of graduate school, I had an opportunity to work with a team collecting sediment cores from the seafloor in the western equatorial Pacific. When I saw the fresh, pure white sediment core (more than 90 percent of the core was composed of calcareous fossils), I was deeply impressed not only by the beauty of the sediment but by the fact that it held an environmental record of the past. It was then that I decided to pursue a doctorate and become an oceanographer specializing in sediments.

The most rewarding aspect of being an oceanographer—or any type of scientist—is that we have many opportunities to make new discoveries. It's like being a treasure hunter. By working in the field, we oceanographers can see, touch, and ultimately understand the processes at work on the Earth. My greatest career challenge came in 1990 when I was a doctoral student. I wanted to participate in the Antarctic Research Project as a member of the Japanese Antarctic Research Expedition. Because the purpose of my doctoral dissertation (amino acid chronology) was different from that of the Antarctic Research Project (biogeochemical cycles in the Southern Ocean), and because only one woman had ever previously been a member of the Japanese Antarctic Research Expedition, my supervisor was firmly opposed to the idea. I wanted to expand my career opportunities and to gain experience in a new field, and I persuaded my supervisor to allow me to attend. After I came back from Antarctica six months later, Antarctic work (paleoenvironmental reconstruction of Lützow-Holm Bay during the late Quaternary) was added to my doctoral research. Prior to earning my Ph.D., I published two articles on my Antarctic work; my dissertation research was published as three additional articles.

I have never exerted much effort to balance my career and personal life. Science has become the highest priority in my life. My husband and I have no children; of course, having his understanding and support has allowed me to concentrate on my work.

Regarding the conditions for women in oceanography in Japan, I have not noticed changes since I started my career. Recently, the number of women playing an active part in oceanography not only as scientists and researchers, but also as marine technicians, has increased in Japan.

Naomi being interviewed in São Paulo, Brazil about a recent cruise of the R/V *Mirai.*

Lois Harwood

Stock Assessment Biologist, Department of Fisheries and Oceans, Yellowknife, NT, Canada,
McLaughlinF@pac.dfo-mpo.gc.ca

Grade 11 Biology—Mr. Puddy's class at Mt. Douglas High—and I was hooked. Biology—especially marine—came so easily and made good sense. What a life-defining moment! This must have been a huge relief for my parents. However, only as a working adult have I come to appreciate the impact of that "choice" back in 1973. From there my path was fairly direct: university, travel, fun, and, eventually, work! It was my first job as an environmental consultant (1980) that landed me working on marine mammals in the Canadian Beaufort Sea. It was also through this job that I was fortunate enough to meet my future graduate school supervisor/mentor/role model, Dr. Ian Stirling of the University of Alberta, a world class polar bear scientist. That was unquestionably the second most-defining moment of my career. Three months after moving to Canada's north for work, I met (and eventually married) a northerner, Charlie Ruben, a polar bear hunter/guide in his own right. We started our family, worked, traveled, and have been learning from each other ever since.

Lois Harwood (center right) with husband Charlie Ruben (far left), and daughters Kayla (11 yr, center left) and Megan (8 yr, far right), in Inuvik, NT, Canada.

Now, about the work. During graduate school, and the 17 years that followed, I have been working in Canada's north on the habits (mostly on the whereabouts and trends) in seal and whale populations of the Beaufort Sea. The connection to oceanography is huge—the animals we have been studying (sampling specimens for reproduction and fatness, counting, tagging, tracking, surveying) are marine mammals that help us learn about the ocean. They are themselves oceanographic sampling platforms! They show us which areas are "biological hot spots" (high prey densities) and when (by the times they aggregate there), and they also are able to access deep ocean habitats that we cannot get to. The satellite-linked tags that we now deploy on the backs of seals are able to collect data on temperature and salinity, in addition to depth and location. The tissues of the marine mammals reflect where they have been feeding (carbon and organochlorine signatures). Even their rates of reproduction and thickness of their fat are a proxy for the productivity of the marine ecosystem. Finally, and perhaps most importantly, our work is done in close collaboration with the local hunters and trappers. Together we have bring the knowledge from western science and traditional local knowledge to bear on the conduct of our projects.

Rachel M. Haymon

Professor of Marine Geology and Geochemistry, Department of Geological Sciences and Marine Science Institute, University of California, Santa Barbara, CA, USA, haymon@geol.ucsb.edu

I have spent my career exploring deep-sea hydrothermal systems and the geology of the mid-ocean ridge, and I have loved this work. The sheer joy of discovering the unknown bottom of the sea is boundless. The mid-ocean ridge is a dynamic, global system with geological, chemical, physical, and biological components, and it is an endless delight for me to observe this astonishing system in action. It also is great fun to work with interdisciplinary groups of talented colleagues and students, piecing together the fascinating interactions among the ocean, seafloor, and biosphere. A few highlights include being at sea when "black smoker" hot springs first were discovered on the East Pacific Rise at latitude 21°N in 1979; leading an expedition where we witnessed an astonishing bloom of microbes spawned by the first-seen eruption of the deep mid-ocean ridge (on the East Pacific Rise at latitude 9°45' to 9°52'N in 1991) (see figure); and, exploring hydrothermal activity and the subseafloor biosphere on the flanks of the mid-ocean ridge since 2002. I have been incredibly blessed and thrilled throughout my adult life by the wonders of the deep ocean floor.

I grew up in Louisiana in the 1950s in a family of non-scientists. Marie Curie was the only woman scientist I'd ever heard about. When I entered graduate school in 1976, there were just one or two women (students) at sea on any given expedition, and crew members thought we were "bad luck." We women collectively feared becoming a failed social experiment; at age 25, I permanently injured my back proving that I literally could carry my own weight at sea. The greatest challenges came after graduate school, when we had to establish ourselves and make difficult choices about balancing our professional and personal lives. But we did it, each of us in our own way, and with help from others; and now young women in our field no longer need ask: can it be done? They need only know themselves well enough to answer the question: is this what I want?

It most definitely was, and is, what I want. I still feel the pull of the seafloor's unsolved mysteries, as I plan yet another expedition, write yet another research paper, teach more young people that there is much left for them to discover, seek opportunities for my students, and share all these joys with my dear husband and colleague, Ken Macdonald. I thank my parents, spouse, teachers, friends, colleagues, mentors, students, staff, crew, techs, program managers, and all who have assisted me along the way.

In March-April, 1991, we witnessed an astounding bloom of chemosynthetic microbes during an eruption of the East Pacific Rise crest at lat. 9°45' to 9°52'N (Haymon et al., 1993, *Earth and Planetary Science Letters*, 118:85-101). In the photo, fragments of white microbial sulfur floc are being blasted out of the seafloor by hot water venting from the volcanic fissure that fed the eruption. The sulfur floc is precipitated on and under the seafloor by microbial oxidization of hydrogen sulfide. This dramatic and unexpected sight opened our eyes to the possible existence of a vast subsurface biosphere fed by chemical energy, and triggered a paradigm shift in scientists' ideas about how planets give rise to life.

Karen J. Heywood

Reader in Physical Oceanography, University of East Anglia, Norwich, UK, k.heywood@uea.ac.uk

Balancing work and family: Karen with Tom, James, and Joss snatching a holiday in Iceland where Karen was joining the RRS *James Clark Ross*.

I am an observational oceanographer, particularly interested in the polar oceans. Most of my current work aims to understand and quantify the circulation and processes in the Southern Ocean. I enjoy going to sea, and find it exciting to collect data in locations no one has ever studied before. At school and university I enjoyed science, because I wanted to find out about the universe. I wanted to apply my physics to the real world, and thought about doing meteorology. It was more than 20 years ago, and I was annoyed to learn that the British Antarctic Survey did not then allow women in Antarctica. I happened to go to an Open Day at the Institute of Oceanographic Sciences (IOS), in Wormley, UK. I was walking along the geophysics corridor remarking grumpily, "I bet they don't let women go to sea," when a voice from one of the offices replied, "Oh yes they do!" That day at IOS, I realized that there were many more things still to discover in oceanography, whereas meteorology seemed to me to be all known about already (ok, I know better now!). So I decided to do a Ph.D. in physical oceanography at Southampton, and have loved oceanography ever since. After a three-year postdoc at the University of Wales, Bangor, I moved to UEA as a lecturer.

During my physics degree, the ratio of men to women was 10:1, so I didn't find it unusual that there were almost no women Ph.D. students when I did my Ph.D., particularly on the physical side. Now that I have Ph.D. students myself, I am pleased that the ratio is much more even. Of the 19 graduate students I have supervised or am currently supervising, 11 are male and 8 are female. At undergraduate level, my physical oceanography class has a similar proportion of women, and that has increased during the 15 years I have been lecturing.

Like everyone else in academia and in science, I find it hard to balance work and family. My husband Martin and I never seem to have enough hours in the day, since we both work full time. For the last 8 years I have enjoyed being Mum to my three stepsons Tom (14), James (12), and Joss (10). Well, most of the time it's enjoyable, sometimes it's maddening! The most rewarding part of my work is supervising Ph.D. students and seeing them grow in confidence. I would like to have more time to do the research myself—I still get a buzz out of getting a program to work, or plotting a section for the first time, or calculating a term in an equation. It thrills me to work in spectacularly beautiful parts of the world, such as Antarctica or, most recently, a fjord on the east coast of Greenland. I do feel fortunate to have a career I enjoy so much, and would like to encourage other women to become physical oceanographers. If I can do it, so can other women!

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Barbara M. Hickey

Professor of Oceanography, University of Washington, Seattle, WA, USA, bhickey@u.washington.edu

I am a physical oceanographer, receiving my Ph.D. degree from Scripps Institution of Oceanography (SIO) in 1975. For about 10 years I was one of two female physical oceanographers at a university in the United States. I was directed to oceanography by my physics professor at the University of Toronto, who took me aside (the only woman and the top student) and told me that theoretical physics demanded too much commitment (for a woman) and that I should look at a (softer) field such as oceanography at SIO where he had done a sabbatical and had been able to surf.

My research interests have evolved over the years. My doctoral work was on equatorial processes, including El Niño. I participated in the first cruise to attempt to moor buoys in the Equatorial Undercurrent (only two stayed put!). I have been very lucky in my career—I had a good mentor following my Ph.D. (I took my assistant professor position before actually finishing my degree AND did no postdoc). Also, I entered the field of coastal oceanography in the "cowgirl" days when almost anything you measured was a new finding. My mentor passed a buoy group to me, so my career path has mostly been one of moored data collection and analysis, supplemented with CTD surveys, satellite imagery, and drifter deployments, as necessary. In recent years I have become almost more interested in interdisciplinary than discipline-specific questions.

I was lucky in that funding was much easier for everyone in my early career years. I have always been on "soft" money and I congratulate myself on keeping a group and many students funded over a 30-year period. As time passed it became necessary to have more and more grants to keep funded (I have had as many as eight simultaneously) and the fun began to diminish as more and more time was spent on writing reports, attending meetings, and writing new proposals. I was thinking of retiring early when I was awarded two five-year multi disciplinary/multi-institutional grants to direct and participate in interdisciplinary projects. The affirmation of my skill by my peers who reviewed this work plus the security of these projects has renewed me and once again I am going to sea and highly motivated. I have never lost the excitement for the challenges and variety that an oceanography career provides.

Dr. Hickey riding her favorite draft horse, Don, on her annual wagon train adventure.

I have managed both career and family (I have two daughters) and a life (a farm and a passion for tennis), but not without some sacrifice. I cut back on meetings, panels, and going to sea when my children were young. The result is being overlooked for special awards (such as Fellow), invited speaker slots, and other forms of acknowledgement. Women were particularly overlooked in my field because there are/were so few of us to promote each other. However, I never felt that the quality or the amount of my work suffered because of my family. Note that this path requires a good and understanding spouse!

Conditions are indeed different now for women in my field—we now have a quorum for discussions in the Ladies Room at meetings. No one is prohibited from going on a cruise because they would be the only female. Yet some challenges remain. A glass ceiling still exists for women in many areas of science. Women remain underrepresented in senior positions (e.g. full professors, department chairpersons) and in national and international positions that determine directions and funding for our science (e.g., membership on scientific steering committees). These are challenges that I am optimistic will be met by the present and future young women and men in oceanography.

Tessa M. Hill

University of California President's Postdoctoral Fellow, Department of Geology and Bodega Marine Lab, University of California, Davis, CA, USA, tmhill@ucdavis.edu

I like to think that I became an oceanographer the first day that my toes touched the waters of Puget Sound, probably before I could walk. As a child in the Pacific Northwest, I was scientifically inclined and curious about the natural world around me. An urge to see a "different" coast brought me to Eckerd College, in St. Petersburg, Florida, where I earned a B.S. in Marine Science. While at Eckerd, I had the opportunity to participate in a project examining the geologic history of West Florida, and completed a senior thesis project using benthic foraminiferal assemblages to reconstruct paleoenvironments in this region.

I began my Ph.D. at UC Santa Barbara in fall 1999, under the mentorship of James Kennett. I was drawn to paleoceanography because of its integrative nature and the clear relevance of investigating Earth's climate. During my graduate studies, I utilized foraminiferal assemblages and stable isotopes to understand the forcing mechanisms of rapid climate change during the Quaternary. My graduate program encouraged me to interact with colleagues in biology, physics, chemistry, and geology—something that is both rewarding and challenging in an integrative field like oceanography.

While in graduate school, it was observed that a number of female students in my cohort decided to leave graduate school or to cut their studies short. In response to this trend, I worked with a group of graduate students to create the Women In Science and Engineering (WISE) group at UCSB, with the goal of slowing the departure of women from scientific careers. Work with WISE taught me a great deal about the challenges that women face in pursuing a career in science, and made me thankful for the women mentors who have been important in the progression of my own career.

I finished my Ph.D. in August 2004, just in time to leave for a research expedition that sailed between Norway and Iceland. Upon my return, I began a postdoctoral fellowship at UC Davis, continuing my investigations of marine records of climate change. In particular, I am studying the utility of deep-sea corals as high-resolution records of climate change to determine if processes such as the El Niño and Pacific Decadal Oscillation transmit temperature and geochemical change to the deep sea. One of the most exciting aspects of my postdoctoral research is that I collaborate with geochemists in the Geology Department and marine scientists at Bodega Marine Laboratory—another example of the interdisciplinary opportunities that a career in oceanography provides.

Tessa Hill aboard the R/V *Knorr*, examining foraminiferal assemblages from the Storegga submarine landslide, offshore Norway.

Emilie Hooft

Research Associate, Department of Geological Sciences, University of Oregon, Eugene, OR, USA, emilie@uoregon.edu

Two events led me to become a marine geophysicist. I was an undergraduate in physics and astronomy when a friend convinced the chairman of the physics department to send us both to the Canadian Undergraduate Physics Conference. There I saw a movie of people throwing scientific instruments overboard; I was attracted by the idea of doing physics while at sea. Then, during the next summer I got a job and went on a seismic cruise to the Juan de Fuca ridge. I was enticed by discovering what lay at the bottom of the ocean.

I became a marine geophysicist and study volcanism at mid-ocean ridges and oceanic islands using passive- and active-source seismology. I enjoy applying physics to Earth processes, which are more tangible to me than the stars. I relish the hard work, group effort, and adventure of going to sea to collect data. I have also worked in Iceland and the Galápagos; in both places the geology is spectacular and the culture interesting. Oceanography involves exchanges across boundaries and at mid-ocean ridges; material and energy are transferred between Earth's mantle, crust, and ocean. Due to the interdisciplinary nature of our science, I interact with different colleagues. I enjoy working with people who appreciate me, and with those who I value.

I came to Oregon because my husband is a professor here. Recently, I have been working half time; we have a daughter of 4 1/2 and boy-girl twins of 2 1/2. About a year ago I felt that it was hard to keep my career going after the disruption in publications and grants caused by having 3 children in 22 months. But, by working consistently, things have been picking up. We are fortunate that my husband has tenure. My ideal is a half-time tenure track position in the same location as my husband. Life is both short and long. In the present moment, I immerse myself in what I am doing and try not to worry. At the same time, I look forward to the future, its promise and possibilities. Women tend to blossom later in their careers than men, says my husband. This idea gives me support and a positive view toward the future. Balancing life and science is a challenge, but also rewarding. I highly value my work as a scientist; I enjoy having a family as well.

Emilie installing a seismometer in the Galápagos islands.

Julia M. Hummon

Research Associate, University of Hawaii, Manoa, HI, USA, hummon@hawaii.edu

I work at the University of Hawaii for a member of the Physical Oceanography faculty. We are interested in ocean currents, with an emphasis on the equatorial and polar regions, and rely on measurements collected by acoustic Doppler current profilers, (ADCP) as our primary data source. These instruments use the Doppler frequency shift in two pairs of opposing beams to calculate ocean velocities. We use them in one of two modes: mounted to the hull of a ship, or mounted on a rosette frame (for full-depth profiling). My work is never boring, and includes a diverse collection of functions: going to sea to collect and process data from these instruments; writing or contributing to technical papers, cruise reports, and grant proposals; developing and improving processing algorithms, interfacing with other people who use our code, and generally helping to demystify ADCPs and make their data more useful and more accessible.

In high school, I knew I wanted to be a scientist, and always assumed I would be a professor in a small college somewhere. I switched majors, trying to find a good fit, and ended up with minors in biology and chemistry, a B.S. in math, and a master's in math. I wanted to find an appropriate and relevant application for my math background, and decided to go into physical oceanography. After my Ph.D., it became clear that I enjoyed the technical aspects of the work, but did not want to be a grant-writing academic. When the opportunity arose to apply for a technical position as opposed to a postdoc, I decided the technical position was a better match for me. I have not regretted that decision.

I think academia, especially for principal investigators, is still geared towards the model of a person who is not the primary caretaker in a family. Because our society's expectation is that the female will be the primary caretaker, I think it is difficult for a woman to have children and be a successful grant-writing research academic. However, it is up to each individual to define "success." As more women choose to work in scientific careers, and make a variety of choices about balancing families and work, I hope the community will become more open to the variety of contributions everyone can make.

Julia Hummon on board ARSV *Laurence M. Gould* during the sea trials of a new shipboard ADCP installed fall 2004.

Susan E. Humphris

Senior Scientist and Department Chair, Geology & Geophysics Department, Woods Hole Oceanographic Institution, Woods Hole, MA, USA, shumphris@whoi.edu

My interest in oceanography was piqued during my last year as an environmental sciences major in the United Kingdom. I wanted a career involving fieldwork, but had not made up my mind what I wanted to do. Looking through oceanography textbooks, I saw photos of research vessels, and was drawn to the idea of research at sea. In 1972, I headed to the United States to begin my Ph.D. in the MIT-Woods Hole Oceanographic Institution (WHOI) Joint Program in chemical oceanography. Thirty years later, I have spent more than three years of my life on ships, been to the bottom of the ocean many times, and used a wide range of deep submergence vehicles in my quest to understand hydrothermal processes.

I am a marine geochemist interested in hydrothermal processes at mid-ocean ridges. A long-term goal of my research is to quantify the chemical fluxes associated with hydrothermal circulation. This has led me in two research directions: analytical work to quantify elemental exchange during hydrothermal water-rock reactions, and field work to investigate the relationships among volcanic, tectonic, and hydrothermal processes to better understand the spatial distribution of hydrothermalism.

Contemplating the upcoming eight-hour dive, I get a last glimpse of daylight through the viewport of the submersible *Alvin* as it is lowered into the water for a dive to the Galápagos Rift in the eastern Pacific Ocean. Photo credit: Craig N. McLean, NOAA.

However, my path to my current position at WHOI did not follow a typical academic trajectory—rather, the reverse! In 1979, I returned to Woods Hole with my new husband who had a position at WHOI. At that time, WHOI rarely hired its own students back so soon after they had graduated, so I began searching for a position elsewhere. Fortunately, I was offered a position at the Sea Education Association—an organization in Woods Hole that offers semester-long undergraduate programs focused on the oceans. I spent twelve years there—first teaching students on shore and at sea on board their large sailing research vessels, and later as Dean of the program. During this time of intensive involvement with students, I maintained an affiliation with WHOI as a way to continue my own research, albeit at a slow pace.

Realizing that I was no longer competitive for a full-time research position, and wanting to undertake a new challenge, I accepted a position at WHOI as coordinator of the NSF-funded RIDGE program. This was quickly followed by three years as Chair of the JOIDES Science Committee for the Ocean Drilling Program. I used these six years to reacquaint myself with the research world and build up my own research program. Not the most common way to do things, but in 1998, I was appointed a Senior Scientist.

In those 30+ years, the involvement of women in the field has changed dramatically. I was one of only two women graduate students in the Department, and often faced ships' crews hostile to having women on board. The Department that I now Chair has more women than men graduate students, and the shipboard complement and climate have changed dramatically. Today, not only do more women go to sea both as scientists and crew, but they often serve in senior positions, such as Chief Scientist and Ship's Captain.

Deborah R. Hutchinson

Research Geologist, Woods Hole Science Center, U.S. Geological Survey, Woods Hole, MA, USA, dhutchinson@usgs.gov

Unlike many members of today's mobile younger generation, I have had the good fortune of working for the same organization, the U.S. Geological Survey, for my entire research career. I was hired as an entry level Geologic Field Assistant, worked my way through two advanced degrees, and then climbed the USGS career ladder. As a new college graduate, one of my first duties at USGS was to move the new Branch Chief from temporary rented office space in the village to a new USGS science building on the recently opened Quissett campus of the Woods Hole Oceanographic Institution. Just over 20 years later, with many cruises and publications behind me, I moved into that same office as Center Director of a much larger, multidisciplinary workforce. Science management is not all glory; one of my first acts was to correct a mundane gender-related inconvenience: because women outnumbered men in our office building, I switched bathrooms so that men used the smaller pink room, much to the confusion of male visitors. Among my other challenges was restoring a focus on science and a trust in management following a difficult USGS reorganization.

My geology education began with mapping exercises in cow pastures in Vermont (B.A., Middlebury College), took a brief detour into an urban, lacustrine, and pre-Mesozoic setting (M.Sc., University of Toronto), then focused on geological oceanography (Ph.D., University of Rhode Island) and has continued with the life-long learning that is part of doing research in an international scientific community (Woods Hole). Most of my research has sought to understand the origin and evolution of the Atlantic passive continental margin and continental rifts in general; many ancillary interests developed along the way—gas hydrates, Quaternary history of large inland lakes, and crustal structure of the Precambrian shield around the Great Lakes. After rotating out of Center Director position, I now lead two projects: USGS Gas Hydrates and USGS Law of the Sea studies. I am also principal scientific advisor to the Coastal and Marine Geology Knowledge Bank project. None of these accomplishments would have been possible without the generous and unflagging support of my first-rate family.

My kind of sea state; my kind of scenery!

Anitra E. Ingalls

Assistant Professor, School of Oceanography, University of Washington, Seattle, WA, USA, aingalls@u.washington.edu

My research focuses on using the molecular and isotopic composition of organic biomarkers to understand the source, cycling, and fate of organic compounds in the present and past ocean. Ultimately, I hope my group will contribute to a greater understanding of Earth's response to the buildup of anthropogenic greenhouse gases.

I took a long, circuitous route to oceanography. When I started college I was an art major. I first took biology only to fulfill my required science credit. I was so inspired that I immediately switched my major to biology. Eventually my interests drifted more towards organic chemistry and biochemistry.

After receiving my undergraduate degree in chemistry, I moved back to New York City. There I found a chemical oceanography lab at Columbia University's Lamont-Doherty Earth Observatory, which was hiring a technician. I spent the next three years working as a research assistant with Jim Bishop and briefly with Bob Anderson. This was an amazing crash course in oceanography; I had the opportunity to be involved in research, attend numerous lectures, and sit in on Wally Broecker's geochemistry seminar.

Anitra at her home in Seattle.

So, I decided to go to graduate school in oceanography. I was fortunate to have Cindy Lee and Robert Aller as advisors, and to be able to build on my background in organic chemistry to study carbon preservation in marine sediments. Cindy and Bob were fantastic mentors. Then, as a postdoc I worked with Ann Pearson and Bob Anderson, broadening my interests into the fields of microbial metabolism and biomarkers in paleoceanography.

Oceanography is a rewarding career not only because of the interesting work we do, but also because of the personal and scientific interactions that are possible with such an interdisciplinary field. The interdisciplinary nature of oceanography presents challenges, however; it's important to have a solid grasp of many fields, as well as a very thorough understanding of your specialty.

Balancing an academic scientific career with my personal life has brought certain challenges. For example, it has required my spouse and me to move several times, which is exciting, but also demanding. Ultimately, it was all worth it. We're thrilled to have ended up in Seattle.

I think my cohort may have a higher percentage of women graduate students who go on to obtain faculty positions than in the past. While some colleagues have to make tough decisions in trying to balance careers and family, many women are choosing to remain in academia. I suspect that as society gradually adjusts to the fact that women are in the workplace to stay, there will be an even greater acceptance of the realities of women's lives.

Alexandra R. Isern

Program Director, Division of Ocean Sciences, National Science Foundation, Arlington, VA, USA, aisern@nsf.gov

The ocean has always played a big part of my life. I grew up in Florida by the ocean and spent most of my childhood on the beach. I lived many summers on boats in the Bahamas, and one summer I even worked a dive boat to help defray undergraduate tuition costs. Despite this love of the ocean, my road to wearing the label "oceanographer" was convoluted: it traversed three continents and was characterized by a sort of career "wanderlust." I seem to have picked up the tag "oceanographer" somewhere along the way since, no matter what I was doing, the oceans were always involved. No great insights or calling got me where I am now, just a series of events where I met interesting people who provided me with opportunities to do interesting things at times when I was ready for a change in direction. As such, I have a very mixed pedigree with publications in many facets of marine geology, although all of these generally have an emphasis on carbonate-platform and reef environments.

My professional experience is sort of similarly mixed, with time spent in academia, a nongovernmental organization, and now the federal government. I suppose my career path as an oceanographer is somewhat atypical, but the advantage of being an oceanographer, in my view, is the ability to move around, change direction, change focus, and always have the opportunity to find something interesting and challenging to do if you look for it. For someone with my lack of ability to sit still, an oceanographer is a great thing to be. Oceanography has also given me the opportunity to live all over the United States, and in Switzerland and Australia. Other disciplines could also have offered these options, but not with the ability to spend a month collecting geophysical data off the Great Barrier Reef in preparation for leading a 60-day Ocean Drilling Program leg drilling ancient reefs and platforms off northeast Australia, or the ability to explore ancient reefal systems in the Alps, the Dolomites, and in southern Spain. Few people get to see the places we do in the ways we get to.

These opportunities have come with challenges, and these challenges have also affected the directions I have chosen. I can say though that I have had great role models in both of my graduate advisors. Judy McKenzie and Margaret Leinen never let the challenges of being female in ocean science create barriers. They provide excellent examples of how to follow a successful path in our science as well as life in general by being yourself and being very good at what you do. For those women who are now embarking on careers in oceanography, excellent role models should get a great deal of credit for opening up doors to conducting exciting research on the oceans at a time when a diverse group of people is needed to understand and protect them.

As co-chief scientist on Ocean Drilling Program Leg 194, multitasking was an essential skill.

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Elizabeth Johns

Oceanographer, Physical Oceanography Division, Atlantic Oceanographic and Meteorological Laboratory, National Oceanic and Atmospheric Administration, Miami, FL, USA, libby.johns@noaa.gov

Mine has been an unusual career path, and I hope my story will encourage others to take "the road less traveled" (to quote the poet Robert Frost) and not be afraid of changing direction as one's life evolves.

Having graduated from Mount Holyoke College in 1976 with a B.A. in English literature, my plan, although then vague, was to become an environmental lawyer. Serendipitously, I happened upon a small brochure entitled *Careers in Oceanography*. By the time I finished reading the brochure, I found myself seriously considering the field of environmental science instead of environmental law, and marine science in particular.

I was the recipient of a fellowship from the National Science Foundation, which covered my first three years at the University of Rhode Island (URI). There, I found that my primary interest was observational physical oceanography, and I enjoyed the challenge of pursuing my Ph.D. work on Gulf Stream dynamics at URI under the guidance of Drs. Randy Watts and Tom Rossby. It was also there that I met my future husband, Bill Johns, another physical oceanography student.

Bill and I each defended our dissertations in December 1984, and relocated to the University of Miami (UM) as postdocs. A year later, Bill joined the UM faculty, and I accepted my present position as a physical oceanographer with NOAA/AOML, doing "blue water" studies of North Atlantic western boundary currents with Dr. Bob Molinari. Life quickly became very full for me, as Bill and I became the parents of three children in less than five years while simultaneously trying to establish ourselves in our careers.

By the time our third child was born, I realized that in order for me to balance the needs of my family and my career, something would have to give. I changed to part-time status with NOAA, although at the time this seemed somewhat risky in terms of professional credibility. I have now resumed a full-time work schedule, and looking back I do not feel that my part-time years have hindered my professional standing. This is likely due to the positive changes in attitudes regarding the work/family balance that have occurred in our profession over the past two decades.

In 1995, after careful consideration, I returned to my original plan of doing environmentally oriented oceanographic research. I am presently studying the coastal waters and ecosystems of South Florida in collaboration with Drs. Peter Ortner (AOML) and Tom Lee (UM), and biologists and fisheries scientists, with particular emphasis on predicting the effects of the Everglades Restoration on Florida Bay, Biscayne Bay, and the waters of the Florida Keys. One of our highest research priorities is to develop a realtime network of physical and water quality sensors for the region. We also strive to make our scientific results accessible and relevant to resource managers so that our efforts can provide aid in their decision-making. This type of research is extremely rewarding for me. At last I feel that I have found my "niche," and the right balance between my personal and professional life.

Libby (second from left) with her husband Bill and their three teenagers in front of their home in Palmetto Bay, Florida. Scott (19) is currently a sophomore at the University of Miami. Lisa (17) is a high school senior who will enter the pre-med program at the University of Miami in August 2005. Keith (15) is a high school sophomore who also plans to attend the University of Miami.

Leah H. Joseph

Assistant Professor, Environmental Studies, Ursinus College, Collegeville, PA, USA, Ljoseph@ursinus.edu

The first time I went out to sea was as an undergraduate on a three-week basalt-dredging cruise of the Easter Seamount Chain upon the R/V *Melville*. My advisor (Bob Poreda) had invited me late in the semester to join the second leg of this project as a replacement for someone who had been severely sick on board during the first leg. I jumped at the opportunity, despite the necessary consequence of sleeping in the library for a few nights trying to finish up my finals before the end of classes. I found that I thoroughly loved being out at sea and was "in my element" there. My interest in the field of oceanography deepened through a senior research project on the helium isotopes of the basalt glasses we had collected. Although my research interests have shifted to the field of paleoceanography/climatology in which I investigate climate change at different time periods and on different time frames using properties of deep sea sediment to reflect certain continental and oceanic conditions, this Valparaiso to Easter Island basalt-dredging cruise enhanced and secured my interest in oceanography by providing actual sea time and a real research experience.

Through readings, observations, and conversations, I suspect that the situation for women in oceanography (both on land and at sea) has improved towards more recent times. I am certain that the advances these women have made have smoothed my own path. However, significant progress still needs to be made before the field stops losing many of its female scientists for reasons unrelated to their ability and potential as oceanographers. Some of my greatest career challenges that have left me questioning my own career path have been in confronting intentional and unintentional prejudices and the repercussions from refusing to admit to myself that this prejudice exists in the field of oceanography/geology. I hope that I can serve as a resource for students in oceanography that may find themselves in similar situations so that they do not mistakenly doubt their own abilities.

I had the honor to visit with this tortoise on the island of Santa Cruz in the Galapagos Islands during a four-month trip abroad to South America with twenty-two of my college students. This was only one of the many amazing excursions we completed and although it was not easy, the overall experience, including watching the affect this abroad trip had on my students, is another potential reward of continuing on in oceanography as an academic.

There are many rewarding aspects to being an ocean scientist. It is always remarkable to be part of the functioning of a scientific research vessel, experiencing the excitement of bringing in the first core, watching the innovativeness of the crew when something goes wrong, hearing everyone's sea-stories and life-stories, and adapting to this relatively unique environment while working onboard with many other scientists and the crew towards a common goal. Each time I have been out at sea, it has been an amazing experience: from the awkward first day aboard, to the last day full of sad goodbyes, to the research and friendships beyond.

It is incredible to experience the sea in its many moods, switching back and forth, within hours, from calm, blue, and placid to huge, powerful, and intimidating. There is little as awesome as the power of the ocean.

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Samantha (Mandy) Joye

Associate Professor, Department of Marine Sciences, University of Georgia, Athens, GA, USA, mjoye@uga.edu

My scientific interests revolve around the role of microorganisms in elemental cycles. I'm particularly fascinated by the microbiology and biogeochemistry of cold seeps and hydrothermal vents, as these habitats serve as analogs for early Earth and thus may help us better understand early life on Earth. The research in my lab includes parallel studies of biogeochemical and molecular ecological dynamics with the aim of identifying links between environmental variables, microbial community composition, and microbial activity. In addition to working at seafloor cold seeps, we also conduct research in coastal and estuarine habitats. My attraction to science began in junior high school and when I entered college, I planned to go into medicine. During my third year at UNC-Chapel Hill, I took an oceanography course from Dr. Conrad Neumann. Conrad is an incredible teacher and I was hooked instantly on oceanography.

As oceanographers, we have opportunities to travel to exotic places, to go on cruises, and some of us have the chance to tour the seafloor in a research submersible. Sharing my experiences and the knowledge I've gained with students and the public, and seeing them get excited about the ocean and wanting to know more about it, is very rewarding. My greatest challenge is balancing my career with my personal life. Because I love my job, am captivated by the work I do, and am generally a high-energy person, it is easy for me to work too much. However, I do take time for myself. I am a horse enthusiast and I do dressage with my horse Fauré four or five times a week; I also enjoy going on hikes with my husband and dogs.

As women oceanographers, it is important for us to seek out and encourage talented young female scientists. There were no female professors in the department where I got my Ph.D. and I remember looking for information about women oceanographers so that I could learn about them and their work; I wanted a female role model and found one in Bess Ward. Today, many of my closest colleagues are women and I am in a department where almost 30 percent of the professors are female. While young women oceanographers may still face many of the issues others faced years ago, the main difference is that today, there are more female role models. The experience and confidence gained from interacting with and learning from such dynamic role models is invaluable.

Mandy Joye SCUBA diving along the west coast of Oahu, Hawaii. The sea turtle accompanied me for much of the dive, though I did not know I had company until I saw the pictures! Photo by Tom Mrowka.

Mandy Joye (left) in the forward compartment (the 'sphere') of the *Johnson Sea Link* research submersible going through the final on-deck checks prior to diving to the seafloor to collect samples from cold seeps in the Gulf of Mexico. Photo by Ian R. MacDonald.

Ellen S. Kappel

President, Geosciences Professional Services, Inc., Bethesda, MD, USA, ekappel@geo-prose.com

My career has taught me a little bit about a lot of things. I was trained at Lamont-Doherty Earth Observatory as a marine geologist specializing in mid-ocean ridge tectonics. But it has been more than a decade since I've gone to sea, and even more years since I have done any serious thinking about mid-ocean ridges.

Ellen's family hasn't failed to notice that she steers them away from the beach to vacations with dramatic topography and lots of hiking. Here, at 8,000 feet at Machu Picchu, Ellen seems happiest.

After receiving my Ph.D., I stayed on at Lamont as a postdoc. It was a busy year of writing papers and proposals, going to sea, and thinking about my next move. Always on the lookout for a good job opportunity, I read an ad in *Eos* and applied for a position as assistant program manager for the Ocean Drilling Program at Joint Oceanographic Institutions (JOI) in Washington, D.C. There weren't many openings in my field at universities (or so it seemed), and while I could have stayed on at Lamont, I had family in Washington. And, truthfully, I was feeling a bit burned out. I interviewed at JOI, was offered the job, and within a couple of weeks, I left Lamont.

At first I told myself, and all the other academics I came into contact with—who inevitably questioned why I was not doing research—that I would stay at JOI for two years and return to academia. Two years seemed to be some sort of unofficial deadline for rejoining the academic club. From the start, JOI generously allowed me to keep my hand in science, so I continued to go to sea on my own cruises by taking short leaves of absence. Roughly two years into my tenure at JOI I was offered an excellent academic position, and had to make a difficult decision. I enjoyed program management a lot, the work was important, and I was good at it. My biggest challenge was convincing myself that I wasn't a failure and that I wasn't letting down the mentors who prepared me to be a chief scientist. After some agonizing, I declined the academic job and stayed at JOI for what turned out to be 12 years. It took me at least three years to feel comfortable with my career choice and stop making excuses to everyone about why I left academia.

I am president and CEO (and only employee) of Geo Prose, where I assemble, edit, and publish documents for a wide array of geoscience programs. I learn many new things every day. I work with a wonderful graphic designer, Johanna Adams, who lives thousands of miles away in Arizona. My "office" is in my family room where my two English Pointers keep me company during the day. I am home when my two children get home from school, and have time to coach girls' sports. I sometimes get lonely for professional face-to-face interaction (my husband can always tell when I haven't spoken to an adult all day), but I haven't yet felt the need to go back to a traditional office job. More by accident than design, I've come up with a way to participate in cutting-edge science and live a well-rounded, wonderful life.

Lee Karp-Boss

Research Assistant Professor, School of Marine Sciences, University of Maine, ME, Orono, USA, lee.karp-boss@maine.edu

As child and young adult I spent most of my vacations exploring coral reefs in the Red Sea, but I never thought about oceanography as a career until my last year of college. I was a biology major intending to continue on in biochemistry. Out of curiosity, I took an oceanography class and got hooked. I was attracted to the complex interactions between biology and physics in the ocean. From flow effects on corals (M.S., Hebrew University, Israel) to phytoplankton hydrodynamics (Ph.D. University of Washington), physical-biological interactions remained the main theme of my research; only the spatial and temporal scales and environments have changed. My postdoctorate work, though, took a slight detour. I felt I was lacking field experience and went to get it at Oregon State University, studying particulate organic carbon dynamics in the upwelling system off Oregon.

My current research focuses on various aspects of phytoplankton ecology. One of my research goals is to advance understanding of the roles of cell size and morphology in the life of phytoplankton and how we can use morphological characteristics of phytoplankton to advance field measurements (i.e., optics). I find the interdisciplinary nature of oceanography very engaging and the continuous process of acquiring new knowledge and skills very rewarding. Most importantly, I enjoy being part of a supportive community. It would not have been a fulfilling experience without the inspiration and continuous support provided by colleagues, students, and my past advisors.

Recently, my nine-year-old son wrote, "In the 18th century women could not work but today women can have any job they want, they can even become oceanographers." I am sure lucky to live in the 21st century and I never felt that gender was an issue in my journey to become an oceanographer. My greatest challenge now is how to balance career and family. As a dual-career couple (both oceanographers) with three young boys, we face interesting challenges that require compromises—from finding jobs, through coordinating schedules and travel, to accommodating deadline pressures. I have been a research faculty member at the University of Maine since 2002. There are many aspects that I like about this position and it gives me a bit more flexibility in balancing career and family, but the lack of secure income is always a concern. The decision to have a family did influence the path I chose for my career and probably the pace at which it advances, but I wouldn't choose differently. Aside from tremendous joy, the boys help me keep my life balanced and my work in perspective.

Making waves with the next generation of oceanographers (Asa Adams Elementary School, Orono, Maine).

Jill Karsten

Education and Career Services Manager, American Geophysical Union, Washington, DC, USA, jkarsten@agu.org

I have made two important discoveries as a woman in the geosciences—over time, they have helped me maintain my sanity and humor.

My first discovery was that I was born a scientist. Growing up in a family of non-scientists, during a time when conventions regarding women in male-dominated fields posed invisible fences, the concept of "being a scientist" was not even in my consciousness. My "eureka" moment only occurred after completion of a geochemistry undergraduate major at Wellesley College and a Masters thesis on water diffusion in silicate melts at the University of Washington, followed by two years as an oceanography technician.

My first discovery was not prompted by a single event, but by accumulated experience. After my M.S. degree, I had shifted my focus from magmatic volatiles to mid-ocean ridge volcanism. The combination of sea-going field work and laboratory analysis of dredged rocks proved a happy marriage of my interests. Suddenly, I knew what I was doing. I could successfully argue with Ph.D.-level scientists! New confidence liberated a passion for science that had never before found its voice and I realized I would not be content until I had the doctoral pedigree that opened doors to scientific autonomy.

My dissertation investigated the tectonic and volcanic behavior of the Juan de Fuca Ridge (Northeast Pacific Ocean). New swath-mapping sonar systems provided unparalleled detail of the seafloor; it was exciting to participate in the rapidly evolving interpretations these images invoked. Tectonic complexities were revealed, and they cried out for exploration and explanation. Submersible dives were unforgettable capstone experiences of my graduate days.

My second great discovery—that the success of women scientists is only accurately measured when integrated over a lifetime—came a few years later. By then, I had married Rodey Batiza, another marine geologist. I was a research faculty member at the University of Hawaii at Manoa (UHM). My career as an independent scientist was on track—I was getting grants funded, going on research cruises as chief scientist, publishing papers, and advising students. And, I had a new son and two older stepsons. It doesn't take calculus to add up the various time commitments and see that Earth's rotations and revolutions are inadequate for getting all of these jobs done well.

By the end of my 12 years at UHM, I was an Associate Researcher, Chair of the Department's Graduate Admissions Committee, and I served on several scientific committees. My study area had migrated a hemisphere away to the Chile Ridge, where I continued to explore mid-ocean ridge behavior, in collaboration with Emily Klein. But, my priorities were always clear: family first. At times, my progress was slowed and, occasionally, important research opportunities were lost because of their impact on the family. But, I do not dwell on those choices.

Currently, I'm on hiatus from research. In 2000, we moved back to the mainland, to spend more time with family. My trajectory is still shifting and the ultimate outcome is unknown. But, my early career discoveries reassure me that I am on the right path and, when I reach its end, I will have been successful.

Miriam Kastner

Professor, Scripps Institution of Oceanography, La Jolla, CA, USA, mkastner@ucsd.edu

I grew up in Jerusalem, Israel and came to the United States for my Ph.D. studies and research. At the Hebrew University, Jerusalem, I completed my M.Sc. degree in geology, plus a minor in chemistry. At that time, some women students and professors were present in every science department at the Hebrew University. During my first year there, I was also enrolled as a student at the Jerusalem Music Academy, and played violin in the university orchestra.

For my Ph.D. degree I was interested in pursuing sediment geochemistry, and clearly at that time, the department at Harvard University had the best team in the world in this field: Bob Garrels was the Department chair and Ray Siever was on the faculty. Because of the uniquely strong Harvard team in sedimentary geochemistry, despite the fact that I was informed that the Earth Sciences Department only once in a while accepts a woman student (at the time that I applied there were none, and no women faculty members), I decided to apply; I was confident that despite my gender, my Hebrew University transcript would prevail. Indeed, I was accepted with full scholarship, and also received a travel Fulbright grant to the United States. Only upon my arrival at Harvard did I realize how large the "cultural differences" between the Hebrew and Harvard Universities were. Because of my background, the fact that I was the only female student in the department during my first three years at Harvard, did not concern me; I simply considered it as an interesting, odd cultural phenomenon. Being able to work with Bob Garrels and mostly Ray Siever (Garrels left Harvard after two years), was what I came for and it was exciting and a pleasure to work with both.

After one year as a Postdoctorate Fellow at the University of Chicago, I joined the faculty of Scripps Institution of Oceanography; I was the first woman faculty member at Scripps (at that time the faculty consisted of ~60 professors). It was an interesting challenge. I enjoyed it, and most of the Scripps faculty members were supportive. Presently, with at least 50 percent female Ph.D. students, the faculty consists of less than 15 percent women professors. At Scripps, a great place to work, I particularly enjoy the very bright students Scripps has, the great interdisciplinary faculty, and the opportunities of working at sea.

My involvement in music continued, as well as my interests in history, archaeology, and in visiting different cultures.

Early in my career as a professor at Scripps, I was often the first woman on most national and international committees. In this capacity I have encountered many fascinating and curious situations, which I am hoping to describe some day. I am pleased to see how things have changed, especially in the past 15 years, and I am hoping that gender concerns in the field will soon disappear.

Deborah S. Kelley

Associate Professor, School of Oceanography, University of Washington, Seattle, WA, USA, kelley@ocean.washington.edu

One of the most satisfying and compelling aspects of oceanography is that it is inherently interdisciplinary. As part of the Extreme Environments research group at the University of Washington, the Astrobiology program, and through participation in the Neptune project (http://www.neptune.washington.edu/), I have a wonderful opportunity to partake in a wide range of interdisciplinary science and outreach projects focused on examining the links among submarine volcanoes, seafloor hydrothermal systems, and the life that they support. It is an incredibly exciting time because of the significant opportunities for important new discoveries still to be made about crust-ocean interactions and life. In addition, a large component of this research forms a critical foundation in guiding us towards exploring for life on other planets.

Although I started our my career as a traditional "hard rock" geologist studying fossilized submarine magma chambers, over the past two decades I have metamorphosed into an odd cross between a geologist, chemist, and fledgling instrument developer with a yearning to understand microbiology. I took a tortuous path to get here, however, having started out my career as an oboe player that transitioned into graphic design.

Part of my current research seeks to understand the conditions under which life thrives, survives and expires within the dynamic environments of submarine hydrothermal vents. This project includes development of an *in situ* microbial incubator that measures environmental conditions inside the walls of black smoker chimneys and allows newly colonized microbes to be recovered. It is part of an intense long-term observatory effort at the Juan de Fuca Ridge (http://www.ridge2000.bio.psu.edu/). This area hosts the most robustly venting hydrothermal system known in the world's oceans and our group has been studying this site for more than 20 years. One of my greatest joys is going to sea with my colleagues and graduate students to this area and studying its seafloor ecosystem through use of robotic vehicles and the submersible *Alvin*.

One of the projects I am most excited about is investigating the Lost City Hydrothermal Field on the Mid-Atlantic Ridge, which we serendipitously discovered in 2000. It is a place of ghostly beauty, hosting carbonate chimneys that tower 60 m above the surrounding seafloor. In 2003, I led an expedition for the first detailed interdisciplinary investigation of this remarkable place (http://www.lostcity.washington.edu/). Ten students dove to the seafloor in *Alvin*, many for the first time. Bathed in hydrogen- and methane-enriched warm fluids, the chimneys are home to a rich community of novel microorganisms and larger animals. For me, this discovery emphasizes that there is much left to be discovered about our planet and the oceans that it hosts.

This photo highlights the sharp contrasts between black smoker chimneys from the Endeavour Segment, Juan de Fuca Ridge, Northeast Pacific Ocean (a "intermediate-spreading" ridge) and carbonate towers of the Lost City Hydrothermal Field at 30°N on the Mid-Atlantic Ridge (a "slow-spreading" ridge). The smoker sample shows an inner, chalcopyrite-lined channel of a 300°C, vigorously venting chimney from the Endeavour Segment. The white carbonate sample is from a diffusely venting, 50°C structure at Lost City. Young chimneys at this site are extremely porous, and their interiors are bathed in hydrogen- and methane-rich solutions with pHs of 9 to 11, which provide habitats for novel microorganisms.

Stacy Kim

Adjunct Professor, Benthic Lab, Moss Landing Marine Laboratories, Moss Landing, CA, USA, skim@mlml.calstate.edu

I've found that in science, the most important thing is to take advantage of opportunities that are available. The research I pursue is mostly due to fortuitous chances that narrowed my broad interest in oceans and biology to disturbance ecology in benthic communities. Opportunities for field work during high school and undergraduate classes centered me on ecology; mentors during graduate school helped me focus on the societal relevance of research that eventually led to my interest in the role of disturbance regimes and human disruption. It is very difficult to find locales that humans have not impacted directly, and impossible to find areas we have not affected indirectly via global changes. By working in remote regions such as Antarctica and the deep sea, I strive to understand the ecology of anthropogenically undisturbed benthic communities, and the role of natural disturbance regimes as well as the effects of human disturbances. The Ross Sea in Antarctica may be the only remaining "whole" ecosystem in which both top down and bottom up forcing are functioning in evolutionarily established balance.

When I meet with potential graduate students, I always emphasize that though it's unlikely that they'll get rich as marine scientists, they have the opportunity to pursue the most satisfying career imaginable. There are so many big, basic issues that we still do not fully understand about the oceans—the consequences of killing off top predators, for example—and the unknowns are very pertinent to our lives. And in the ocean sciences, we live and work in some very beautiful locations. But for me, the best thing about my work is that it is a balance between a mentally challenging, physically demanding, and spiritually fulfilling job. Though it has been tough to find a job within the constraints of family, it was my choice to be responsible to family obligations. Creativity, stubborn persistence, and the support of an unconventional group of individuals have allowed me to create an individualized path despite institutional resistance. The fascinating and brilliant people I work with, and who have become my friends, add zest to an already gratifying career.

At the institution where I began my graduate work, female students were always well accepted though there were no role models. This lack was not recognized by anyone (including myself) as a deficiency. By the time I finished my graduate career (and at a different institution), there were many more examples of female scientists, and they offered diverse models ranging from "how to be an excellent scientist and mentor" to "how to minimize competition by discouraging graduate students." Seeing the examples of various paths set by these women opened up a realm of aspiration (and avoidance) that was otherwise unimaginable. As women reach parity at all levels of science, they offer guidance and allow us to set higher goals for ourselves.

Stacy Kim prepares for a dive under the ice in Antarctica. Her research at McMurdo Station focuses on recovery dynamics of benthic communities, using an experimental design that takes advantage of the installation of a sewage treatment plant as a large-scale manipulation to additionally test scaling arguments.

Emily M. Klein

Professor of Geology, Nicholas School of the Environment and Earth Sciences, Duke University, Durham, NC, USA, Ek4@duke.edu

My research interests focus on the generation and evolution of the oceanic crust at mid-ocean ridges. The creation of new oceanic crust is the dominant magmatic process occurring on our planet today, leading to the generation of sixty percent of Earth's surface. As a geochemist, I contribute to this field by using the major element, trace element, and isotope geochemistry of mid-ocean ridge basalts to explore the processes by which melt is generated in and segregated from the mantle and evolves to form the crust. My research involves fieldwork in the form of sea-going mapping and sampling investigations, chemical analyses, and theoretical modeling of the data in light of pertinent geophysical and geological information.

I came to this field of study in a rather roundabout way. As an undergraduate, I was interested in both literature and science, and considered merging the two to become a science writer. After receiving my undergraduate degree, financial pressures compelled me to take employment as a technician in a medical research laboratory. Through that experience, I discovered that I loved basic scientific research. Through a fortuitous set of circumstances, I was able to merge my interest in basic research with my desire to explore the world. So, I took courses in geology, applied to graduate school, and despite my odd background, was accepted at Columbia.

I find two aspects of ocean sciences particularly rewarding. The first is the fundamental excitement of exploration: going places and seeing things that no one has before. The second is to be among the first generation of women to do this as a regular part of our work: to lead expeditions and to train the next generation of ocean scientists.

My greatest challenge has been balancing my personal life and career. Raising children has surely reduced the number of my publications, as it does, I believe, for many women scientists. It is for that reason that I support the approach taken by Duke University (where I am a professor) and other institutions, in which candidates for tenure are evaluated on the basis of their research impact rather than number of publications. In regard to the impact of my work on my family, I have consciously limited the amount of time I spend at sea. I am fortunate to have a husband who is supportive of my work and willing to be a single parent while I am away.

Over the 20 years of my career, the conditions for women in my field have changed in some ways but in other perplexing ways they have stayed the same. On the one hand, women now typically comprise about half of the graduate students in ocean sciences as well as half of the scientific party on-board ship. On the other hand, I was the first woman hired in my geology department at Duke, and 15 years later there are only two of us. While we seem to graduate equal numbers of female and male Ph.D.s in my field, women choose to leave the field in greater numbers, for reasons that I do not entirely understand. In chatting with female graduate students about this, I have tried to emphasize that while one must work hard as a scientist, it is a wonderful profession to merge with family and motherhood because of the great time flexibility that the academic life allows.

Emily Klein, Co-Chief Scientist on board the R/V *Atlantis*.

Michelle Kominz

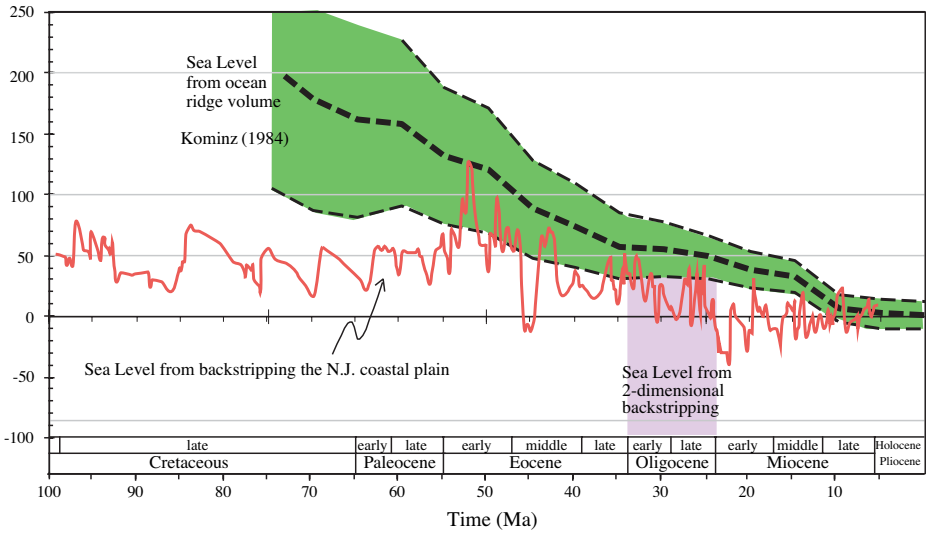
Associate Professor, Department of Geosciences, Western Michigan University, Kalamazoo, MI, USA,
michelle.kominz@wmich.edu

As an oceanographer I am quite unique in that I do not go to sea. Not everyone would aspire to this distinction, but I really have had a lot of fun doing it. For example, I have done some of my oceanography at 5,000 ft. in the Canadian Rocky Mountains. That is where I helped gather data to study the Cambrian passive margins. Some 500 million years ago these sediments were deposited offshore on a coastline that resembled the current U.S. east coast. Our work helped to establish the breakup of a super-continent some 540 million years ago.

I like to attack "big problems" and this means that I do most of my work at the computer. I am currently trying to determine how the volume of Earth's ocean basins changed over the last 140 million years. This is a very big question and requires huge data syntheses as input. Many ocean scientists spent years collecting magnetic, gravity, bathymetry, and sediment thickness data while others methodically collected porosity data from sediments while sailing with the Ocean Drilling Program. Others developed models of plate spreading for a specific ocean and/or continental breakup and collision. All of these data must be re-assessed and quantified to fit into the large picture of ocean volume change. Anyone who is collecting the data does not have time to engage in such a broad problem. Thus, it is my problem because I want to know if variations in ocean volume caused sea-level changes and I want to know if variations in oceanic volcanism affected atmospheric carbon dioxide.

I also like to find new ways to approach difficult problems. For example, as a graduate student I used a method called "backstripping" to quantify past sea-level change. At the same time, a new paradigm, sequence stratigraphy, was introduced that was also used to estimate past sea level. Both methods made considerable sense but were pretty much incompatible. I decided that if both had merit then there had to be a way to integrate the two and come up with a much better method. I found one location where the quantitative data required for the new integrated method was possible—the Oligocene (about 24 to 35 Ma) sediments beneath the coastal plain of New Jersey. So I have a pretty good idea of what sea level did for about 11 million years. And I hope that everyone knows that if they collect enough data, it is possible to calculate sea-level change.

I will always have questions to try to answer and challenges to tackle. And there are more than enough problems for many Earth scientists to devote their careers to seeking to understand how our Earth works and its history. Being a woman in oceanography is great! You are more likely to get your own room at sea. You are always noticed and people always remember who you are. I don't worry about being a "nerd" or being too "aggressive." We are all a little intimidating (both the men and the women) once we have our Ph.D.s, our classes to teach, and our own scientific agendas.



The two sea-level curves show the differences between the resolution of the backstripping and integrating the volume of the ocean basins. The Oligocene backstripped result is based on two-dimensional backstripping, while the rest of the results are from one-dimensional well data. The two curves should be compatible. The divergence before about 52 million years ago indicates that there is a problem. This is one reason why I am working to re-evaluate the ocean volume through time. Data are from Kominz, M. 1984. *American Association of Petroleum Geology Memoir #36,* p. 109-127 and Van Sicket et al., 2004. Basin Research 16:451-465.

Carina B. Lange

Professor, Department of Oceanography, and Director, Center for Oceanographic Research in the eastern South Pacific (FONDAP-COPAS), University of Concepción, Chile, clange@udec.cl

My principal research interests lie in the fields of paleoclimatology and paleoceanography. I use the micropaleontological records of plankton communities (mainly diatoms) encoded in the marine sediment archive to study past ocean productivity and climate over time scales of decades to hundreds of thousands of years. In order to use the fossil record to interpret past climatic conditions, I find it crucial to assess the quality and accuracy of the information preserved in the sedimentary record. The expertise I gained from working on projects dealing with the transformations associated with the settling of biogenic material from the uppermost layers of the ocean to the seafloor was of uttermost importance for venturing into the geological record to explore the long-term history of productivity in the ocean.

I was born and raised in Buenos Aires, Argentina. My first degree was in biology from the University of Buenos Aires followed by a doctorate in marine biology. I am very fortunate to have had a number of wonderful mentors and collaborators in my career. Even before my Ph.D., a series of short- and longer-term stays with Professor Grethe Hasle at the University of Oslo in Norway shaped me to become an expert in marine diatoms. A UNESCO scholarship took me to the Scripps Institution of Oceanography in California in 1984, and what was supposed to be a one-year stay turned into almost eighteen years of hard work and exciting research on laminated Quaternary sedimentary records. Wolfgang Berger was a generous mentor while I worked at Scripps; he is responsible for initiating the thrilling transformation in my career from a marine biologist to a paleoceanographer.

After all those years in the United States, I returned to South America in 2001 (I have closed the loop!), joining the University of Concepción's Oceanography Department in Chile as an Associate Professor in charge of developing the area of geological oceanography. I am now a full professor in the department, and the new Director of the Center for Oceanographic Research in the eastern South Pacific (COPAS) hosted at the University of Concepción. As a professor, the most rewarding part of my work is teaching and supervising graduate students. As a newcomer to the arena of science management, I am still in the process of learning that I do not have much time to do research myself and that my new responsibility involves working to make possible the science of the creative and productive researchers around me.

Carina with son Alexander enjoying a Sunday afternoon at Concepción Bay, Chile.

Balancing career and personal life remains a challenge and I still struggle to find the time and energy (especially) to accommodate both academia and family responsibilities. My family includes a wonderful eight-year old boy, Alexander, and a seagoing spouse who still commutes between California and Chile.

Alicia M. Lavín

Research Scientist, Instituto Español de Oceanografía, Centro Oceanográfico de Santander, Spain, Alicia.lavin@st.ieo.es

My main research interest is related to water mass characteristics and their temporal variability. I am interested in other topics in physical oceanography as well, such as air-sea interactions, marine dynamics, and the new field of "operational oceanography." It took me a long time to decide what I wanted to study, but once I found it, I knew immediately that water masses analysis was what I wanted to do. After 14 years of working on related matters, I had the opportunity to get a master's degree in oceanography in United States, to participate in interesting cruises, obtain exciting results, and continue with my research.

The large number of interesting scientists that I have met is the most rewarding part of being an oceanographer. It seems to me that everybody likes to help each other, and collaboration seems to be greater than competition. Also, nice human relations develop during oceanographic cruises. You have the opportunity to meet people that otherwise you would never meet. Life during cruises is a vivid experience that generally makes you feel closer to the others who are sailing with you.

Finishing my master's degree in oceanography took an extraordinary effort, but somehow I managed and finished it. Afterwards, I worked toward obtaining my Ph.D. That, too, took a great effort on my part, but I finished. After those academic challenges, I took on professional leadership in my research group and in international meetings. My group needed a leader and I was asked to become one. That was fine, but it was in the international context where I improved my organizational skills, which has enabled me to conduct my group even better.

Balancing my career and personal life has been tough. I balanced them for a long time, but as of a few years ago, it has been getting more difficult as both career and family seem to demand more of my time. I now feel the need to reduce the amount of time I put into my work. If I wait too long to decide, it might be too late.

There were no women in my area when I began, only one very senior woman who retired upon my arrival. Even now, I do not know why, but there are very few women in physical oceanography. It is necessary to improve the recruitment of women. I do not know how, but it is necessary.

Alicia Lavín with Instituto Español de Oceanografia colleagues J.M. Cabanas and G. Díaz del Río prior to launching an Argo float on board the R/V *Cornide de Saavedra* in September 2003 near 45°N, 9°W in the southern Bay of Biscay.

Dawn Lavoie

Associate Program Coordinator, Coastal and Marine Geology, U.S. Geological Survey, Reston, VA, USA, dlavoie@usgs.gov

I have been the associate program coordinator for the Coastal and Marine Geology Program at the U.S. Geological Survey since 2002. The Coastal and Marine Geology Program supports a broad portfolio of activities related to coastal hazards, marine resources, environmental issues, and instrumentation, and data management. Prior to coming to the USGS, I spent a year on detail to the Office of Naval Research where I managed the Geology and Geophysics Program.

The bulk of my career has been spent at the Naval Research Laboratory (1982-2002) where I was a Research Marine Geologist. My early years were spent at sea and in the laboratory characterizing geotechnical and geoacoustic properties of siliciclastic and carbonate sediments. These studies were in support of acoustic modeling efforts during the blue-water years when the U.S. Navy was concerned about antisubmarine warfare. With the demise of the Soviet Union and the increasing emphasis on shallow-water (shelf depths) environments, my research turned to the influence of early diagenetic alteration on sediment properties and microstructure. My seagoing activities also changed from research requiring weeks at sea on T-AGORs, U.S. academic research vessels, and the Ocean Drilling Program's drillship *JOIDES Resolution* (Legs 101 and 135) to shorter sampling and experimental activities on smaller vessels in nearshore environments. During my shallow-water phase, I used scanning and transmission electron microscopy to qualitatively characterize sediment; image analysis to quantify microfabric elements; and discrete element modeling and effective medium theory to predict compressibility and permeability. Knowing that sediment response to the environment is a function of biology and chemistry as well as physical processes, one of my major accomplishments was to build a biogeochemistry team that is now conducting outstanding interdisciplinary research within the Naval Research Laboratory.

I obtained a B.A. in sociology from the University of New Hampshire and a M.A. in counseling from the University of Rhode Island. After working as Dean of Women at a small Catholic Women's College in Wakefield, Rhode Island, now no longer in existence, and as a rehabilitation counselor for the State of Rhode Island, I decided to follow my husband both into oceanography and to the Naval Research Laboratory located at Stennis Space Center in Mississippi. I obtained a M.S. in geology from the University of New Orleans where I learned to love the Louisiana wetlands, and a Ph.D. in oceanography from Texas A&M University where I was heavily influenced by Dr. William Bryant. He continues to impress me with his ability to see how the pieces of the marine world fit together.

Dawn Lavoie: At play on the S/V *Dawn Treader*, a 30-foot Baba, sometime during the late 1980s.

Margaret S. Leinen

Assistant Director, Directorate for Geosciences, National Science Foundation, Arlington, VA, USA, mleinen@nsf.gov

In what seems like the blink of an eye, I have moved from being someone who read about the three or four "women in oceanography" of my graduate student days (the mid-1970s), to working in a community with many established—and powerful—women in oceanography. The many profiles of women in this issue of *Oceanography* magazine are an inspiration to me!

I struggled with what to discuss in my profile, and finally settled on answering one of the questions that I'm asked most often: "What motivated you to move from a realm of envy (sea-going, full professor) to a realm often ridiculed (science administration—which equals brain death, or, if you can't teach, administrate)?"

My first foray into administration was a half-time position as Associate Dean, University of Rhode Island Graduate School of Oceanography. It was Bob Duce, then Dean, who first brought me over to "the dark side." My concern at that time was for the graduate students and for curricular evolution. In that position I could still mentor students, do research, and go to sea.

When I was asked to consider full-time administrative positions, I agonized about whether I would enjoy them. One of my close colleagues, John Delaney, kept pointing out that I seemed to get as much satisfaction from making it possible for others to do their science as I did from doing my own. Even more important, he spoke about valuing this asset. As time went on and I accepted more administrative responsibility, becoming Dean, I realized that administering science exercised all of the same muscles as doing it. But the scale or focus was different. Instead of worrying about the situation for my own students, I worked to improve the situation for all graduate students. Instead of worrying about funding for my own lab, I developed strategies to increase funding for my institution. Instead of "selling" my own science ideas to reviewers and program officers, I argued within the university and to other funding sources for the ideas of an entire institution.

Many have said to me that the most important sacrifice in going into administration must be giving up the creative side of research—"connecting the dots" to result in a new insight about the oceans. I think that most scientists substantially underestimate creativity in administration. There are individuals in science administration who are not very creative. But there are individuals in science who aren't very creative as well. The people I admire most in science administration are extremely creative. They read widely, not only in science, but in world affairs. They explore and challenge the ideas that are coming from the community. They see opportunities as a result of developments outside their fields, challenge the community to incorporate these results, and think of innovative ways to communicate the excitement and importance of science to non-scientists. Finding a creative way to remove an obstacle to science is satisfying. Seeing another administrator or a legislator become excited about a scientific opportunity and endorse it for funding as a result of one's work is very rewarding. Seeing the community take advantage of an opportunity that wouldn't have been there without your work is a legacy, even if it is not a publication with your name as first author. Oceanography has benefited by many creative administrators over the years and I was blessed to have one of them, John Knauss, as a mentor. They are powerful role models for those of us in administration. As you think about your future, consider the importance of opening opportunities to others: lead by making the road rather than traveling it.

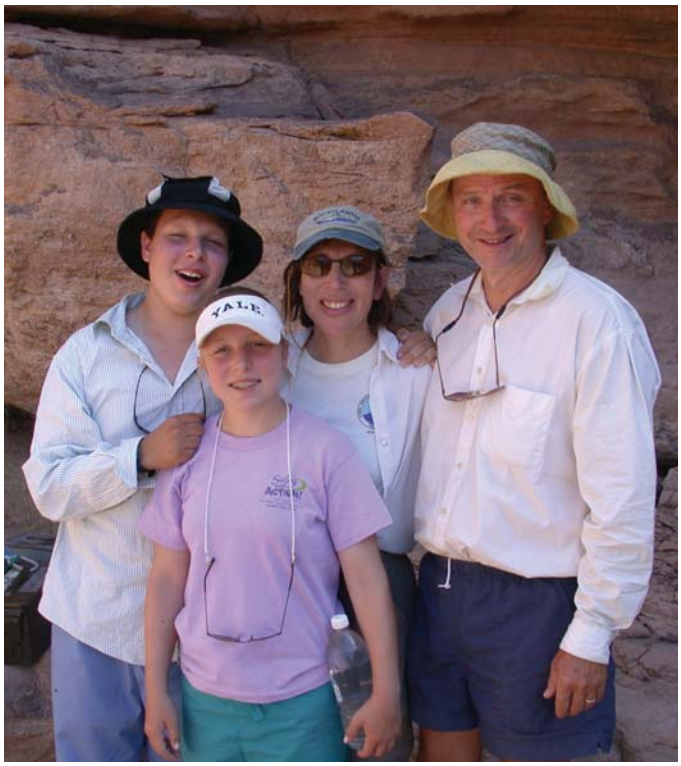
Lisa A. Levin

Professor, Scripps Institution of Oceanography, La Jolla, CA, USA, llevin@ucsd.edu

I am one of those people who never stopped playing in the mud. I dig, probe, and sieve to explore the ecology of invertebrate communities inhabiting muddy sediments in ecosystems ranging from the deep sea to intertidal salt marshes. Of particular interest has been community response to stress: natural hypoxia on continental margins, sulfides at methane seeps, and organic enrichment in wetlands. Another favorite theme is the significance of invertebrate life histories for population dynamics, connectivity, and recovery from disturbance. Polychaetes and giant protozoans (xenophyophores) are among my favorite study organisms. While some find my propensity to keep one foot on shore and the other in deep water a bit schizoid, I argue that the same principles guide animal adaptation in sediments at any water depth, and for both basic and applied research.

My fascination with marine organisms began at the age of 16, during an NSF-sponsored summer course at Humboldt State University. Nurtured and inspired by pivotal biology instructors in high school and college, the decision to become a biologist was easy. But it took a full year of consulting work in the "real world" to convince me that graduate school was the only way to learn enough to make a difference. After graduate school at Scripps Institution of Oceanography (UCSD) and a postdoc at Woods Hole Oceanographic Institution, I spent my early academic career at North Carolina State University in Raleigh. In 1992 I returned to UC San Diego. Throughout this journey I have been blessed by a very supportive husband, two amazingly talented children, and a wonderful set of peers, colleagues, graduate, and undergraduate students.

Travel to remote parts of the ocean, friends around the world, and daily discoveries make oceanography the most wonderful career I can imagine. Peru, Chile, Mexico, Oman, Pakistan, and Alaska are but a few of the regions whose seafloors I have come to love. Over the past decades, email and the Internet have been truly enabling technologies, making global collaboration a reality, but also accelerating the demands on my time. Finding time is the perpetual challenge—time to raise kids, to nurture graduate students, to improve class lectures, and to think and write! Travel is a must in this job—for me it is both the most enjoyable and most conflicted of activities—thrilling adventures come at the cost of missed childhood milestones. Despite the many pressures and conflicts, I feel among the most fortunate. I have had access to newly opened doors throughout my life, participating in the first truly coed year class at Radcliffe/Harvard, and entering the academic workplace at a time of recognition that women faculty enrich the community. Unfortunately, those once wide-open doors sit ajar. With so many female oceanography Ph.D.s produced in the last two decades, one can only wonder why they are still so underrepresented in the academic workforce. Can we do more as mentors?



Lisa Levin, husband David Checkley, son Garen, and daughter Laura on the shores of the Colorado River, midway through a rafting trip.

Beate Liepert

Doherty Associate Research Scientist, Lamont-Doherty Earth Observatory, Palisades, NY, USA, liepert@ldeo.columbia.edu

I grew up in a village (Meitingen) in Bavaria in southern Germany where there are many wonderful castles. When asked what I would like to be as an adult, I always answered that I wanted to be a tailor like my grandaunt Tante Lina. As a child I could spend endless hours on my aunt's sewing machine next to her concentrating on complicated stitches and creating fantasy clothing. I admired Tante Lina's undisputable sense of style ("never wear green and blue together"), and her independence and power over the taste of her customers. She was the center of social life in her village but never married and had no children.

As an atmospheric physicist I study climate change and the expected human influence of greenhouse gases and aerosols on climate, particularly the energy and water budget at the surface. I am interested in feedback processes of clouds and interactions between atmosphere, ocean, and land. The effect of "global dimming," which I helped discover, might sound familiar. My research is mainly theoretical, doing substantial data analyses. More recently my interests have been experimental, with observations of radiative properties of the atmosphere.

What has sewing and my aunt to do with my scientific interests? Sewing is about measuring and putting pieces together, creating patterns or seeing patterns. Style is what happens if all the work comes together as one thing. Earth system science in the broadest sense reminds me of this idea. Arguably, my talents and preferences affect my science and I believe they make it more unique and creative. And my life reminds me of my aunt's life. Nowadays, I can spend endless hours in front of my computer trying to find things out putting things together stitch by stitch in a virtual world. Still, I love fabrics and cloth and spend too much money on them. I even brought my Swiss sewing machine ("every woman has to have a sewing machine") all the way from Europe to New York.

Ironically my mother in the village called me one day last summer and told me that in her local newspaper is an article about "global dimming" describing that US scientists discovered that the world got darker. She thought of me and thought this might interest me. Well, I told her that I am the US scientist...

Sometimes I wonder what my life would have been like had I become a real tailor. Would I live this typical New Yorker-single woman life? I guess so. I might have gone into theater or the arts and might have ended up on the same street, namely, on Broadway, only several blocks further downtown from Columbia University and NASA Goddard Institute for Space Studies. Now and then, when I print out these colorful plates from climate simulations or observational maps and look at the pattern of the pressure fields I see "green and blue together" and laugh...

Frances Lightsom

Supervisory Oceanographer, Woods Hole Science Center, U.S. Geological Survey, Woods Hole, MA, USA, flightsom@usgs.gov

I currently serve as Project Chief for the Knowledge Management Project of the U.S. Geological Survey's (USGS) Coastal and Marine Geology Program, and group leader for information science and information technology at the USGS Woods Hole Science Center. My groups develop systems to serve and preserve scientific information: digital library, map server, databases, Web sites, archives. Within the Center, we support the computer, information, and publications aspects of scientific research. I am also responsible for oceanographic time-series data, including the data archive and the people and programs that process the data.

While balancing career and family over my lifetime, I emphasize one or the other as appropriate at each life stage. For the last 20 years, I have been the primary caregiver for my children. Although family responsibilities prevented me from pursuing a standard oceanographic research career, the challenges of parenting led me to develop the skills, values, and approaches that are especially mine. Parents learn to do what needs to be done, even when it's neither fun nor our area of expertise; to set priorities, accept risks, and balance competing benefits; and to work toward results that will be decades and generations in arriving. Parenthood is intensive on-the-job training in supervising lovable people with difficult personalities and immature skills. And the experience of repeatedly wondering, "Why do I even bother?!" develops a practice of discovering and clarifying the larger purpose behind daily activities. These lessons are valuable preparation for a position that involves managing multiple complex projects that cannot be abandoned.

Fran Lightsom (center) looks at time series of ADCP current profiles with coworkers Polly Hastings and Sarah Swift. (Data are displayed in beam coordinates, and were recorded by a bottom-mounted instrument in about 10 m of water near Myrtle Beach, South Carolina.) Photo by Dann Blackwood, USGS.

My current position is especially rewarding because it contributes directly to a larger purpose: our civilization's shift to a wiser relationship with the natural world. Scientific discovery alone is not sufficient to create a better way of living; what we learn must also be available and useful outside the scientific community. Achieving this is a major focus of my current position. In addition, a better world will depend on institutionalizing more respectful and loving ways of interacting, not just with other people, but also with the other creatures and systems with which we share the world. Working as a manager and supervisor gives me an opportunity to help develop new institutional structures and to put these values into action. For fun, my job also includes the activities and discoveries of observational science, and the mental pleasures of puzzle-solving and applied mathematics, which attracted me to oceanography 30 years ago.

M. Susan Lozier

Professor, Earth and Ocean Sciences, Duke University, Durham, NC, USA, s.lozier@duke.edu

When I was a graduate student studying chemical engineering at the University of Washington, a professor of an applied mathematics course repeatedly used examples from geophysical fluid dynamics to illustrate applications for differential equations. I never looked back. I was hooked from the start on the material, but now, through the years, it is a community of scholars, colleagues, students, and friends that has me hooked. Though I take pride in my individual research, I am keenly aware that the support of the physical oceanographic community has been invaluable to my work. In particular, I was fortunate to have had great mentors at UW, as a postdoc at Woods Hole Oceanographic Institution, and as a new faculty member at Duke. In appreciation of such support, I recently initiated an effort to promote community-wide mentoring of junior women in physical oceanography: our community is strengthened by our commitment to one another.

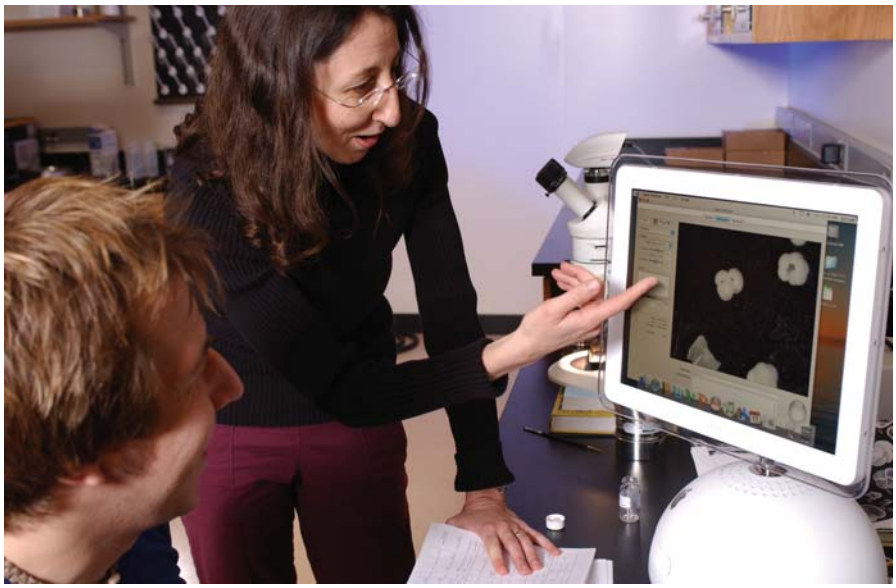
In physical oceanography, my research interests center on the structure and pattern of an ocean basin's flow and property fields, with a specific interest in how active and passive tracers are distributed from source regions. The application of my work has focused on the North Atlantic basin; a current field program focuses on Labrador Sea Water pathways, while a recently funded modeling project focuses on the climatic variability of the Mediterranean overflow waters. My work is greatly enhanced by my role as an educator. Teaching is no longer something I do: it is something I relish. I could not be more serious about my role as an educator or more grateful for the opportunities and satisfaction it brings.

My professional path has been decidedly shaped by my personal life. Though I am a researcher and an educator, I am also a wife and a mother of two teenage boys. I left Seattle in 1989 with a new degree and a new baby to head to WHOI for a postdoc and then, two years later, I left WHOI for a faculty position at Duke with another baby in tow. I've spent the last sixteen years balancing the needs of my family and the demands of my work. Long ago I realized that dedication to my career was not going to be measured by the number of hours that I spent at work. Rather, I have chosen to express my dedication by approaching my work with a commitment to my science, my colleagues, and my students.

Susan Lozier received her Ph.D. in 1989 from the University of Washington; the first woman to graduate from the physical oceanography program. Following postdoctoral studies at WHOI, she joined the faculty of Duke University in 1991, where she is now a full professor and holds the Truman and Nellie Semans chair in Earth and Ocean Sciences. Susan received an Early Career Award from NSF in 1996. She teaches undergraduate and graduate courses at Duke and is currently the Director of Undergraduate Studies for her department and an adjunct scientist at WHOI. Though her work has primarily focused on data analyses and modeling, now that her children are older she is enjoying heading out to sea once again.

Jean Lynch-Stieglitz

Associate Professor, School of Earth and Atmospheric Sciences, Georgia Institute of Technology, Atlanta, GA, USA, jean@eas.gatech.edu



Jean Lynch-Stieglitz discusses the identification of planktonic foraminifera with graduate student Tim Nowak. Photo credit: Georgia Institute of Technology/Nicole Cappello.

I am a paleoceanographer, working to understand how ocean circulation and climate have changed during the past. I mainly look at the isotopic and elemental chemistry of the small shells of foraminifera. These single celled organisms have both planktonic and benthic forms, recording past conditions in the surface and deep ocean. Much of my current work is focused on reconstructing past ocean circulation from the distribution of density in the ocean. I'm currently working on a detailed history of the transport through the Florida Straits over the last 20,000 years.

Although I can't say that I have known since I was a child that I wanted to be a paleoceanographer, I have always been attracted to the logical approaches of science and math and had an interest in the natural world. Spending a semester at the Duke Marine Lab convinced me that physical oceanography was a good fit. While I had done a short research project in paleoceanography, I set off to NOAA's Pacific Marine Environmental Laboratory in Seattle to learn more about physical oceanography and El Niño. I enjoyed this job enormously, but it was time to move back east, and graduate school seemed like a logical next step. I decided to go back to paleoceanography, attracted by the first-order questions that remained unanswered, and completed my Ph.D. at Lamont-Doherty Earth Observatory. However, my physical oceanography training started to trickle back into my work during my postdoc at Woods Hole Oceanographic Institution and continues to influence it today.

I very much enjoy being a scientist and oceanographer. I love that I have to know a little bit about biology, chemistry, physics, geology, and even astronomy to do my work well. While some are put off by the uncertainties associated with reconstructing the past, I am still excited when my research can answer first-order questions about past ocean circulation or climate. I also enjoy being an academic scientist. The rewards and challenges of teaching undergraduates, mentoring graduate students, tinkering in the lab or on the computer, and coordinating large research programs are all different. On the other hand, it sometimes is a bit frustrating when each of these jobs could benefit from more time than I am able to give it. I am also the mother of a pre-schooler and a third grader, another job that could always use a bit more of my time. However, I find that an academic career is pretty flexible. In general, our productivity is judged over a long time scale, so an afternoon off to stay home with a sick child, or even a relatively unproductive six-month span, can ultimately be made up by having a good year that follows.

Patricia Lee Manley

Professor, Geology Department, Middlebury College, Middlebury, VT, USA, patmanley@middlebury.edu

I began my career a bit later than most. After receiving my B.S. in geology at Kent State University, I worked for ten years as a research assistant working on various marine geology projects at Lamont-Doherty Earth Observatory of Columbia University. It was here my interest in marine geology and geophysics began. During this time, my husband and I had our two children and he received his Ph.D. I started graduate school when my children were ages 2 and 6 and this was a big challenge. It was those years, while I was in graduate school, where I learned to juggle classes, research, and family; it took planning and a very supportive spouse. Once I received my Ph.D. (also from LDEO) my husband and I had to make a decision about dual careers. In the end we chose to come to Middlebury College, a liberal arts college, where we both teach in the Geology Department. Here I have been able to maintain a level of research that has allowed me to stay in the field even though Middlebury College has no graduate program in geology.

Patricia Manley standing on Lake Baikal in Siberia.

My research is field based and is aimed at understanding how currents redistribute sediment at the bottom of large lakes, rivers and oceans. Focusing my research on sedimentary bedforms such as furrows, drifts, mudwaves and deep-sea fans has directed my investigations towards three main regions: large lakes (Lake Ontario and Lake Champlain), rivers (Hudson and Buffalo Rivers), and the North and South Atlantic ocean. In Lake Champlain I have identified and studied furrows and large groundwater produced pockmarks. Furrows were also discovered in a segment of the Buffalo River, Buffalo NY. In the North and South Atlantic, I study the morphology and history of sediment drifts, and their associated mudwaves. I have also investigated the large mud dominated deep-sea fan (Amazon Fan). Recent research has focused on Holocene climate variability as recorded in cores from the continental margins of Antarctica.

I have participated on numerous ocean research cruises predominantly doing seismic surveying and coring work along the continental margins of Antarctica, sediment drifts south of Iceland and Greenland, mudwaves in Argentine Basin, and drilling the deep-sea Amazon Fan (this cruise was with the Ocean Drilling Program). Currently I am part of the SHALDRIL investigators scheduled for a demonstration cruise to Antarctica, spring 2005, to test a new portable drilling rig. Whenever possible I bring undergraduate students on these cruises.

The quality of students and the incorporation of undergraduate research have made working at Middlebury College very special. People don't recognize the level of research that undergraduates are capable of conducting. Besides teaching and research, I have found that it is also important to take the time to be a mentor to others, especially to young women. Mentoring, introducing students to the field of marine geology, taking students out to sea and seeing their excitement, teaching and doing fantastic research makes me happy that I chose this career path over 15 years ago.

Nancy Marcus

Chair and Robert O. Lawton Distinguished Professor, Mary Sears Professor of Oceanography, Department of Oceanography, Florida State University, Tallahassee, FL, USA, marcus@ocean.fsu.edu

The scientific party of the R/V *Chain* cruise—my first. I am sitting down on the deck, the third person from the right.

As a young girl growing up I enjoyed science. My parents encouraged this interest though neither were scientists. I attended Goucher College, a small woman's college (following my mother's lead) because I wanted a small school and it had a strong reputation in science. I majored in biology, thinking I wanted to be a high school teacher, but in my senior year realized that I wanted to go to graduate school. I was introduced to marine science as an undergraduate through two great opportunities: my ecology professor took a group of us to spend a "January term" at the Bermuda Biological Station in my junior year, and the following year I spent January at the Duke Marine Laboratory conducting research on phytoplankton with a fellow student from Goucher. In 1972 I entered the Ph.D. program at Yale University to work with Dr. Luigi Provosoli. Dr. Provosoli told me to go the library and figure out what I wanted to do. In the end I didn't work with him, choosing instead to focus my work in the area of population genetics of marine organisms as this topic was receiving a great deal of interest at the time. My doctoral advisor was Dr. Joseph Ramus, an algal physiologist. Joe was a very supportive advisor even though my research didn't involve his area of expertise. While I was a graduate student, Dr. Rudolf Scheltema came to Yale University to give a seminar, and extended an invitation to participate in one of his research cruises. I took him up on the offer and joined a two-week cruise on the R/V *Chain* to the Sargasso Sea (see photo). What a fantastic eye-opening experience!

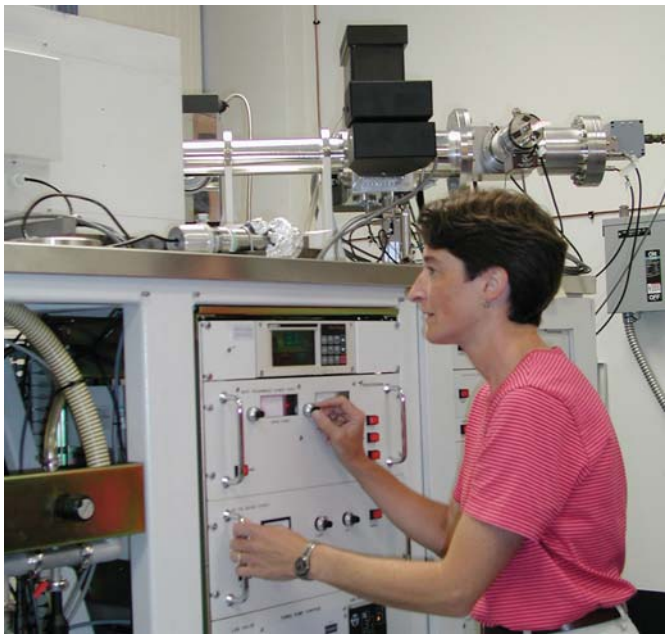
I graduated from Yale University in 1976 with a Ph.D. in biology specializing in ecology and evolutionary biology. I then went to the Woods Hole Oceanographic Institution as a Postdoctoral Scholar to work with Dr. Scheltema with whom I had corresponded after the cruise opportunity. I spent 11 years at WHOI, but when the opportunity arose to join the Department of Oceanography at Florida State University, I took it. I have been a professor for 17 years and truly enjoy what I do. I am currently Chairperson of the Department of Oceanography and Director of the Women in Math, Science, and Engineering (WIMSE) program at Florida State University. Over the years I have received a few external awards, but in 2001 I was quite honored when my colleagues at FSU bestowed upon me the Robert O. Lawton Distinguished Professor Award, the highest award given to a professor at the university. Throughout my life and career I have very much believed in balance, and to receive this award in recognition of research, teaching, and service meant a great deal to me. I have also been committed to promoting the participation of women in science and was extremely honored to be named a Fellow of the Association for Women in Science in 2004. In my free time I enjoy fishing and golfing with my friends, playing with my two basset hounds, and still do an occasional magic show.

Ellen E. Martin

Associate Professor, University of Florida, Gainesville, FL, USA, emartin@geology.ufl.edu

The relationship between ocean circulation, particularly deep circulation, and climate change is the primary focus of my research. There are no true proxies for past circulation patterns, thus our knowledge of this key factor in poleward heat transport has been pieced together over the past decades using proxies that indicate more about patterns of aging and nutrient contents of water masses, than the actually sources and flow paths of those waters. Nd isotopes offer a promising proxy for water mass that had been relatively unexploited by the paleoceanographic community. I have been working to identify and test various archives for Nd isotopes, such as fossil fish teeth and Fe-Mn oxide coatings, and to apply those techniques to studies of circulation patterns during critical intervals of climate change on Cenozoic time scales.

When I chose to become a geology major in the late 1970s, it was mostly because I'd witnessed the excitement, travel, and adventure associated with geology/oceanography through an older brother who spent a semester studying volcanoes in Guatemala. Throughout my B.A., M.S., Ph.D. and postdoctoral programs, as well as a job in oil exploration, I found I was always part of a supportive group of colleagues composed of at least 50 percent women. In contrast, there were very few women in positions of authority. I had the naïve impression that I was part of a group that was working its way up through the ranks, thus, the number of women faculty and supervisors would increase dramatically with time. There have certainly been improvements. The departments that granted my B.A. and M.S. degrees now have a few women on the faculty, which is vast improvement over none, but the percentages are still relatively low. The slow rate of progress in moving women into the upper ranks really hit home in 2001 when I became the first women in the Department of Geological Sciences at the University of Florida to receive tenure. Coming from cohorts that included so many women at every other level of my training, I did not expect to be breaking new ground. I've noticed through the years that the obstacles for women tend to be very subtle, and therefore more difficult to identify and address. One important step that we could make as a group would be to be more supportive of each other. It sounds so simple, yet I've found that many of the women who have made it into the upper echelon of academia are particularly critical of lifestyle choices and research techniques of younger women. There are many talented women interested in oceanography. We need to support each other at all levels if we hope to increase our numbers in the top levels.

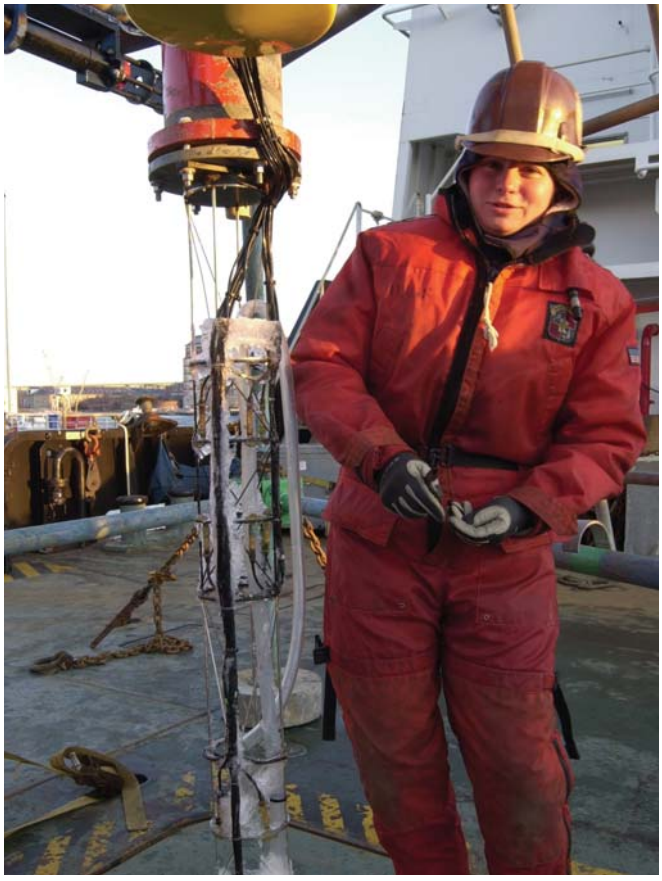


Ellen Martin working on the thermal ionization mass spectrometer used to analyze Nd isotopes for interpretation of past ocean circulation patterns.

Marinna Martini

Ocean Engineer, Woods Hole Science Center, U.S. Geological Survey, Woods Hole, MA, USA, mmartini@usgs.gov

I gravitated towards ocean engineering somewhat by default. I love technology and to know how things work. I have a poor memory for rote learning, which immediately scared me off subjects that are initially learned through lots of memorization. Engineering and math seemed easy compared to remembering details of biological systems. Coupled with an uncle who was a merchant mariner and a father who loved sailboats, the ocean was in my blood, the engineering on my mind. I earned a B.S. with honor in mechanical engineering and marine engineering systems from the United States Merchant Marine Academy. I spent a year with TRW's Federal Systems Group as a member of the technical staff before going on to the University of New Hampshire for a master's in ocean engineering and electronic instrumentation. I have worked for the U.S. Geological Survey at the Woods Hole Science Center ever since.



Aboard the USCG Buoy Tender *Marcus Hanna*, inside the large tripod frame (15 ft x 12 ft x 1 ton) preparing instrumentation for near-bottom current measurements for the USGS Massachusetts Bay Long Term Study. This study, ongoing since 1989, seeks to develop a capability to predict the fate of contaminants associated with fine-grained sediments on a regional basis. Photo by Dann Blackwood, USGS.

I lead two technicians, and together we provide project support to scientists in the nationwide USGS Coastal and Marine Geology Program. The work requires me to be a "Jane of all trades." I design moorings and instrument platforms, write software packages for data processing, conduct engineering evaluation tests of sensors and sensor systems, lead field work, supervise personnel, plan budgets and logistics, publish papers, give talks, and scrape barnacles off instrumentation. I love the variety and the opportunity for creative problem solving.

The greatest pleasure in my career and the most direct influence in my success has been the quality of the people with whom I work. I am fortunate to be gainfully employed in public service. The lack of a profit motive in Earth science research keeps the culture open and generous, and I treasure this. I worry that budget cuts and intense competition for funding will kill this most valuable aspect of ocean research.

The most persistent challenge in my career has been bridging the invisible divide between scientists and support staff, which is common in many research institutions. By my choice of education and work, I land in the middle. As a manager of technicians and an engineer who helps scientists achieve their goals, I walk a fine line between being free to determine my own destiny and being limited by an inherently support position. My choice not to pursue a doctorate is personal: it may limit my career options, but it also limits my stress; it may affect how others perceive me, but I get the satisfaction of a large variety of problems to solve. Industry uses technical career ladders to retain technologists with my skills and experience. It is tempting to see if the grass really is greener on the other side, but no job is perfect. Our USGS office has many redeeming qualities: I have a ten minute commute, a beautiful place to live, and someone to enjoy it all with who also has satisfying work nearby. It has been easier here to balance a work and private life, and I know many others who are not so lucky.

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Patricia A. Matrai

Senior Research Scientist, Bigelow Laboratory for Ocean Sciences, West Boothbay Harbor, ME, USA, pmatrai@bigelow.org

I am currently a Senior Research Scientist at Bigelow Laboratory for Ocean Sciences. After debating the merit of the initially favored chemical (but indoors) engineering with those of marine (but outdoors) activities, I chose to study nutrient cycling in an upwelling system for my B.S. in marine biology (Universidad de Concepción, Chile). My undergraduate degree led to studying phytoplankton species distribution along an open ocean-to-coastal gradient for my master's at Scripps Institution of Oceanography (SIO), though I finished doctoral studies in organic sulfur cycling in marine waters (SIO). I began my professional life as a research assistant professor studying biological production of climatically relevant gases (other than CO_2) and rose through the ranks to associate professor at the Marine and Atmospheric Chemistry department, RSMAS, University of Miami. I moved to Bigelow in 1995 to grow more phytoplankton, find colder air and, recently, include CO_2 in my work.

Paty sampling the microlayer of an Arctic lead at 89°N for possible atmospheric particle precursors during the Arctic Ocean Expedition-2001. The expedition was funded, in part, by the National Science Foundation. The need for clean air conditions required, at times, that the equipment be pulled with skis and sleds. The Swedish Icebreaker *Oden* can be seen in the background.

My research has focused on biological production and consumption of organic sulfur and halogenated compounds of climatic relevance and their environmental controls in various oceanic environments. This has led into research on the precursors and controls of the production of new atmospheric particles in the Arctic, the role of the physiological ecology of phytoplankton and associated food web on carbon and sulfur cycling, and the inclusion of such biogenic rates and controls in climate models. I am also interested in physiological controls of harmful algal blooms.

My research interests have also led me to interact with the oceanographic and atmospheric chemistry communities, challenging me every day to represent each in front of the other: I have been labeled a (marine) biologist, a (marine) chemist, a biochemist, an oceanographer, a gas person, a bug person and, as such, an expert in all topics within each discipline. The greatest challenge has been to avoid falling through interdisciplinary cracks because of wearing multiple hats.

These research interests have led to many fruitful field campaigns and meetings in almost all corners of the world, allowing me to meet and visit many wonderful people and places. The same exciting travel represents the largest challenge in balancing my career and personal life that includes a sea-going spouse, also in the field of oceanography, and two wonderful teens: Sine qua non, a parent is always on the premises! So, flexibility has been a must and the progeny are well traveled.

My children have also fostered regular interactions with K-8 students and teachers in several local schools either in the classroom, hosting some in my lab, interacting at sea or from away via the Internet, being a science judge at the Nor'Easter Ocean Bowl, and taking a chemistry teacher to sea for two months. I also teach undergraduates at the University of New England, allowing me to meet enthusiastic REU (Research Experiences for Undergraduates) students to annually take out to sea and work in the lab.

Patricia McAndrew

Ph.D. Candidate, University of Hawaii, Department of Oceanography, School of Ocean & Earth Sciences & Technology, Honolulu, HI, USA, pmcandre@hawaii.edu

Aloha! I am a graduate student in oceanography at the University of Hawaii, working with Dr. David Karl. My research interests are in metabolic balance in the open ocean and the physical processes affecting this balance.

Although I have had a fascination with the ocean since I was young, I was not exposed to the field of oceanography until college. My undergraduate degree is from MIT in environmental engineering; the required material for this major included introductory physical oceanography courses. These courses introduced me to the science behind the bodies of water that intrigued me as a child.

Another influence on me during college was my advisor, Professor Sallie Chisholm. Through discussions with her about environmental science, engineering, and research, I was introduced to the field of biological oceanography. What caught my attention about this particular field was its interdisciplinary nature. In order to understand life in the ocean, it would be necessary for me to study the physics, chemistry, and geology of the oceans as well. I began doing research on coastal bacteria diversity under the supervision of Professor Martin Polz, and eventually wrote my undergraduate thesis on bacterial diversity in Lake Tanganyika. This research, along with my training as an engineer, has proven to be great preparation for my studies in oceanography.

Balance during any stage of one's career is important—physically, mentally, and emotionally. I am a long-distance runner and run six days a week. I compete in marathons and trail races in the mountains near my home. I also hike and surf as often as my schedule allows. Running and hiking allow me time to reflect and clear my mind if stress is accumulating from work. During the week, I am in lab or at school eight to twelve hours a day. I always try to take time off on Sunday, go to church, and spend time with close friends.

Upon completion of my graduate studies, I want to become a professor. In this role I will be able to do research and teach. I love the energy and creativity of the university setting as well as the opportunity to interact with students. I am grateful for the professors in my life who have shown me that one can be a successful scientist, teacher, and mother. I hope that someday I may become all of these too.

Left: Trisha McAndrew running the winch during a sediment trap deployment. Above: McAndrew collecting oxygen samples from her incubation experiments.

Julie McClean

Research Associate Professor, Department of Oceanography, Naval Postgraduate School, Monterey, CA, USA, mcclean@nps.edu

I first became involved in oceanography during my final undergraduate year at the University of Sydney, Australia. I was completing a second major in marine sciences, the other being applied mathematics with an emphasis on meteorology. At the break, the University took us to Northern Queensland to experience all the flavors of marine science fieldwork. Whether we were measuring river flow, collecting sediment cores, or squelching through mangrove swamps, I was totally enthralled and decided on oceanography as a career. These days, I spend my time in front of a computer. As a numerical modeler, I am always looking for more cycles and faster high-performance computing architectures on which to run high-resolution global ocean and ice models. These models afford us the opportunity to study the ocean at its true dynamical scales, thus providing a means of furthering our knowledge of ocean dynamics and climate change.

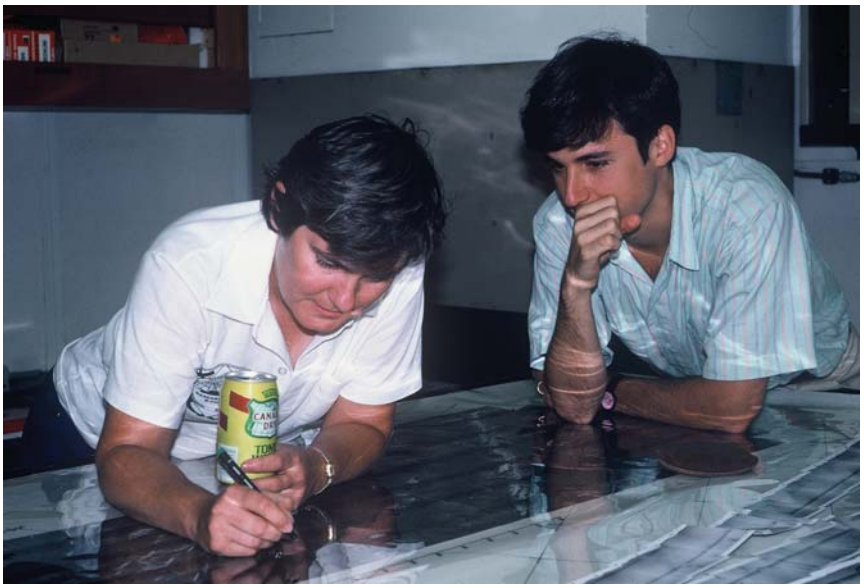
Julie McClean standing in front of the Naval Oceanographic Office's IBM RS 16000 SP3 (HABU).

I have never once regretted pursuing oceanography and enjoy being an active researcher. The greatest professional challenge I have faced during my career has been establishing and maintaining a research program built entirely on research funding and obtaining sufficient resources for the computationally intensive numerical simulations on an ongoing basis. The outcome of these efforts, however, has been personally rewarding and I believe they are of value to those who use the global simulations to further their research. On a personal note, my oceanographer husband and I are employed at institutions some three hours drive apart; consequently we live separately during the week. And, of course, I live on the other side of the planet from my family. Flying back to Australia as often as possible helps to overcome the reality that I am not "around the corner" and allows me to see my nephew grow up.

I have seen many changes over the last 25 years in the representation of women in my sub-discipline. When I was a graduate student in Australia, there were no senior-level women in physical oceanography. From my perspective, the number of women in oceanography in the United States has increased significantly since I attended my first American Geophysical Union Fall Meeting in 1986. Our numbers are still small, however, relative to those of our male colleagues at some of the specialty meetings. Hopefully, active recruitment and mentoring of younger women will improve this representation.

Bonnie A. McGregor

Regional Director, retired, Eastern Region US Geological Survey, Martinsburg, WV, USA



Bonnie McGregor and Fabio Trincardi studying a GLORIA side-scan sonar mosaic on a 1988 cruise mapping the EEZ off Kauai, Hawaii. Photo by Ellen Kappel.

In my early teens, I developed an enthusiasm for science and the oceans. Due to the fortunes of time, I was at the leading edge of oceanography, and the accompanying revolution in scientific thought and technology. Following a bachelor's degree in geology from Tufts University, my formal introduction to oceanography began at the University of Rhode Island's Graduate School of Oceanography (GSO). Reflecting the newness of the discipline, my incoming class actually doubled the number of students at GSO. Being the first woman studying marine geology posed several challenges. One such challenge was in 1965 where much persuasion was required before I could sail as the only woman on a 90-day research cruise. On the cruise, I hand plotted, in six-minute intervals, the water depth, magnetics, and gravity values every day we were at sea. These were stimulating times for oceanography, with the identification of seafloor spreading and plate tectonics. My research, along with that of many others, focused on understanding the details and implications of seafloor spreading, and studying processes occurring at actively spreading mid-ocean ridge crests and related hydrothermal mineral deposits.

My first job as an oceanographer was with the National Oceanic and Atmospheric Administration (NOAA) laboratory in Miami, Florida. Upon completion of my Ph.D. at the University of Miami, I became the first woman Ph.D. in oceanography within NOAA.

With the U.S. energy resource interests turning to the offshore area in the mid 1970s, I shifted my research interests to transport pathways and physical processes responsible for shaping the continental margin. This change in research interests led to a research position with the U.S. Geological Survey. President Reagan's declaration of an Exclusive Economic Zone (EEZ), converted to the national domain the seafloor out to 200 nautical miles. With the EEZ declaration, came a mandate to map this new seafloor frontier. I was program coordinator and project manager for the USGS EEZ mapping program, using state-of-the-art sonar, GLORIA. This international cooperative program provided the first regional-scale images of seafloor processes of the continental margin and graphically demonstrated the dynamic nature of the seafloor.

In the early 1990s, I became the first woman at the USGS to hold a Senior Executive Service position and became the Associate Director, responsible for program development, strategic planning, interagency coordination, and interdisciplinary science. Prior to my retirement in 2004, I was the Director for the USGS Eastern Region and led programs providing science for major restoration efforts in the Chesapeake Bay and the Florida Everglades ecosystems.

My 40-year career provided rewarding and challenging research and agency management opportunities. I owe much to those talented and unselfish men who served as mentors and champions allowing me to achieve many firsts as a woman scientist.

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Send all correspondence to: info@tos.org or The Oceanography Society, PO Box 1931, Rockville, MD 20849-1931, USA.

Cecilia McHugh

Professor, School of Earth and Environmental Sciences, Queens College, City University of New York, NY, USA, cmmqc@forbin.qc.edu

I received my Ph.D. in marine geology from Lamont-Doherty Earth Observatory (LDEO) of Columbia University in September 1993. Upon graduation I was hired at the Geology Department of Queens College, City University of New York where I am now a full professor. I am also an adjunct researcher at LDEO and have participated in more than 15 sea-going expeditions including two Ocean Drilling Program legs and *Alvin* dives in both the east and west coast continental margins of the United States. The road to success was not easy, but I firmly believe that if you set goals, remain focused, work hard, and are patient, you will achieve your dreams. The words, "It can't be done" are not in the vocabulary of this down-to-earth marine geologist. Having immigrated to the United States from Argentina at the age of 19 with minimal knowledge of English, I had a steep learning curve. Together with my husband Tony, we raised our sons, Keith and Anthony, who are now 25 and 27 years old, and have embarked on their own careers. While raising my sons, I went to night school for my undergraduate degree and traveled sometimes eight hours a day to the Columbia University campus in New York City to attend graduate classes.

Cecilia McHugh on board of the R/V *Endeavor* where together with a team of colleagues from the Lamont-Doherty Earth Observatory of Columbia University, Queens College of CUNY, Rutgers University, and Florida Atlantic University they surveyed the continental margin off-shore New York with geophysics and sediment sampling for the purpose of understanding global sea-level changes and climate.

My attraction to marine geology was rooted in a desire to find out about the beginning of Earth and how life originated, to understand the processes that shape the landscape beneath the sea, such as huge canyons and deep basins, and to investigate the causes of climate change and how these changes are going to impact our future.

My life experience is transmitted to the City University of New York students where I teach. Seeing the students achieve their goals is one of the most rewarding experiences I've ever had. Scientifically, the most rewarding project has been my involvement with an international team studying earthquake risk assessment in the North Anatolia Fault Zone beneath the Marmara Sea in Turkey. A major tectonic plate boundary, similar to the San Andreas Fault, it is located perilously close to the city of Istanbul, on the shore of the Marmara Sea. There hasn't been a major quake on the seabed in over 200 years, which makes the risk of an impending earthquake very high. Being able to contribute to a cause that may prevent loss of life is one of the greatest achievements anyone can hope for.

Fiona McLaughlin

Research Scientist, Fisheries and Oceans Canada, Institute of Ocean Sciences, Sidney, British Columbia, Canada, mclaughlinf@pac.dfo-mpo.gc.ca

After working for the government of Canada as a chemical technician for 13 years, analyzing nutrients and other geochemical tracers in seawater, I became part of a team in 1985 beginning a five-year hydrographic and hydrocarbon study of the Beaufort Sea. This Arctic experience marked a turning point. New adventures working from Twin Otter aircraft and skidoos on the ice, sampling from Coast Guard icebreakers, the excitement of discovery, and opportunity to work with a close community of talented researchers were all factors that led me back to graduate school in my forties to complete a master's and, then, a doctoral degree.

Fortunately, this occurred when the government of Canada was encouraging women's participation in science but, more importantly, I enjoyed support from two senior scientists who supervised my work and encouraged me to continue my studies. This meant I was able to work in the Arctic, collect data, and enrol in graduate school all at the same time. Returning to university, I found few women involved in oceanography, much less Arctic oceanography. In some quarters, there was resistance toward women in Arctic fieldwork. Generational change, however, produced a more-enlightened attitude and, thankfully, I never felt constrained by the fact that I was female.

Interest in the origin and composition of the water column led me to investigate ongoing changes in the Canada Basin and their relationship to atmospheric and upstream forcing, to local and far-field ventilation, and to circulation through nutrient, oxygen, and CFC analysis. These topics have remained my principal research interest.

When I began my studies, conventional wisdom held the Arctic to be an isolated and static ocean. But this has changed. And, I was lucky enough to be involved in expeditions that helped document a new view of the Arctic, its dynamic character, and its connectivity to the larger global system. Three expeditions, in particular, are memorable: the first, in 1993, when we discovered the boundary between Pacific and Atlantic waters had shifted from the Lomonosov to the Mendeleyev Ridge;

Fiona McLaughlin at the Firth River, collecting samples for end-member determinations. Helicopter support was provided by the CCGS *Louis S. St-Laurent.*

the second, in 1994, participating in the first modern crossing of the Arctic Ocean from west to east; and, the third, in 2002, leading a multidisciplinary expedition that provided the first remotely operated vehicle images of biota living in the entire water column, from the surface to the seafloor.

Most rewarding in Arctic research is the ever-changing parade of sky, light, and ice formations, not to mention the unexpected delight of coming upon a polar bear and cubs. Playing baseball on the ice at the North Pole was unforgettable, marred only by the fact that I was away for my husband's fiftieth birthday. Most challenging, apart from securing funding, is responsibility for leading multidisciplinary and international expeditions. Unpredictable ice conditions, competing research agendas for space and wire-time, extravagantly high logistical costs, and problems of dealing with diverse cultures and personalities, make it essential for the chief scientist to have the skills of a diplomat, a capacity for patience, and the fortitude of a hockey referee.

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Marcia McNutt

President and CEO, Monterey Bay Aquarium Research Institute, Moss Landing, CA, USA, mcnutt@mbari.org

I have always been interested in science and excited by the possibility of using observation and experimentation to discover the underlying laws that would simplify the world around me. And because I was brought up in a family with only daughters and attended an all-girls school until college, I avoided all of the gender stereotyping that might have dissuaded me from pursuing science at a young age. I was fortunate enough to be facing the decision of where to focus my interest in science just as the plate tectonic revolution was sweeping through academic circles. Choosing a career in marine geophysics at that time was like entering biology right after Darwin penned *Origin of the Species* or physics right after Einstein published his special theory of relativity: the old ideas were being tossed out, and everything needed to be newly discovered. My first few oceanographic expeditions as a young graduate student at Scripps Institution of Oceanography were led by fellow graduate students. The opportunities seemed endless, even for young minds lacking experience and unfamiliar with the "ancient" literature (defined as anything published prior to the late 1960s).

I spent most of my career (~15 years) teaching and performing research at MIT, surrounded by bright, enthusiastic students and colleagues. For the past seven years I have had the good fortune to be the director of the Monterey Bay Aquarium Research Institute. My decision to stop doing my own science and instead work to enable the science of others was primarily motivated by an honest assessment of my own strengths, weaknesses, and contributions. I had already advised enough talented graduate students who were out making their own marks in marine geophysics to more than compensate for me going off in a new direction. Furthermore, my colleagues seemed increasingly more interested in my opinion of other people's science than in the results of my own, more narrow research. Therefore, a move towards science management seemed natural, and while at MBARI, I have learned to take a vicarious pleasure in the accomplishments of all of the creative researchers around me.

Balancing career and family life was been a particular challenge, as I was widowed with three children under the age of seven soon after I earned tenure at MIT. Fortunately, the university administration, particularly my department heads, were very helpful and supportive. This was a time in my life when I had to become very efficient to survive. Now that the girls are all off to college, I don't have to be thinking of new ways to multitask every minute. Once upon a time, I thought that I would enjoy the freedom of not having to divide my time between work and family, but that is not the case. I'd gladly turn back the clock to have them all living at home again.

Marcia McNutt and daughter Dana collect a prize at the California Rodeo.

While in many ways I think conditions for women have improved (more role models to follow, less tolerance for gender bias whether overt or subtle), I see new problems emerging for young oceanographers today that were not issues for me. One of the largest is the cost of housing. Many oceanographic research institutions are in lovely coastal areas like California, Florida, Cape Cod, and Hawaii, where housing costs are beyond the means of academic salaries, even if there are two of them. But overall, I am delighted to see the growing cohort of women oceanographers and all of the brilliant contributions they are making to the field.

Erika E. McPhee-Shaw

Assistant Professor, Moss Landing Marine Laboratories, Moss Landing, CA, USA, eshaw@mlml.calstate.edu

One of the most defining moments in my scientific career was the day that I worked up the courage to walk into my advisor's office and tell him that I did not think I could coax a good Ph.D. thesis out of the project I had been brought into graduate school to work on. He took this news calmly, but then told me I was on my own for choosing a new topic. He had several criteria for what makes a study worthy of a Ph.D. One was that it include a combination of theory, observation, and experiments. Another was that it must focus on a process of relevance to the ocean as a whole rather than being a description of a particular place. Then he basically told me to go bury myself in the library and get back to him when I figured it out. He assured me that he would do his best to make sure I got funding (a luxury I know many students do not have). Being given this long a tether was scary, but exciting. I landed on the idea that layers of elevated suspended particulate matter emanating from continental slopes might be akin to the layers of mixed fluid seen spreading away from boundaries in laboratory experiments on turbulent mixing. I ended up concocting a project focused on the effects of internal wave mixing on continental margin sediment. This study straddled several disciplines: physical oceanography, laboratory fluid mechanics, and geological oceanography. I was only successful because at the University of Washington I found experts in all of these fields who were willing to be on my committee, to co-author papers, and to give me access to laboratory equipment and ship time. I am incredibly fortunate to have had such wonderful mentors.

Research since my dissertation has not been quite as free from constraints. A few NSF proposals to do exactly what I wanted to do have not met with much success, although I am hopeful that will happen someday. One real downside to academic oceanography is that jobs are relatively rare: you generally have to move to a job rather than being able to choose a place to live and then finding a position there. I met my husband while we were both postdocs at the University of California, Santa Barbara, and being two instead of one definitely leads to career decisions based on questions such as "Can I do this and live here?" and "Will it pay our bills?" rather than "Will this fulfill my primary research goals and position me right where I want to be in my career?" But, decisions based on such factors led me to move into a project looking at coastal dynamics and kelp ecosystems, which introduced me to great colleagues and a line of research in which I feel I really thrive. I was also given the opportunity to teach a graduate-level course. Although I did end up having to leave that job to follow my husband, I later got a tenure-track teaching position during the same year we had our son. So far, juggling a new teaching load and a new baby at the same time as trying to maintain a footing in research has been tough. However, I am thrilled to be teaching and feel lucky to work in an institution with a strong sense of community and mission towards marine science, and generally feel that I have had tremendous opportunities.

Erika with her son Henry, who is 9 months old.

Rachel A. Mills

Senior Lecturer, Southampton Oceanography Centre, University of Southampton, UK, ram1@soc.soton.ac.uk

My research interests are in the field of marine biogeochemistry. I study the impact of geological and biological processes on the delivery of material to and the cycling of trace elements within ocean sediments. I have a particular interest in hydrothermal systems and chemosynthetic environments on the seafloor where there is active cycling of trace elements when oxygen levels are depleted. I have been involved in a wide range of shipboard programs to collect sediments, including submersible studies of active vent sites.

Like many marine scientists, I started off in a different field. I enrolled for an oceanography module that looked interesting while I was studying for a degree in chemistry. The new Southampton undergraduate program in oceanography allowed me to apply chemistry in more exciting ways and I transferred to major in oceanography. Research was a natural progression, and I studied for my Ph.D. in Cambridge with Harry Elderfield and at the Institute of Oceanographic Sciences (IOS) with John Thomson. I returned to Southampton to a faculty position where I have now been for something close to 11 years.

Aboard the Inter-island Ferry in New Zealand.

The most rewarding aspects of my job are huge variety in activities associated with an academic job and seeing long periods of planning and effort come to fruition. It is satisfying when a cruise program is successful, when a Ph.D. student graduates and becomes an independent scientist, and when a paper is published. I thrive on working with enthusiastic people at all stages of their career. A career in science is a great way to balance a career and personal life if you get along with scientists. My partner shares my enthusiasm for research and travel and our children love the trips. The eldest was in the field at 10 weeks old and has traveled round the world twice at the age of five.

I have seen huge advances in women's visibility in the UK over the last decade. Ten years ago I was one of a few women in the Science Faculty at Southampton. Six years ago I was one of a handful of women to take maternity leave and come back to work at the SOC. We still have a long way to go, but there has been a huge shift in the numbers and expectations of women in ocean science. The challenge for the next decade is to generate an exciting environment that young graduates aspire to work within and that taps all of our potential.

Kathryn Moran

Associate Professor, Graduate School of Oceanography and Department of Ocean Engineering, University of Rhode Island, Narragansett, RI, USA, kate.moran@uri.edu

I'm interested in understanding how the Earth works; I view it as an organism. As a high school student, I was good at science, and my physics teacher, Mr. Missile (no joke), encouraged me to go into engineering. I did so, and here I am, years later, teaching others and conducting my own research.

Looking back on my career, I can't say that I ever had any "mentors," per se. If I had questions or concerns, I'd simply ask and seek answers. I'm self-sufficient, as are many scientists. I tend to learn both by working independently, and by collaborating with colleagues, whether they were fellow students, employees, or faculty members.

Focusing on the gender of oceanographers leaves me a bit cold. I think the emphasis should be on good oceanographers, regardless of gender. That said, I think the practice of science would benefit from greater participation by women, because I sense that we tend to work well together in groups.

The most rewarding part of my work is making a connection between a science problem and the technology necessary to address it. Maybe that's why I have a joint appointment at URI, in both the College of Engineering and in the Graduate School of Oceanography. I also like bringing the right people together, into a team, to work on problems. I derive a lot of satisfaction from that. A good example is the Arctic Coring Expedition (ACEX) of the Integrated Ocean Drilling Program. The science, understanding the paleoenvironment of the high Arctic, essentially an unsampled region, has been a long-standing, but previously unachieved goal in the international scientific community. After much effort, patience, help, and a bit of luck, we were able to convince the community, the operators, and, most importantly, the funding agencies, that the proposed effort would produce first-rate science, and more importantly, was technically doable. The greatest challenge we faced was convincing people to take the risk. My sense is that some sponsors are too conservative. I'd like to see greater risk-taking. Fortunately, politics and science aligned for ACEX, and the expedition was authorized and, thankfully, it was successful and has garnered a lot of attention.

Kate Moran and URI colleagues past and present (clockwise from Ted Moore [kneeling], David Smith, Matt O'Reagan [Kate's Ph.D. student], John Farrell, and Kathy Couchon, a science teacher participant from the NSF-funded ARMADA program). We are celebrating at the North Pole, on September 7, 2004, after the first successful Integrated Ocean Drilling Program coring expedition to the high Arctic. The Swedish icebreaker *Oden* is in the background.

I'm a bit surprised by the women oceanographers who solicited our contributions and asked, "How have you balanced your career and personal life?" I've never heard this asked of my male colleagues. I wonder how some of them would respond?

Margaret R. Mulholland

Assistant Professor, Department of Ocean, Earth and Atmospheric Sciences, Old Dominion University, Norfolk, VA, USA, mmulholl@odu.edu

I am a biological oceanographer interested in elemental cycling (primarily N and C) in oceanic and estuarine systems. The biogeochemical cycling of these elements affects the ecology of microbes in marine and estuarine systems. I study biologically mediated elemental transformations in a variety of contexts. My research projects to date have focused on competitive interactions between phytoplankton mixotrophs and bacteria, harmful algal blooms, the fate of N and C from N_2 fixation, uptake and regeneration of organic and inorganic nutrients, and interactions between major plant nutrients and other elements including sulfur and trace metals.

I chose oceanography after taking a limnology class as an undergraduate, where I double majored in geology and biology. In 1984, I was advised that combining multiple scientific disciplines was not a viable strategy for success. It has turned out that oceanography was a perfect venue for proving this contention wrong. Many of the exciting scientific discoveries of the last two decades have come at the interfaces of the more traditional disciplines; interesting new disciplines increasingly employ new combinations and numbers of prefixes (e.g., biogeochemistry). The multidisciplinary aspects of oceanography were particularly appealing as I could combine my interests in current processes and chemical transformations of elements over time.

Margie Mulholland and daughter Maeve in the laboratory counting cells.

Because I'm still pretty new to this, I expect that many of my great challenges (and hopefully rewards) lie ahead. Advising students, continuing to meet and form collaborations with new people (with expertise different from my own), keeping current, and exploring new research opportunities make my job both challenging and rewarding. To date, my greatest challenge has been to juggle all of the interesting projects so as not to short-change any one while also devoting time to advising and teaching.

A major life challenge for everyone is balancing career and personal life. I did not take a direct route through the academic ranks. Instead, I explored a variety of alternatives, including stints in the Peace Corps, private sector, and doing a second master's degree in marine policy. I see many of these experiences as assets to my current career, particularly with respect to the business of doing science.

As a result of my less-than-direct route to academia, I reached my position as an untenured faculty member at an age where I had to choose to have kids or not. I am now expecting my second child. This is a tough career for women who want to have a family. I am fortunate in that I have a supportive partner with a flexible schedule and mindset. While I love travel, many of my developing research interests are now done at field sites closer to home and I now routinely have family in tow during meetings.

When I first went to graduate school in the 1980s, and when I returned in the 1990s, the gender demographics of graduate students were about the same as now. Something that surprises me is that faculties still do not reflect that. While conditions have most certainly improved for women, many universities still lack paid maternity leave for faculty, which is likely a large factor in retention of female faculty to more senior ranks.

Gisèle Muller-Parker

Professor, Western Washington University; Currently serving as Associate Program Director, Ocean Education, National Science Foundation, Arlington, VA, USA, gmullerp@nsf.gov

My personal interests in science have evolved from a purely artistic appreciation of marine life to a fascination with invertebrates, to aquaculture, and then to symbiosis. For the last 20 years my research interests have been focused on symbiotic algae and the nature of their relationship with coral and sea anemone animal hosts. I am a marine biologist, although I do teach a course in oceanography at Western.

The most rewarding aspect of my career has been working with people, especially students. I also enjoy traveling; my work on coral reefs takes me to great places where I love to spend time underwater. The best part of my career is that I get to decide what topics I want to research, when I have the time to do research.

Gisèle Muller-Parker (middle) celebrating seaweeds with Western Washington University undergraduate student volunteers Dawn Michaels (left, holding *Laminaria saccharina*) and Julie Schram (right, holding *Costaria costata*) during a field trip to the intertidal zone on Fidalgo Island, Washington.

As a professor at a regional university, balancing teaching, research, and service has been the most challenging aspect of my career. I think the key to succeeding in this balance is to be good at multi-tasking, flexible in what you do, and creative in how you exploit opportunities that arise. My career is a result of this mix; somehow I ended up in graduate school, and I enjoyed it so much that I decided to do a Ph.D. One thing has led to another, including a husband and two kids. After 15 years at Western, including service as department chair, I am taking a break from my university to work as a "rotator" at the National Science Foundation (NSF) in the Division of Ocean Sciences. I am at NSF because I hope to make a difference; education is my main interest. This short stint at NSF is a really great opportunity to do service that is meaningful and broad-reaching.

Having the full support of a family behind my career has made the journey rewarding and has kept me grounded. I had my first son while I was a graduate student; he has just graduated from college. I think the strong support of mentors was also important. My graduate and postdoc advisors were great mentors; they cared about me and accommodated my family obligations. I've never had a woman mentor. Sometimes I wonder if that might have made a difference, but I don't really think so. I was fortunate to have the right mentors for me. I think the odds of having good role models and mentors are better for young women today.

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Lauren Mullineaux

Senior Scientist and H.W. Jannasch Chair, Biology Department, Woods Hole Oceanographic Institution, Woods Hole, MA, USA, lmullineaux@whoi.edu

I am a biological oceanographer interested in seafloor ecosystems. I ask questions about how larvae of benthic invertebrates disperse, and how dispersal affects the structure and dynamics of benthic communities. These studies take me by foot into the intertidal zone, and by submersible into the deep sea. The interdisciplinary nature of the work gives me an opportunity to interact with many different kinds of scientists outside of my field, including physical oceanographers, chemists, and mathematical ecologists. One of the most rewarding parts of my career is teaching and advising students. They are full of surprises, and keep my outlook fresh.

Balancing work and home life is an adventure. My typical day starts with making lunch for my sons, ages 8 and 11. Then my husband, also a scientist at WHOI, takes over, and I head to work. On a good day in the lab, I spend time planning projects, conducting research, or analyzing data, usually in collaboration with students and colleagues. I rarely get as much accomplished as I'd like, but that's life. Occasionally I get some exercise in. At some point, I dash off to transport my offspring to a sport or other after-school event. Because I work reduced hours, I have time to volunteer weekly in the public schools. Compromises are made: dinner often is a speedy affair, and my boys have been known to arrive at school with unusual hairstyles. Our home system works only because my husband is a full partner in parenting (and much more than that when I'm at sea).

Am I happy with my career and family? Yes. Do I have a lifestyle that is typical for a scientist or parent? Perhaps such a thing no longer exists. I'm fortunate that my workplace and my family are flexible enough to accommodate a nontraditional system that works for me.

Lauren Mullineaux aboard the *Atlantis II* during recovery of the submersible *Alvin*. The cylinder with hoses in the foreground holds samples of deep-sea plankton that were pumped and filtered during the dive.

Helen Neil

Marine Geologist, National Institute of Water & Atmospheric Research, Kilbirnie, Wellington, New Zealand,
h.neil@niwa.co.nz

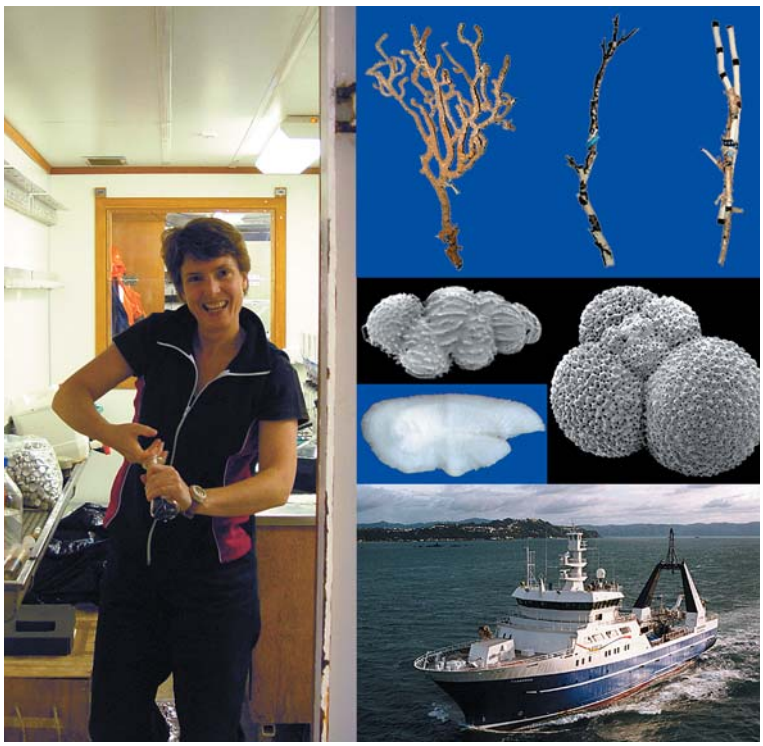
I am a marine geologist with the National Institute of Water & Atmospheric Research (NIWA), in Wellington, New Zealand. I became involved in oceanography quite by chance. My university professor had a student place on a research voyage and it sounded like fun. Balmy ocean days, sun, and surf. That appealed to me. The reality turned out to be quite different—a cold Southern Ocean, ship fumes, mud, and that uncomfortable queasy feeling in one's stomach! But I was hooked, and went on to study paleoceanography at the University of Waikato.

The strength of NIWA's oceanographic research is due to strong multidisciplinary and integrated teams. Consequently, I am involved in many aspects of oceanographic research in the subtropical and subantarctic oceans around New Zealand and Australia, in particular: paleoceanography of NZ's Subantarctic Zone, deep-ocean sedimentation, paleoenvironmental and ecological interpretation of foraminiferal assemblages, and isotopic characterization and climatic variability of present day water masses. I have also been involved in commercial contracts, such as telecommunications cable routes.

My use of stable isotopes is also applied to fisheries and climate science, deriving ages and life histories of shellfish and deep-sea fish communities, historical marine temperatures from bivalves and corals, and reconstructing the environment from speleothems. This work has certainly led to some long but interesting hours in the lab.

I have led or participated in 12 research voyages, including several multinational expeditions to the Southwest Pacific and Southern Ocean, and have also spent time in Antarctica. While there were several women involved in all aspects of oceanography in New Zealand when I started my career, the noticeable difference eight years later is the significant increase of women across all areas of this science. You are no longer the only woman on the research vessel, and at times women are the majority.

I have always received support and encouragement from senior scientists. The NZ oceanographic community is diverse, innovative, and friendly, with many opportunities for field and laboratory work in research and applied fields. With a vast ocean as my backdoor there is still much to be discovered. Who wouldn't want to be an oceanographer?



NIWA marine geologist, Helen Neil, on board *Tangaroa*—one of the National Institute of Water & Atmospheric Research's (NIWA) blue-water research vessels. NIWA is NZ's leading provider of environmental research and consultancy services. Inset from top right are bamboo corals Isididae: Keratoisidinae, foraminifera *U. peregrina* and *G. bulloides*, an otolith of *H. antarctica*, and the R/V *Tangaroa*.

Marlene Noble

Physical Oceanographer, Western Coastal and Marine Geology, U.S. Geological Survey, Menlo Park, CA, USA, mnoble@usgs.gov

I started my scientific career pursuing a Ph.D. in elementary particle physics at Princeton. While there, I became frustrated with a field that was becoming increasingly congested; individual scientists tended to be responsible for only small portions of large research programs. I decided to change fields. I had taken a few undergraduate courses in oceanography at the University of Washington and was a summer intern in the field. I thought that oceanography was less esoteric than particle physics and that understanding transport patterns in the coastal ocean could be an interesting challenge. I transferred to Woods Hole Oceanographic Institution. I was subsequently hired as a physical oceanographer at the U.S. Geological Survey. While there, I finished my Ph.D. at the University of Rhode Island.

Marlene Noble next to a Geoprobe tripod designed to measure bottom suspension processes and profile currents over the entire water column. This tripod was deployed for four months in 60 m of water off Huntington Beach, CA.

At that time, coastal oceanography was a relatively new, compact and exciting discipline. Management policies for the coastal ocean were just being developed. One of my biggest challenges at the USGS was to develop cooperative research programs that would (1) further our understanding of coastal-ocean transport processes and (2) provide solid information to coastal-ocean management agencies. Hence, our programs tended to combine basic and applied research. At the moment, we are working with the Environmental Protection Agency to monitor and model the transport, deposition, and fate of DDT-contaminated sediments off southern California. While carrying out this programs, we also model resuspension processes associated with energetic internal bores and determine the velocity structure of violent turbidity currents in submarine canyons.

Many years ago, when I first became an oceanographer, it was somewhat unusual for women to go to sea. However, both WHOI and the USGS were quite supportive. Now, men and women at the USGS share bunkrooms on vessels that have limited accommodation options. Unfortunately, women were and are still under-represented in the field. There are only a few women senior scientists at the USGS.

Given that my husband and I are both physical scientists (he's in laser fusion), we share many common interests. We were fortunate to both live on the east coast in the early days. We bought a small plane to facilitate travel between Princeton, NJ or Rochester, NY (his residences) and Woods Hole (mine)—the best little weekend "commuter" airline in the region. When he moved to the Lawrence Livermore Laboratory in California, I was able to transfer to a sister USGS office in Menlo Park. We finally bought a house together!

In general, oceanography is and has been an interesting and rewarding career.

Suzanne O'Connell

Associate Professor and Chair, Department of Earth and Environmental Sciences, Wesleyan University, Middletown, CT, USA, soconnell@wesleyan.edu

When I read *Wind in the Willows* as a girl, I was intrigued by the mischievous adventures of Toad, but the line I remember most clearly is Water Rat's assurance to Mole that, "Believe me, my young friend, there is NOTHING—absolute nothing—half so much worth doing as simply messing about in boats." That's part of what I get to do for a living. Here, on a beautiful day, I'm out on the Connecticut River with a class of students, preparing to launch our side-scan sonar/subbottom profiler to examine the river bottom. Photo by W. Burkhart.

I never planned to be a professor or a marine geologist. As a girl I loved the outdoors, in part because being from a large family and living in the country, it was a place to find a little peace and quiet. I also liked science and wanted to make a contribution to the world, and so went to collage thinking I'd major in biology and become a medical doctor. I might have continued on that path, but during the summer of 1971 I was fortunate enough to be a teaching assistant in a field biology course. We spent two weeks in the classroom and then four weeks in the field studying four different environments: a river system, a bog, a section of the coast in Maine, and the White Mountains in New Hampshire. There were three professors and one was a geologist. I was stunned to discover that these mountains might be connected to an undersea mountain chain (the New England Seamounts), that sea level is rising, and that Earth's crust is broken into a series of plates. I had to find out more. In the fall, when I returned to college, I enrolled in a geology class. I loved the subject and the people. Professors were called by their first names, we had lunch together in a "rock garden," and they brought in several truly outstanding speakers: Miles Hayes with "Suzanne's Lament" about the fate of coastal areas, and Tanya Atwater, Kevin Burke, John Dewey, and Peter Molnar to talk about the new plate tectonics. Hearing these talks, how could I not want to be a geologist?

As an undergraduate, I also learned about the Deep Sea Drilling Project (DSDP) because there was a woman in the department, a radiolarian specialist, who had sailed on the *Glomar Challenger.* She didn't have an official position with the university, but as the wife of the former department chair (deceased), she had been given the use of an office and a lab in another building. I don't remember ever speaking with her and maybe saw her once or twice. Clearly, however, the other professors (five men) thought that sailing on the *Glomar Challenger* was very special. They spoke of her in reverential terms—she had sailed on the *Glomar Challenger*! I never thought it was something I could do.

Fortunately I was wrong, I've sailed on both the *Glomar Challenger* and the *JOIDES Resolution* and hope to sail again. I can't imagine a better experience—to spend two months totally immersed in collecting data, literally day and night, with other people who care about answering questions about Earth's ocean.

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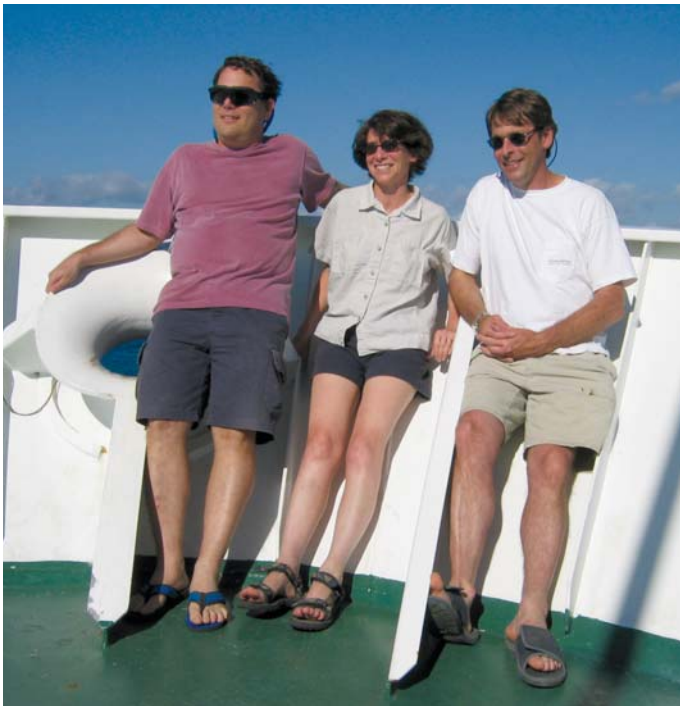
Delia Oppo

Associate Scientist, Wood Hole Oceanographic Institution, Woods Hole, MA, USA, doppo@whoi.edu

A phone conversation with a good friend changed my life. I was working as an actuarial trainee and looking for something more personally rewarding. Math had always been fun—puzzles and games. However, applying my skills to pricing a maternity expense benefit rider for a major insurance company was not what I envisioned when I learned (sort of) topology and statistics in college. My friend, also a math major in college, told me that she saw posters announcing geology graduate programs that were looking for people with undergraduate math degrees. Okay, I thought, I'll try that...I'd taken two semesters of physics in college, and that was the extent of my science background. I began taking freshman chemistry after work, and reading up a little bit on the Earth sciences. It sounded like the right direction. I quit my job, took a few undergraduate geology courses over the course of a year, and applied to graduate programs in geophysics and physical oceanography—programs I thought might be interested in someone with a math background.



Delia Oppo nearing the end of a 30-day cruise in Indonesian waters on the *Baruna Jaya VIII.* With two great colleague—on the right, Brad Linsley (University of New York at Albany) and on the left, Yair Rosenthal (Rutgers University) who share my interest in the tropics. We plan to use the sediments we collected to reconstruct past changes in climate and current strength in the Makassar Strait.

I chose Columbia University for my graduate school. I learned about the solid Earth, the oceans, atmosphere, and climate. The more I learned, the less I knew, a pattern that continues to this day. After a few classes on past climates, I was hooked. True, my professors were inspirational, but the unknown itself grabbed my attention. Here were real puzzles to be solved. Why did atmospheric carbon dioxide vary so greatly from glacial to interglacial time? Why did the water that sinks today to great depths in the high-latitude North Atlantic stop sinking during glacial times (or so we thought then)? How did these differences impact the ice age climate?

I had a great time learning in graduate school. I also married, and met several women who would become my best friends and colleagues, and met men whom I still count among my friends. For the most part, I did not experience any gender discrimination. I overlooked the occasional slight or disparaging remark. I moved on.

After I defended my dissertation, I went to the Woods Hole Oceanographic Institution (WHOI) for a postdoctoral position. Cape Cod was beautiful, even if a little grey in winter. Fifteen years later, I am still at WHOI. I have a view of the water from my office window. I walk along the beach nearly every day. I have had cruises to the North Atlantic, South Atlantic, and Indonesia to recover marine sediments for my research. I have great colleagues at WHOI and elsewhere. I still ask questions about past climate and the role of the ocean. I maintain my early interests, and have developed new ones, particularly the influence of the tropics and the hydrological cycle on glacial-interglacial and on rapid climate change. It is difficult to spend enough time with our boys, Ryan, 13 and Troy, 10. I understand why women leave research careers. However, I am, for the most part, happy with the road taken.

Mónica V. Orellana

Senior Research Scientist, Institute for Systems Biology, Seattle, WA, USA, morellan@systemsbiology.org

I have always been fascinated by the sea: its motion, and its flora and fauna. I grew up in Chile, a long, narrow country buttressing the Pacific, where the ocean casts a spell on its people. In Chile, the ocean touches all of us, from giants like the Nobel laureate Pablo Neruda ("Ode to the Tuna at the Market"), to students like myself wondering about the intricate beauty of the marine microscopic world. What type of life is there, and what is it doing? These questions I first asked while studying biology at the Universidad de Concepción are still relevant. Imagine, 1.2 million new genes have been recently discovered in the ocean!

Doing science results from a chain of human interactions: I have been influenced and supported in my endeavors by great mentors, fellow students, past and current colleagues, and students. I am especially fortunate for my thesis adviser, Mary Jane Perry at the University of Washington, who has remained a lasting influence. Her intellectual vision, energy, and enthusiasm allowed me to understand that technology can drive biological discovery. In my graduate research, I coupled flow cytometry and antibody probes to measuring RubisCO in single cells. Today I continue the take advantage of new observational and measuring capacities that promote the emergence of new and very specific questions.

After graduate school, I worked in the Department of Bioengineering at the University of Washington, where I experienced the challenge of being at the interface of scientific disciplines. I think that by visiting the boundaries between disciplines, we can observe new practices, methodologies, and perspectives that enhance the manner in which we do research. I would like to think it is here at the interface of technology and oceanography that I have contributed to the oceanographic community. Working in an interdisciplinary environment has been rewarding, but not an easy road to travel. It has required additional training to understand fundamental differences in the thought processes and languages of different disciplines. This path has also involved some inherent risk, one of which is the slow pace of recognition for the applicability of new concepts in oceanography, and being outside the normal oceanographic environment. The risk has been balanced by the gratification springing from innovation and new understanding of old ideas and producing new paradigms.

Mónica and her family.

Today, I continue at the interface at the Institute for Systems Biology in Seattle, working with an interdisciplinary team to help develop new technology to understand ocean processes and to uncover the fingerprints that cells leave in the ocean. This has been another exceptional opportunity. Alongside the pathway of my career, I have been able to live a good and rewarding life, and have raised two fine sons who give me great pride.

Tuba Özkan-Haller

Assistant Professor, College of Oceanic and Atmospheric Sciences, Oregon State University, Corvallis, OR, USA, ozkan@coas.oregonstate.edu

My scientific interests are in the area of nearshore oceanography. In particular, I work to improve understanding of beach processes, be it the dynamics of breaking waves, the generation and variability of nearshore circulation, or changes to the beach profile due to the combined action of nearshore waves and currents. Waves in the nearshore region are powerful and beautiful and they release large amounts of energy as the break. The energy supplied to the circulation by wave breaking is an order of magnitude larger than that provided by wind forcing in the deeper ocean, so it should come as no surprise that the resulting currents are strong (1-2 m/s). The combined effect of waves and currents can move truckloads of sediment in the course of hours. This changing bathymetry also feeds back to the hydrodynamics, altering the waves and circulation as the beach evolves, giving rise to a system where nonlinear feedback is important and emergent behavior likely. This is very dynamic part of the ocean and it is also the area where humans most commonly come in contact with the ocean. Consequently, many scientists are interested in the nearshore ocean, including physical oceanographers, marine geologists, biologist, marine resource managers, and coastal engineers. There is much overlap between the interests of these disciplines and I very much enjoy trying to see problems from each point of view. It is very exciting to see that inter-disciplinary approaches are now becoming more commonplace. There is much to learn from the interaction of scientists who are experts in different fields working in the same area of the ocean.

Tuba and her kids Atlas and Bora collecting sediment samples at Marmaris, Turkey.

As a native of Istanbul, Turkey, and the daughter of a naval officer, I grew up surrounded by water. My graduate work was in coastal engineering and I taught naval architecture before arriving in a career in oceanography. With a husband who is a faculty member in Civil Engineering, and two little boys in tow, we travel back to Turkey every year and visit a different coastal village each summer. The boys and I dig around in the sand a lot and that gives me ample opportunity to tell my kids cool facts about the sand, watch the waves, see how the bathymetry changes overnight just by walking the same line every morning, and think and learn about wave groups just by listening to the sound of each breaking wave. Does that count as field work?

Mercedes Pascual

Associate Professor, Department of Ecology and Evolutionary Biology, University of Michigan, Ann Arbor, MI, USA, pascual@umich.edu

I am an ecologist interested in numbers. I work with mathematical models that help us understand and predict patterns of temporal and spatial change in ecological systems. One specific area of research addresses the dynamics of infectious diseases in relation to climate variability and climate change. For example, we have been trying to understand the complicated seasonal and interannual cycles of cholera in South Asia. Interestingly, the ocean is part of the story because the El Niño Southern Oscillation, as measured by the variability of sea surface temperature in the Pacific, drives the multiyear cycles of cholera in South Asia (Bangladesh). Also, the pathogen itself inhabits coastal aquatic environments, such as brackish water and estuaries.

On the margins of the Dhonagoda river, a tributary of the Meghna and one of the many waterways that form the large estuary in Bangladesh that opens to the Bay of Bengal. The population in this area is in close contact with water in the environment, as seen in this picture, and is therefore exposed to *Vibrio cholerae,* the pathogen that causes cholera and is found in this estuarine habitat. The International Center for Diarrhoeal Disease Research, Bangladesh (ICDDR,B) has been conducting a remarkable surveillance program for the disease in this region since 1966. These data have been the basis of quantitative analyses by Mercedes Pascual and her colleagues on the role of climate variability on the temporal dynamics of cholera.

But my career path started in another part of the ocean, with the summers spent in the coast of Uruguay and the high school years in Rio de Janeiro, and a growing fascination with the marine environment and sailing. I started college in marine biology, then switched to mathematics, and finally transferred back and graduated with a degree in biology. Only later when a series of lucky circumstances brought me first to a summer course at the Marine Biological Laboratory in Woods Hole, and then to Cornell, I realized I could combine my interests in numbers and biology, and for this, I always remember the inspiring encounters with Tom Eisner and Simon Levin, and later with Hal Caswell.

Dual-career issues led me through a longer post-graduate path than usual and several institutions, from the desert in southern New Mexico back to the coast at the Woods Hole Oceanographic Institution, where I finally completed my doctoral degree in biological oceanography from their joint program with MIT. One of the most rewarding aspects of that field of study was its interdisciplinary nature: while I was working on theoretical ecology and plankton dynamics, I could learn about dynamical systems from many other perspectives. In fact, the ocean is all about dynamics, whether one is interested in biology, geophysics, or climate. In that sense, ecology and biological oceanography have much in common, but separate traditions, scientific societies, and journals keep these fields somewhat separate. Efforts to bridge, compare, and integrate their perspectives are needed. I often get asked what are the major roadblocks for women in science. The difficulties of dual careers at the postdoctoral and beginning academic jobs are high in my list, even though an increasing number of institutions have recently recognized this problem and are actively pursuing creative solutions. More progress is still needed.

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Send all correspondence to: info@tos.org or The Oceanography Society, PO Box 1931, Rockville, MD 20849-1931, USA.

Uta Passow

Research Scientist, Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, and Adjunct Faculty Member, University of Kiel, Germany, upassow@awi-bremerhaven.de

By the age of ten, I knew with absolute certainty that I would be a biologist. It was love at first sight, when years later I was introduced to the ocean and biological oceanography. I packed up and moved to the ocean and began studying in Kiel. Only once did I have second thoughts, on the first day of my first cruise. We were all trying to survive extremely rough weather. More hands were needed to recover a sediment trap so as not to lose it in the coming storm. Out on deck both fresh and salt water was flying in all directions, the wind was howling, and the boat was being tossed around. Holding on to everything in sight, and ignoring my seasickness, I not only survived, but also managed to help save the floundering trap. Thereafter, I was always welcome on this particular ship, although as every seaman knows, women on board bring bad luck!

Realizing that sedimentation of phytoplankton was species-specific, I went to search for the mechanisms driving sedimentation. Again I packed up, and moved to California to work on aggregation. Here I was lucky enough to discover, together with two colleagues, transparent exopolymer particles (TEP). Studying the role of TEP in biochemical cycling and food webs kept me entertained for many years. Now back in Germany, while I ponder mechanisms driving the carbon and silica cycle or the importance of small-scale processes for overall budgets, I still encounter these acidic polysaccharide-rich particles. As I study the speciation of trace elements, the scavenging of ballast material by aggregates, and diffusion, dissolution and degradation within aggregates, TEP keep reappearing like a pop-up clown.

Research topics aside, I get inspired by the multitude of work environments: diving in a marine snow storm, spending weeks in a remote field laboratory, watching ice bergs drift past the boat, tinkering in the lab or playing with data on the computer, fitting another puzzle piece into place. I'm happy to be a member of the oceanographic community, joining forces with people who are international (oceans know of no borders). Oceanographers are informal and fun (it is impossible to stay aloof when crowded for weeks together on a wildly rocking vessel) as well as inspiring. After years of backpacking, hiking, sailing, kayaking, and mountain climbing in my free time, I found my second great love, my husband and our twins, now seven years old. Balancing my two great loves, my work and my family, is challenging—but what better challenge can one ask for?

Here I'm working at a field station near Bergen, Norway, enjoying a quick trip with a dinghy to nine large mesocosms moored offshore in a fjord. The experiment investigated the impact of rising atmospheric CO_2 concentrations for oceanic communities. Experiments like these and the iron fertilization *in situ* experiments, which look at issues regarding climate change, have a high publicity value, pushing oceanography out of the ivory tower of basic research into the limelight of the public and politics.

Adina Paytan

Assistant Professor, Department of Geological and Environmental Sciences, Stanford University, CA, USA, apaytan@stanford.edu

My research focuses on marine biogeochemical cycles and dynamics in the present and past, and on their connection to the Earth system as a whole. The overarching goal of my work is to investigate the relation between these cycles and global climate and environmental changes. To achieve this goal I use the chemical and isotopic record enclosed in seawater and marine sediments to study present-day biogeochemical processes as well as past oceans and climates over time scales of centuries to many millions of years. The oceans are in interactive contact with the atmosphere, biosphere, and lithosphere; all elements pass through the ocean. Investigating the biogeochemical cycling of elements in the ocean reveals the interactions among the solid Earth, oceans, and atmosphere. Changes in ocean chemistry elucidate the relation between Earth's surficial processes, and global climate and environmental changes.

I was drawn to the field of oceanography, and particularly marine biogeochemistry, because of the interdisciplinary nature of this field. It was hard for me to decide what I wanted to be when I grew up—a geologist, biologist, or chemist—so I choose to be a little of each. Indeed, understanding marine biogeochemical cycles requires understanding geological, chemical, physical, and biological processes and the complex interaction among these processes. This kind of interdisciplinary research is best addressed through multi-investigator interactions and collaborations. Accordingly, most of the research projects in my laboratory involve collaborations with a wide range of experts. These working relationships with my students, postdocs, and colleagues enable me to continue to learn, develop, and expand my horizons.

The primary reason I chose an academic career was the opportunity to combine the excitement of cutting-edge scientific research with the rewarding mission of teaching and mentoring. Accordingly, I strive to be an effective teacher at both the undergraduate and graduate level. I feel that a synergistic relationship exists between research and teaching: doing research enables me to keep learning, and teaching provides me with a means to transfer my knowledge to others and be fertilized by student's ideas and perspectives. By conveying my excitement for science, work ethic, spirit of inquiry, and zest for problem solving, I act as a role model for students, promote their enthusiasm for science, encourage creativity and intellectual vigor, and provide an education that will enable students to become leading scientists or literate citizens. As a woman in the Earth sciences, I feel a particular responsibility to mentor students, not only in the more traditional ways, but also by exposing the students to the skills and life strategies required for combining intensive research productivity and family responsibilities. I also believe it is important to convey the very relevant issues of Earth and environmental sciences to the general public through outreach activities and to promote a scientifically literate citizenry.

Paytan Lab – Halloween 2004

Cindy Pilskaln

Senior Research Scientist, Bigelow Laboratory for Ocean Sciences, West Boothbay Harbor, ME, USA, cpilskaln@bigelow.org

My research interests are marine biogeochemistry and sedimentology, with specific focus on geochemical particle fluxes, particle aggregation, and remineralization processes, and the resultant formation of sediment.

I was one of those weird kids who always wanted to do just one thing and one thing only when I grew up—study the ocean. This probably resulted from a Southern California childhood, numerous visits to the submarine ride at Disney Land, a steady diet of National Geographic magazines and Jacques Cousteau specials in the 1960s, and parents who always encouraged and never said that "science wasn't for girls"—although I was told this a number of times after I got to graduate school (which I obviously ignored). Particle biogeochemistry was perfect for me as it appealed to my integrated, "big picture" approach to understanding the ocean that I had gleaned from my geology training, and allowed me to combine several disciplines that I thoroughly enjoyed. Thanks to Ray Siever and Sus Honjo, I ended up doing my doctoral work at the Woods Hole Oceanographic Institution at a great time when the Joint Global Ocean Flux Study program was just beginning.

Being an oceanographer has many rewards, and at the top of my list is the opportunity and challenge to uncover something new with every research project—I love this aspect. Additional perks for me have been working with people from all over the world and traveling to some of the most amazing places on Earth—plus getting paid for it! Translating all of this to students through teaching has added immense satisfaction to my career.

Cindy deploying time-series sediment trap mooring off California.

I believe that the greatest challenge we face as women scientists is to be accepted as individuals whose ambition, creativity, and commitment to science is every bit as serious as our male counterparts—and that this is a good thing! Even the field of oceanography, which has done well over the years to encourage and keep women in science, is not immune to the problems that plague the "traditional" scientific disciplines and lead to an attrition of women from science following receipt of their doctorates. Such problems are persistent sexual stereotyping and pre-conceived notions of what a woman's role in science should be. This in turn makes it difficult for many women to gain access to the male-dominated networking system that greatly enhances a scientist's collaborations and involvement in new research endeavors. By staying in science AND being successful at it, women ocean scientists are proving daily that we have left the recently publicized idea that "innate biological differences" render women incapable of high achievement in science, back in the Dark Ages—where it belongs.

Ashanti J. Pyrtle

Assistant Professor, College of Marine Science, University of South Florida, St. Petersburg, FL, USA, apyrtle@marine.usf.edu

I appreciate the value of determination, confidence, and faith. As one of just a handful of female African American oceanographers, I have often had to call on each of these qualities while striving to achieve my academic and professional goals. I recognize the benefit of having a strong support system, comprised of my family, colleagues, mentors, and friends. My support system often provided me with encouragement during tough times and sound advice at periods of transition in both my professional career and personal life. Now, as an established chemical oceanographer who studies the behavior and transport of radionuclides, I am devoting myself to conducting noteworthy scientific research and facilitating the development of support systems for other minorities who are committed to achieving successful Earth system science careers.

My interest in determining the fate of radionuclides (both naturally occurring and man-made) upon introduction into the aquatic environment first began while examining sediment cores collected from the Lena River estuary in northern Siberia. Since then, I have investigated the behavior of radionuclides in Savannah River estuary (Georgia), Tampa Bay (Florida), and Puerto Rico.

In addition to conducting radiogeochemistry investigations, I also engage in activities designed to facilitate the advancement and professional development of students. My most recent endeavors include directing the NASA and NSF-funded Minorities Striving and Pursuing Higher Degrees of Success in Earth System Science (MS PHD'S®) initiative (www.msphds.usf.edu), the NSF-funded Florida Georgia Louis Stokes Alliances for Minority Participation (LSAMP) Bridge to the Doctorate Graduate Fellowship Program (www.msphds.usf.edu/BDFellowship), and the Alfred P. Sloan Foundation's Minority Ph.D. Program for the USF College of Marine Science (www.sloanphds.org), and co-directing the NSF-funded USF OCEANS GK-12 Graduate Teaching Fellowship Program (http://www.marine.usf.edu/education-and-outreach/GK12). My recent professional service activities include participation on the NSF Advisory Committee on Environmental Research and Education (http://www.nsf.gov/geo/ere/ereweb/advisory.cfm), American Geophysical Union Diversity Subcommittee, American Society of Limnology and Oceanography Education Subcommittee, and International Safe Water Conference Steering Committee, as well as serving as the site host for the 2005 Digital Library for Earth System Education Annual Meeting (www.dlese.org).

I balance my research, teaching, and various professional and personal activities with the support of my husband, family, friends, students, and mentors. You really do need a network and a support system because things do get hard sometimes. When they do, you need people who will help and encourage you. With my extended circle of love and support, I stay positive, upbeat, and committed to the spirit of giving. I'm known to work hard and long hours, but sometimes you may catch me at the movies in the middle of the day, smiling over an apple pie, or dancing in the office.

Ashanti Pyrtle retrieving a sediment sample from the Gulf of Mexico using a box corer.

Isabella Raffi

Associate Professor of Paleontology, Dipartimento di Scienze della Terra, Universita "G.d'Annunzio" di Chieti-Pescara, Italy, raffi@unich.it

I am a micropaleontologist. My scientific interest focuses on calcareous nannofossils. My research addresses both the biostratigraphy and paleoecology of these microfossils and uses these tools to investigate the paleoceanography of the Cenozoic.

I decided to become a micropaleontologist during a course in geological sciences that I attended at the University of Parma in Italy. My father was one of the first micropaleontologists working in the Italian Oil Company during the 1950s and 1960s, and in a way I have followed in his footsteps—with his full support and encouragement. I started my research after taking the degree (the *Laurea*) in geological sciences in 1977, and focused my studies on calcareous nannofossils from the deep sea and on-land marine stratigraphic sections, mainly in the Mediterranean region. My challenge was to go beyond the provincialism typical of many paleontologists in Italy at that time, and in this effort I had the support of Professor Maria Bianca Cita, micropaleontologist and stratigrapher, and the first Italian woman internationally known as a paleoceanographer. My experiences as a participant on several Ocean Drilling Program (ODP) scientific cruises, starting in the 1990s, opened up my horizons toward the oceans, and greatly enhanced my expertise as a nannofossil micropaleontologist.

Between 1991 and 2003 I participated as nannofossil paleontologist on five ODP Legs: Leg 138 (1991) in the eastern equatorial Pacific, Leg 154 (1994) in the western equatorial Atlantic, Leg 172 (1997) in the North Atlantic, Leg 199 (2001) in tropical Pacific, and Leg 208 (2003) in the South Atlantic. The opportunity to work together with famous and expert paleoceanographers (Nick Shackleton, Ted Moore, Jan Backman, Jim Zachos, among others) was important and extremely useful for improving my knowledge of the field and related disciplines. All the achievements in my scientific and academic career have been obtained with the support of my family, and my husband Magnus and daughter Margareta, who patiently adjust to my leaving home to attend scientific meetings and for the two months duration of each ODP cruise.

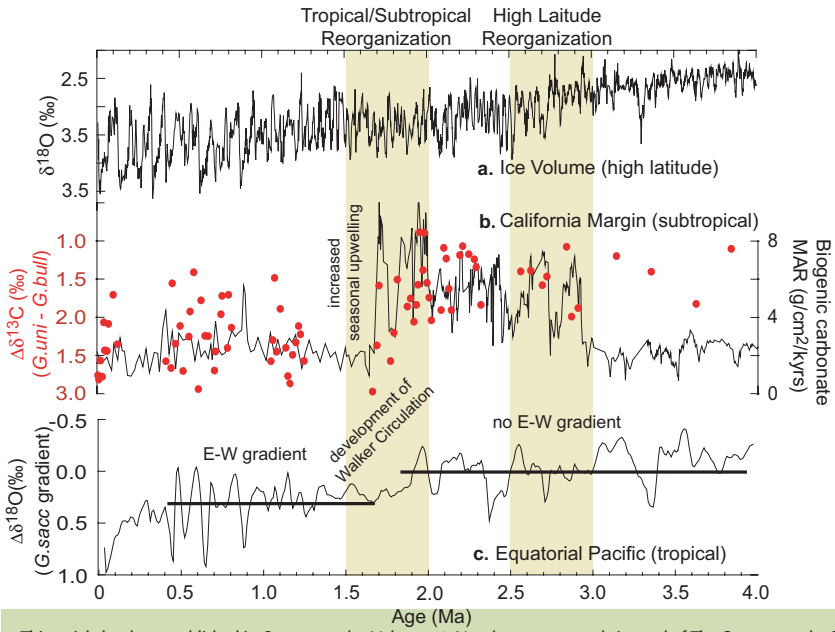
Isabella Raffi at sea, on board the *JOIDES Resolution* during ODP Leg 208 in the South Atlantic (Walvis Ridge, 6 March-6 May 2003).

Christina Ravelo

Associate Professor, University of California at Santa Cruz, CA, USA, acr@ucsc.edu

I am a paleoceanographer with primary interests in tropical and subtropical oceans and their role in global climate change over the last five million years. I generate micropaleonotological and geochemical records of past oceanographic conditions, and use statistical analyses of these records to resolve causes of climate variability. My initial desire to become a paleoceanographer was born out of my undergraduate research experience under the mentorship of Dr. Tjeerd van Andel at Stanford University. From this experience, as well as others that followed, I learned the importance of exposing students to research and of mentors who love what they do and have high expectations and faith in their students' abilities. I currently have a job that I love, studying and teaching oceanography at the University of California, Santa Cruz. One of the most rewarding aspects of my job is the opportunity to work with people from different backgrounds, which has led to many interdisciplinary and inspirational interactions that have shaped my career.

While I have only occasionally experienced personal discrimination, I have encountered many challenges related to being women, a minority, and a mother while trying to have a successful scientific career. Institutionalized measures of scholarly "excellence" and even expected professional and social behavior, originally defined decades ago predominantly by men, do not adequately accommodate or support diverse lifestyles and needs. How this has influenced me personally would require more than the 400 or so words allotted here. To give one example: even while many institutions grant child-bearing leave, merit and promotional personnel reviews do not accommodate a drop in research productivity during times when women are pregnant or are acting as primary caregivers of newborn infants. In short, my biggest challenge has been figuring out how to cope with the pressure of trying to meet the high standards of my "careers" as both a scientist and as a mother. I wish I knew how to meet this challenge; for now, I just try to focus on and appreciate the aspects of each "career" that are personally rewarding and fun. The support I receive from my wonderful collaborators and from my family, especially my husband, has been essential. In addition, many senior colleagues in my field and at my institution, both men and women, have been generous with their advice, encouragement, and enthusiasm throughout my career. As a community, I believe that we are like-minded in our recognition that diverse perspectives enrich creative scientific thinking and education, and best serve the needs of our society. My hope is that in the future we can make changes to our professional culture by institutionalizing support for enhanced diversity within our scientific community.



Climate change of the last five million years (Ravelo et al., 2004 and references therein). Subtropical upwelling and tropical Pacific Walker circulation were reduced in the warm early Pliocene (~5 to 3 million years ago [Ma]) relative to today. The subsequent cooling was not globally synchronous suggesting it was forced gradually rather than by a regional episodic event. a. A benthic $\delta^{18}O$ record indicates that ice age climate at high latitudes was established by ~2.5 Ma. b. Sub-tropical seasonal upwelling at ODP Site 1014 and c. the tropical west-east surface hydrographic gradient and Walker circulation, as indicated by the $\delta^{18}O$ difference between ODP Sites 851 and 806, were established at ~1.7 Ma. (Reference: Ravelo, A.C., D. Andreasen, M. Lyle, A. Olivarez Lyle, and M.W. Wara. 2004. Regional climate shifts caused by gradual global cooling in the Pliocene epoch. *Nature*, 429, 263-267).

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Send all correspondence to: info@tos.org or The Oceanography Society, PO Box 1931, Rockville, MD 20849-1931, USA.

Maureen Raymo

Research Professor, Boston University, Boston, MA, USA, raymo@bu.edu

I can safely say that my whole life I wanted to be an oceanographer. By age seven I was dreaming about (and reading about) Jacques Cousteau's underwater adventures. At age 12, I had the wonderful experience of living for a year within feet of the ocean, in a small fishing village in western Ireland. Few days went by that didn't find me prowling for miles up and down the rocky shoreline collecting periwinkles, small shrimp, seaweed, shells, and sea anemones. Years later, I attended Brown University where I was introduced to very small marine fossils (foraminifera) and the field of paleoceanography. John Imbrie was the undisputed star of the geological sciences department and his discoveries about how Earth's climate had changed in the past were generating much excitement. My path was clear: forams and climate.

Maureen with her children Vicki and Dan.

From college on, I have studied the causes of climate change over Earth's history. At Brown, I learned taxonomy from Nilva Kipp and began what would be ten years of untold (and pleasant) hours at a microscope generating data. In the 1980s, I did my graduate studies at Lamont-Doherty Earth Observatory of Columbia University where I worked with Bill Ruddiman, an inspiring scientist who I continue collaborating with to this day. Using the first spliced cores recovered by the Deep Sea Drilling Project, we were able to generate continuous, high-resolution isotope records of late Pliocene Ice Age onset. We were able to show that northern hemisphere glaciation occurred gradually over half a million years, and with carbon isotope records, undertake the first studies of North Atlantic Deep Water circulation history over the Plio-Pleistocene.

Many years and many jobs later, I work as a research professor at Boston University and continue to study how Earth's climate has changed in the past. I study the interactions between tectonics and climate, the influence of orbital forcing on global climate, and the history of past thermohaline circulation variations. For over 25 years I've met fantastically interesting people, traveled to extraordinary places, and been able to pursue whatever research interests I've had. The months I've spent at sea have been some of the best times of all. I still feel an attraction to the ocean that defies rational explanation and rarely a week goes by that I don't think about that day in the future when my kids are grown up and I have retired to another house by the sea (preferably in the tropics!). I'll continue collecting shells, sponges, bits of rocks and bones and look out to sea and think how lucky I was to have been able to live my life as an oceanographer.

Beatriz Reguera

Researcher, Centro Oceanografico de Vigo, Instituto Español de Oceanografia, Vigo, Spain, beatriz.reguera@vi.ieo.es

I have always loved nature, and I knew I would someday work with plants or animals for my career. I grew up near an oceanographic laboratory, and early on, marine biology attracted me. I wandered a few years between phytoplankton ecology and mass production of planktonic organisms in an institute with research priorities and assessment duties. I finally chose phytoplankton (with a focus on harmful species), and am lucky that the organisms that are my present obsession are important in socio-economic terms. My other research interests include morphological/physiological variability of phytoplankton in response to the environment, their life history strategies, and their seasonal and interannual fluctuations in relation to climate.

Early rewards were a British Council scholarship and grant that took me abroad. Now, my professional life is full of small rewards: a new finding in my field, getting projects funded, writing satisfying articles, and helping young, enthusiastic scientists. Participation in European and international working groups, cruises, and conferences is also enriching, and participation in UNESCO programs is especially gratifying; I feel proud to chair the Intergovernmental Oceanographic Commission (IOC) Intergovernmental Panel on Harmful Algal Blooms (IPHAB).

Coordination of the VIII International Conference on Harmful Algae in 1997 was a major challenge for me. Writing my dissertation at a mature age was another. A problem I encountered was that when I concentrated my mind and energy a lot, I end up exhausted and did not even enjoy the final results. My present short-term challenges are obtaining successful results in our multidisciplinary projects and keeping alive countries' interest in the IPHAB and related activities.

A full-time research position and three teenagers can be exhausting, but much of this pressure is relieved by a supportive husband who never complains about my professional commitments. I do not feel that I ever sacrificed anything because I always acted on impulse. As a civil servant, I had to eventually choose between research and management. I definitely chose the former. After a brief period as a laboratory director, I realized it made no sense to have a higher salary if that meant continuous stress, no feeling of fulfilment, and an inability to "switch off" at home.

Beatriz Reguera at the terrace of the Instituto Español de Oceanografica, Vigo, Spain, with the Cies Islands in the background.

Officially, there has never been sexual discrimination in Spanish institutions. But "machos" are still around. Off the record, one may hear that a male colleague prefers female collaborators because they work harder and are submissive, or another one who selects single women or those not planning to have children. And sexual harassment exists. I suffered sexual harassment as a young student, just when most in need of scientific guidance and support. Sexual harassment can be directed toward a person of either gender, but it is much more frequently suffered by women. Harassers should be denounced, otherwise the same history will be repeated on new victims.

While gender bias still exists, the main difference these days is that there is a higher proportion of female scientists in oceanography, which makes for a more pleasant, balanced atmosphere.

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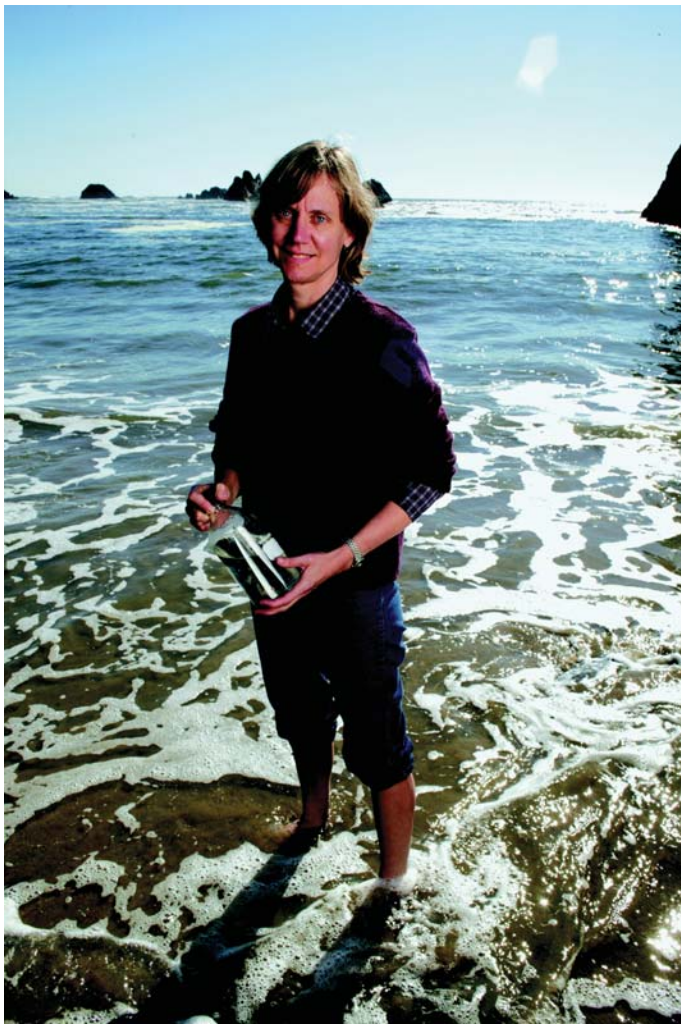
Clare E. Reimers

Professor of Chemical Oceanography, Oregon State University, and Director of the Cooperative Institute for Marine Resources Studies, Hatfield Marine Science Center, Newport, OR, USA, creimers@coas.oregonstate.edu

As a chemical oceanographer, my research focuses on sediment biogeochemistry, which I approach through pore water and solid phase analyses, *in situ* microsensor measurements, diffusion and diagenesis models, and applied electrochemistry.

I received my B.A. (1976) from the University of Virginia in environmental sciences and an M.S. (1978) and Ph.D. (1982) in oceanography from Oregon State University. As an undergraduate, I was a Woods Hole Summer Fellow and an Intern at the Jet Propulsion Laboratory during the Viking Mars project. After ten years at Scripps Institution of Oceanography as postdoc, and assistant and associate research professor, I spent a brief interval at the University of Alaska and then accepted a tenured position at Rutgers University in the Institute of Marine and Coastal Sciences. Six years later I returned to Oregon State University as part of a move initiated by a career opportunity for my husband (who is a fisheries oceanographer), but also because of our desire to return to the Pacific Northwest. Here, we are now living in a log house and raising our son.

I find the most rewarding aspect of being an ocean scientist is the license to pursue interdisciplinary studies and to work with colleagues from all over the globe. Right now I am excited about containerless microbial fuel cells that rely on pairs of inert electrodes positioned with one on either side of an interface between oxic seawater and anoxic sediment. These simple devices may soon power autonomous instrumentation in the ocean, and the development work in my lab is allowing me to work with electrochemists, microbiologists, and engineers on a range of fundamental problems. This is just the kind of interdisciplinary science I find captivating.



Clare Reimers enjoying the Oregon coast during a recent photo shoot sponsored by Oregon State University to promote marine research.

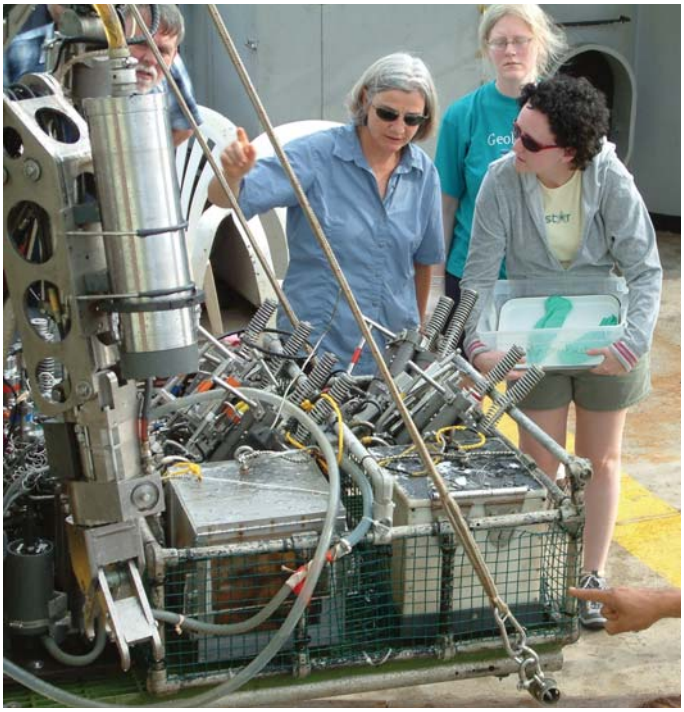
Anna-Louise Reysenbach

Professor, Biology Department, Portland State University, Portland, OR, USA, reysenbacha@pdx.edu

My research interests span all aspects of microbial interactions at both terrestrial and deep-sea hydrothermal systems. Much of my research has focused on the ecology and physiology of thermophilic chemolithotrophs that are involved with biomineralization. Additionally, I am interested in the patterns of microbial and genomic diversity at hydrothermal systems that might provide clues on culturing some endemic thermophiles.

I arrived where I am today by taking a circuitous route, from a Ph.D. in South Africa working with what I thought to be quite the extremophile: an obligate anaerobe. I wanted to continue to explore the physiology and ecology of extremophiles, and at the time, by far the most compelling environment for such research was hydrothermal vents. Of course, since I am an avid windsurfer and diver, oceanographic research was even more compelling! I joined Jody Deming's lab at the University of Washington, where my foray at vents started. Later in Norman Pace's lab at Indiana University, I began working at terrestrial geothermal systems. Both research areas collided when I discovered a thermophilic bacterial lineage that occurs both at deep-sea and terrestrial thermal environments. I now spend equal amounts of field research time at sea and on land. Some of the challenges of being at a research and teaching institution are the ability to juggle research and teaching commitments. Doing field research enables me to get into the "lab." When not at work, I am invariably playing outside, hiking or windsurfing; or indoors reading a good book or making tiles, throwing a pot on my pottery wheel, or spinning and weaving.

There are many aspects of my work that I find rewarding. The research itself is very interdisciplinary. Being able to collaborate with excellent colleagues is perhaps one of the most stimulating aspects of this research. Furthermore, there is still so much unknown scientific territory that remains to be explored at vents. The genomic era, too, has provided new tools that just 10 years ago I would not have imagined I'd be using to address some of our research questions. One of the aspects of my work that I find immensely rewarding is the educational outreach activities that I am involved in—whether it is with the public, kids, school teachers, or university students. I am always reminded of a little girl at Spencer School in rural Indiana after a talk I gave. She raised her hand and asked: "Miss, how can I be like you?" Hydrothermal systems, whether it's on the seafloor or in Yellowstone, provide ample opportunities to inspire kids to not only consider science as a career, but also to realize that almost anything is possible if you are passionate about it.



Anna-Louise at the *Alvin* sample basket with student Sara Kelly, and technician Amy Banta.

Mary Jo Richardson

Professor of Oceanography, Texas A&M University, College Station, TX, USA, mrichardson@ocean.tamu.edu

Sometime in my early teenage years I decided that I wanted to be an oceanographer. It was not the marine life that fascinated me; instead I was taken more by the tides, waves, storms, and sediment movement. I attended Smith College as an undergraduate. My senior year was Smith's centennial year, so Smith asked prominent alumnae to host a student for a January intersession project in 1975. I was hosted by Elizabeth (Betty) T. Bunce at Woods Hole Oceanographic Institution. That internship led to my sailing on the R/V *Knorr* with John Farrington and Bob Gagosian, co-chief scientists, in February 1975 during spring semester of my senior year. The experience cemented that oceanography was to be my future.

While in graduate school, I met my best friend, Wilf Gardner. We worked together in a dynamic research team with Ed Laine, Roger Flood, and Sandy Shor, all students of Charley Hollister. Graduate school was intense, and a far different experience from my undergraduate experiences at Smith and Wesleyan. Some of the most entertaining learning occurred while driving by car to/from MIT with Hank Stommel and others.

Wilf and I married when I graduated, and I moved to Lamont as a postdoc where he was a research scientist. Two children later, we decided to avail ourselves of an opportunity for a tenure-track faculty position for Wilf at Texas A&M University. I took a leave from my tenure-track position in New York. The climate, culture, and employment changes of Texas brought significant challenges to our family. I taught 2272 students (7 percent of all the undergraduates at Texas A&M) during a four-year period and received a NSF Faculty Award for Women Scientists and Engineers. In 1990 I was tenured and Wilf was promoted to full professor. At that time we had three young daughters.

Throughout our careers at Texas A&M, Wilf and I have continued to work closely together in our research—the dynamics and biogeochemistry of particle formation, sinking, resuspension, transport, and deposition in the ocean from the continental shelf to the deep sea, and from the surface waters to the seafloor. Now we are working on the development of satellite algorithms sea-truthed with *in situ* particulate organic carbon and transmissometer (optical instrument) data to unravel global ocean processes of carbon recycling.

Grand Canyon at sunset after a day hike from the South Rim to the river (Phantom Ranch) and back.

Currently, I am a professor in the Oceanography Department, chairing a university-wide task force commissioned by the university president as his primary initiative for this academic year—to enhance the undergraduate experience at Texas A&M. The previous two years I served as the Interim Dean of Geosciences, a college comprised of oceanography, atmospheric sciences, geology and geophysics, and geography. For nine years before that I was the Associate Dean for Academic Affairs for the college.

The balancing act has been difficult at times, most especially when challenges arise on both fronts simultaneously (personal life and work). The stresses do not decrease; they only change. We are blessed to have three daughters who are now mostly grown (22, 20, and 17). They have brought, and continue to bring, joy and happiness beyond description to our lives. Interestingly they have all chosen quantitative fields of study—computer science, physics, and math.

Are there still biases against women in the sciences? Of course, that was clearly articulated recently by Harvard's president. However, it is preferable to focus on the positive. I am fortunate to be married to my best friend. We are both tenured professors at a great university. I have a fabulous family and an enriching career. The challenges have been many. There are more ahead. No one said it would be easy. But, it is worth it.

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Rosalind E.M. Rickaby

University Lecturer in Biogeochemistry, Department of Earth Sciences, Oxford University and Tutorial Fellow of Hertford College, Oxford, UK, rosr@earth.ox.ac.uk

My overarching research interest is the interface of oceanic life, seawater chemistry, and climatic evolution. More specifically, I work on the application of chemical signatures captured in biogenic minerals as proxies of oceanic processes. These proxies help me to construct an understanding of the climate system on time scales from years to millions of years. I also aim is to build a mechanistic understanding of the uptake of chemical signatures into biogenic minerals during biomineralization as a foundation for this proxy application

The interdisciplinary nature of a subject such as paleoceanography makes it perfect for indecisive people like me! Throughout my undergraduate study of natural sciences at Cambridge University, I was torn between enjoying the rigor of chemistry compared to the imagination of geology. The opportunity to pursue postgraduate research in geochemical proxies in palaeoceanography with Harry Elderfield, followed by postdoctoral research with Dan Schrag, allowed me to blend both of my scientific interests whilst indulging a fascination in understanding past climate. I love the fact that I need to read papers involving biology, physics, and chemistry in order to move towards my research goals, and that at some point my work may impact our predictions for future climate. In addition to finding this cocktail of marine science so rewarding, the chance to participate in research cruises to measure the sea and sediment, and develop great scientific camaraderie in locations as diverse as the Indian Ocean and Antarctica, is unrivalled.

I have certainly struggled with a couple of challenges along the way to Oxford. The first was to develop the belief that I could succeed. I worried about the limited number of faculty jobs available, the slim chance of one appearing at the right moment, and the even slimmer chance of ever being offered one! I have to thank both Harry and Dan for being fantastically supportive mentors and convincing me to persist. The second challenge now, is to stand on my own two feet, learn to use my own judgement, and establish independently a research strategy and group (whilst juggling departmental and College commitments). I am discovering that being your own boss is tough, but having yourself as your boss is even tougher. The demands on your time can be incredible, and I am learning to be strict about delineations between work and home life—weekends and netball matches are sacred. I am lucky to work in a supportive department, but look forward to the time when the abundance of female undergraduates, graduates, and postdocs finally filters through to our faculty (currently comprising only two!).

Ros Rickaby pictured en route with the *James Clarke Ross* in the Gerlache Strait to collect sea ice diatoms and core samples from Marguerite Bay, Antarctic peninsula.

Shimi Rii

Candidate, Master of Science, University of Hawaii, Department of Oceanography, School of Ocean & Earth Sciences & Technology, Honolulu, HI, USA, shimi@hawaii.edu

I have a sticker on my car that says, "The ocean is my playground." As a graduate student in biological oceanography who paddles, surfs, and scuba dives in her spare time, I can honestly say that my life is pretty great. I am studying how the distribution of pigments within a cyclonic eddy off of Hawaii relates to carbon flux obtained using sediment traps. When people hear that I grew up in Hawaii, they nod in understanding. It's as if a career in oceanography is the most natural path for all children who grow up on a paradise island. Sure, I went to the beach every weekend when I was a child, but I also went to a college-prep high school and was initially pre-med at UCLA. I was one of a thousand doctors and lawyers that college-prep schools spit out every year. Dissatisfied, I searched for something that made me excited about life. I worked in various labs: extracted DNA from rat tails, stuck electrodes on kids with trauma, and counted polychaete larvae. I took an introductory marine biology class in which I got a miserable C+. Yet, I didn't give up and I went to study for a semester at Bodega Marine Lab, University of California, Davis. There, I fell in love. Living a life controlled by the tides amidst beautiful sunsets, I searched for the patterns in nature, the inevitability of occurrences due to chance happenings. The rest is history.

Shimi Rii preparing sediment trap collection tubes for deployment.

After graduating and returning home to Hawaii, I tutored at the Sylvan Learning Center and became a technician working for a physical oceanographer on the Hawaii Ocean Time-Series Project. I entered the University of Hawaii's oceanography program in 2003. What I dream to do with my M.S. degree is to spread my love to young adults, especially those wondering what to do with their lives after high school. Too many kids grow up in beautiful places without realizing that its beauty must be maintained. While tutoring kids at Sylvan, I realized that the possibility of studying the ocean simply does not enter their minds. This void is due to lack of exposure, similar to my experiences. I want to educate young students about the vast opportunities in the ocean, and let them know that not only can you actually make a living learning about and protecting the ocean, but you can also have a blast while doing it.

Paola Malanotte-Rizzoli

Professor of Physical Oceanography, Director, MIT-WHOI Joint Program in Oceanography and Applied Ocean Science and Engineering, Department of Earth, Atmospheric and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, MA, USA, rizzoli@ocean.mit.edu

I first attended the University of Padua, Italy, where I obtained the Italian doctorate in physics, summa cum laude, with a thesis in quantum mechanics. After one year as postdoctoral fellow in Padua, in 1970 I joined the Istituto Studio Dinamica Grandi Masse, established by the Italian National Research Council after the famous Venice flood of November 1966 to investigate the problems affecting Venice and its lagoon. The high water itself is produced by the storm surges of the Adriatic Sea, and my first study was the construction of numerical models for the prediction of sea level in Venice. In 1971 I started visiting the Scripps Institution of Oceanography (SIO). Between 1971 and 1975, I commuted between Italy and California, working at oceanographic issues related to the Venice problems, specifically modeling the Adriatic general circulation and wind-wave field responsible for the destruction of the lagoon coastline during the storms.

Always commuting, I completed a Ph.D. in physical oceanography at SIO between 1975 and 1978. My Ph.D. thesis focused on the investigation of the dynamics of coherent structures (i.e., strong oceanographic and meteorological flow structures endowed with long lifetimes, such as atmospheric blocking and cold/warm rings in the ocean that are shed by jet-like boundary currents like the Gulf Stream). These flow features violate the principles of "chaos," that is, the intrinsic unpredictability of most atmospheric and oceanic flows. Between 1978 and 1980, I was at SIO with a Green Scholarship. In 1981, I joined MIT as Assistant Professor, hired by Professor Ed Lorenz, the discoverer of chaos, whose work had been the motivation of my thesis. I obtained tenure in 1987 and am now Professor of Physical Oceanography. Since 1997, I have also been the MIT Director of the MIT/WHOI Joint Program in Oceanography.

My current major research interest is modeling the tropical Atlantic circulation and its interactions with the subtropics, with focus on the coupled ocean/atmosphere modes of variability, which are of crucial importance for climate. Past research interests include modeling of the Gulf Stream system with emphasis on nonlinear wave-mean flow interactions, and biophysical modeling of the ecosystems of enclosed and marginal seas, such as the eastern Mediterranean Sea and the Black Sea. A major interest of mine since the late 1980s has been in data assimilation in ocean models, the most recent effort being on ensemble approaches. Finally, since 1995 I have been working again at the Venice problem as a consultant for the construction of the mobile gates designed to close the lagoon inlets and protect the city from the floods.

Paola Malanotte-Rizzoli in the robe of her "alma mater," the University of Padua, at the MIT graduation ceremony. The color of the sleeves lining indicates the specialty, with emerald green representing physics. The University of Padua is the second oldest in the world, founded in 1021 after Bologna (988). It was the first university to admit women in the 1550s. Photo credit: Donna Coveney.

Robin Robertson

Doherty Associate Research Scientist, Lamont-Doherty Earth Observatory of Columbia University, Palisades, NY, USA, rroberts@ldeo.columbia.edu

Modelers and observationalists often operate in different circles. I enjoy operating at the intersection of those circles. As a modeler, I simulate realistic scenarios, incorporating real data and verifying the results against observations. In turn, my simulations suggest where certain processes may be observed. I also collect data in field experiments, which is used for model verification. Field work reminds me how complex the real ocean is and what the models are still missing.

Although much of my career has been involved with waves of many types, vertical mixing mechanisms in the polar regions became my broad interest in the early 1990s. More recently my primary focus became tides. Tides are believed to be a major vertical mixing mechanism throughout the world ocean. Much of the mixing is believed to occur through interactions of the barotropic tide with the continental slope or rough topography generating internal tides. To determine the role of tides in vertical mixing, I model the tidal fields in various regions in three dimensions. Presently, I am simulating internal tides not only in the Antarctic Seas (Ross and Weddell), but also in the Indonesian Seas.

My career path has not been the standard, direct, one-discipline approach, but rather has combined oceanography and ocean engineering; academia and industry; and field work, data analysis, and modeling. My first modeling projects were done as an ocean engineering student, simulating oil dispersion due to wave motion and the dispersion of pollutants. At the time, I and four other women were the first to be admitted to the Ocean Engineering Department at the University of Rhode Island.

So how did a modeler start doing field work, especially in those days when many people felt that women should not go to sea? At the time I finished my master's degree, things looked grim for an inexperienced ocean engineer due to a glut of unemployed, experienced ocean engineers when oil prices dropped. After I was hired by SAIC, I was soon actively involved in their environmental monitoring field program. This was fortunate, because suddenly I became a modeler with field experience. This would later open doors for me, for instance, at Ocean Research and Engineering, where I ran a field program to measure surface waves using stereo photography.

Dr. Robin Robertson collected XBT (expendable bathythermograph) and CTD (conductivity-temperature-depth) profiles on the AnSlope III field program in the Ross Sea. Here, she is aboard the RVIB *Nathaniel B. Palmer* launching an XBT with the mascot of the 6th grade class at George Grant Mason Elementary School, Tuxedo, NY. She is now is at Lamont-Doherty Earth Observatory of Columbia University where she further investigates vertical mixing mechanisms, particularly internal tides and waves, in the Ross, Weddell, and Indonesian Seas.

I earned my Ph.D. at Oregon State University modeling tides while working with an observationalist and going to sea. My modeling work provided tidal estimates for subsequent field operations. In 1999, I joined Lamont-Doherty Earth Observatory (LDEO) of Columbia University. LDEO has strong observational and climate programs, which allows me to concentrate on the modeling aspect of my work, as well as to participate in field work and discuss the relevance of the results to the climate community.

Biggest Rewards: interesting work; interactions with interesting people; getting grants funded; and outreach to school kids and getting them to like science.

Biggest Challenges: Past – overcoming prejudices against women scientists (things have improved); Now – getting funding, along with everyone else.

Rebecca Robinson

Research Scientist, Princeton Environmental Institute, Princeton University, Princeton, NJ, USA, rebeccar@princeton.edu

My attraction to the ocean and the natural sciences began during childhood when, like many children, I was sure I was going to be a marine biologist. After a few years as an undergraduate geology major and one summer of sailing, I applied to graduate school to study the history of the oceans. I wanted to combine my new geology knowledge with my love for the sea to unravel the mysteries of the ancient oceans.

During my graduate studies, I became captivated with the cycling of biologically important elements and with the interconnectedness of the physical, chemical, and biological processes occurring on Earth. This led me to my current research, which focuses on the history of the marine nitrogen cycle. I use the stable isotopes of nitrogen in sedimentary organic matter as a tool to study the movement/transformations of nitrogen through oceanographic systems. It is a difficult task to reconstruct the past from what is buried on the seafloor, but at the same time, it is exciting and satisfying work to carefully extract a clean signal from amongst the noise and generate a record of nitrogen cycle changes that might otherwise have been overlooked.

Giving my son Gavin an early introduction to the drillship *JOIDES Resolution* in Galveston, Texas. We are standing on the catwalk where cores are delivered by the drill crew to the science party. The red, iron roughneck sits on the drill floor in the background.

Although a large part of my motivation comes from careful hours in the laboratory capped with the fun of synthesizing those data, I cannot deny that I just plain love working at sea. Deep-sea coring expeditions are an excellent opportunity to get your hands dirty and participate in the basic, reconnaissance-level, group data collection that tends to generate many amazing ideas and questions. Then there is also the front row seat for viewing breaching whales, glorious sunsets, and powerful storms.

I love being a scientist but I am certainly most proud to be a mother. I am looking forward to introducing my son to the intricacies and the order of the natural world. Combining motherhood with my career is demanding, but I cannot imagine living my life any other way. At the same time, it is alarming to watch the number of my female peers advancing in science decline so dramatically as we move beyond graduate school and decide to start families.

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Leslie Rosenfeld

Research Associate Professor, Department of Oceanography, Naval Postgraduate School, Monterey, CA, USA, lkrosenf@nps.edu

I have worked in the field of physical oceanography for over 25 years as a researcher, educator, and consultant, most of that time working on issues related to the circulation and water properties off the coast of California. My expertise is primarily in the area of collection, analysis, and interpretation of *in situ* and remotely sensed data, but I also work extensively with modelers to validate and improve numerical simulations of ocean and atmospheric processes. My research emphasis has been on coastal upwelling and tidal band processes, and recently I have been involved in the organization and implementation of a regional ocean observing system for central and northern California. I have taught a range of courses including: coastal physical oceanography, ocean mesoscale variability, operational oceanography, and descriptive oceanography.

I decided early on a career in oceanography, having spent a lot of time in and around the water while growing up, and having a proclivity toward the sciences. After briefly attending Tufts University and then sailing across the Atlantic aboard Sea Education Association's training research schooner *Westward*, I attended the Jensen Beach campus of the Florida Institute of Technology from which I received an A.S. in oceanographic technology in 1976. I then transferred to the University of Washington from which I received a B.S. with a major in physical oceanography in 1978. During my undergraduate years I worked summers at the Harbor Branch Foundation in Ft. Pierce, FL and Lamont-Doherty Earth Observatory in Palisades, NY, and in 1980 participated in an unsuccessful search for the *Titanic*. Then, after two years at the Naval Oceanographic Office in Mississippi, and The Johns Hopkins University's Chesapeake Bay Institute, I entered the WHOI/MIT Joint Program in Oceanography, from which I received a Ph.D. in physical oceanography in 1987. I was a postdoctoral associate at the Cooperative Institute for Marine and Atmospheric Studies at the University of Miami for two years before moving to Monterey, CA. I started out as a scientist at the Monterey Bay Aquarium Research Institute, with an adjunct position at the Naval Postgraduate School. In 1995, I reversed my roles at these institutions, and am now full-time on the research faculty at NPS, and have an adjunct appointment at the Monterey Bay Aquarium Research Institute.

The most important factor in determining the enjoyment I get out of my work is the interaction with my colleagues at all levels. I am still very close with my graduate school cohort, and I have maintained decades-long friendships with some of my former teachers, supervisors, and students. Although the number of female physical oceanographers in this country was exceedingly small at the time I embarked on my career, I know that I have had the help, in both subtle and explicit ways, of a couple of them. My career has afforded me a level of independence and adventure, that would be hard to find in many other jobs. I've traveled extensively throughout the northern hemisphere, and have sailed on many kinds of ships, including Chinese research vessels, aircraft carriers, and once as the only woman on a Navy survey ship. In recent years, much of my professional travel has been together with my husband, a professor in a closely related field, which has made it even more enjoyable. The most challenging aspect of the job is the struggle for funding. The fact that I am not the sole provider for a family has allowed me the freedom to make career choices that I may not otherwise have made.

Leslie Rosenfeld aboard the aircraft carrier, *USS Dwight D. Eisenhower*, in the Arabian Gulf in June 2000, during a visit to the Navy Meteorology-Oceanography Center in Bahrain.

Robin M. Ross

Research Biologist, Marine Science Institute, University of California at Santa Barbara, Santa Barbara, CA, USA, robin@icess.ucsb.edu

The 2004-2005 Antarctic season is my 24th season of working on various aspects of the ecological physiology of *Euphausia superba*, the Antarctic krill. But, for the first time I am sharing the experience with my entire family—husband/Co-Principal Investigator and son/volunteer are also at Palmer Station. My first oceanographic cruise was as a volunteer on a ship from the University of Rhode Island right after I graduated from the University of Rochester. I would have been the only woman on board, and was not allowed to join unless I found another woman to join me! Such a situation would be highly unlikely now. This year, the science group was half women and half men for the Palmer Long-Term Ecological Research (LTER) cruise in January.

Robin Ross (center) with son Gregory Quetin (left) and husband/collaborator Langdon Quetin (right) on the ARSV *Laurence M. Gould* west of the Antarctic Peninsula, January 2005.

Although "ecological physiology of zooplankton" is a phrase that encompasses my scientific interests, one group of zooplankton, euphausiids, captured my interest early in graduate school. Why euphausiids? At the University of Washington, where I was a graduate student, several of us routinely went out to collect water and zooplankton every week, and I was fascinated by the swimming behavior of *Euphausia pacifica*. That simple observation was the beginning! I met my Co-Principal Investigator and husband, Langdon Quetin, when we were graduate students at different institutions. As with many scientist-couples, we had decisions to make about the balance of careers and family. Our choice was to mesh our research interests and expertise so we could work together after graduate school. After two years of postdoctoral research in Australia, we were funded by the Office of Polar Programs to conduct research on the early life history of Antarctic krill. And after our son Gregory arrived, our two mothers helped out in the early years so that we could continue our intensive fieldwork in the Antarctic. Since then, we alternated time in the field so that one of us was always home during his school years.

The rewards of this life style are both professional and personal—as have been the costs. After 14 years of sampling, the rewards of our participation in the Palmer LTER, a multi-disciplinary group focused on the marine pelagic ecosystem in the Southern Ocean, are now evident—and definitely outweigh the time and effort involved in planning and executing a six-month field season each year! Now we can ask questions about trends and cycles that were unanswerable without such a rich data set. Personally, I have enjoyed the joint efforts inherent in having spouse and close collaborator in one person, and now Langdon and I are back in the field together. A less tangible but important reward comes from sharing the fun of discovery with the young volunteers each year and now my whole family.

Carolyn Ruppel

Associate Professor, School of Earth and Atmospheric Sciences, Georgia Tech, Atlanta, USA, cdr@eas.gatech.edu

Almost 35 years later, I still have the rock that I pocketed as a first grader and that launched my lifelong passion for the Earth sciences. What started as a casual hobby led to searching creek beds for Ordovician fossils as a teenager and to choosing MIT for college based on its strong Earth sciences program. Back then, MIT undergraduates were overwhelmingly male and stereotyped as wholly focused on math and science. Encountering women professors teaching upper division courses was instrumental in making geoscience seem like a viable career choice. And my peers' occasional disdain for those of us with parallel interests in the humanities became easy to ignore once I realized the importance of reading and writing skills to success in the sciences.

In the mid-1980s, I chose to stay at MIT for a Ph.D. in continental geophysics and geology, which at that time was considered interdisciplinary science. It was not until I landed a postdoctoral fellowship to study marine analogs of continental rifts at Woods Hole Oceanographic Institution (WHOI) that I developed an appreciation for oceanography. The postdoctoral years at WHOI transformed my career and research and convinced me to go back to sea, something I had avoided since an overly eventful Southern Ocean cruise in graduate school. Since leaving WHOI, I have participated in and led numerous oceanographic cruises and spent over a decade as a professor at Georgia Tech. Today, I work with microbiologists, geotechnical engineers, and aqueous geochemists on field-based and numerical modeling projects focused on marine gas hydrates and coastal zone environmental geophysics and hydrology. My most satisfying accomplishment at Georgia Tech has been engaging our talented undergraduates in research projects aboard oceanographic vessels and in salt marshes.

For the past 18 months, I have concurrently served as a temporary program manager in the National Science Foundation's Division of Ocean Sciences. Science might benefit if more mid-career researchers deviated temporarily from the predictable academic career path and took advantage of the opportunity to work in Washington, D.C.

During a cruise on the R/V *Atlantis* in 2003, I discussed new images of the seafloor with University of Wyoming seismology Ph.D. student Matt Hornbach. Collaborating with biological oceanographer Cindy Van Dover from the College of William and Mary and with support from NOAA Ocean Exploration, I organized DSV *Alvin* dives and geophysical surveys aimed at understanding the link between seafloor chemosynthetic communities and the physics and chemistry of the underlying methane hydrate reservoir. Photo by M. Olsen.

The joy I derive from my scientific work has been tempered by the challenges of maintaining a personal life. Since being married more than a decade ago, my engineering professor husband and I have always worked at universities in different cities, sometimes more than 2000 miles apart. While fairly unusual among dual Ph.D. couples, this choice ensured that neither of us sacrificed the intense research career for which we had trained. The recent birth of our daughter has meant a welcome beginning to family life, something we thought we had forfeited by putting career-building ahead of our personal lives in our thirties.

Ann D. Russell

Associate Research Scientist, Department of Geology, University of California, Davis, CA, USA,
russell@geology.ucdavis.edu

I came to oceanography by a circuitous route, probably because I didn't discover an affinity for science until mid-way through college. After an undergraduate degree in Latin American Studies, I shifted my emphasis and completed an MS in hydrogeology, hoping to make an applied, practical contribution to the world. With my graduate degree in hand, I worked for several years in consulting on ground-water quality issues.

However, I found my consulting work intellectually unsatisfying. In 1986, a friend in Seattle told me about his research in oceanography and encouraged me to get involved. Of all the fascinating topics in chemical oceanography, the development and application of trace metal and isotope geochemistry to problems in paleoceanography appealed to me most. I finished my Ph.D. in oceanography at the University of Washington in 1994, and have been working on trace metal and isotope geochemistry of biogenic calcite for the last fifteen years.

One of the most difficult aspects of a career in oceanography is the lack of geographic flexibility. When my husband and I, both oceanographers, finished graduate school, family considerations forced us to seek employment in Northern California. I became affiliated with the Department of Geology at UC Davis by writing a proposal to fund a postdoctoral position, and my husband landed a job with the U.S. Geological Survey. Later, I became a research scientist in the same department, and have funded all my own salary and research since then through a variety of granting organizations.

The biggest career challenge I have faced has been to find the time and energy to apply myself both to my scientific interests and to my family. I chose a research scientist career path rather than a tenured faculty position because of the greater geographic and scheduling flexibility I needed to balance family and professional demands. For a two-career couple, the lack of security of a soft-money career is mitigated somewhat by the second income.

Would I choose this path again or recommend it to others? Oceanography holds tremendous appeal to me because of its global nature and its integration of many different disciplines. A Ph.D. in oceanography has allowed me to create my own career niche and follow up new areas of interest as they develop. Ultimately, the choice of a career in oceanography has been a rewarding one, offering intellectual challenge and satisfaction, as well as recognition of my effort and scientific contributions.

Ann collecting specimens of *Mytilus californianus* in Mendocino, California as part of a study that uses the oxygen and carbon isotopes of archaeological mussel shells to determine changes in upwelling along the northern California coast. Her field work has also led her to culture planktonic foraminifera, and to discover that U/Ca in foraminiferal shells is sensitive to seawater pH and could thus serve as a new paleoceanographic proxy for changes in the seawater carbonate system.

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Ana Sabatés

Research Scientist, Institut de Ciències del Mar (CSIC), Barcelona, Spain, anas@icm.csic.es

What triggered my entry into science was the need to make a choice between music and biology for university studies. Ultimately, I decided that I had better do formal course work in biology and maintain my interest in music on the side. At the end of university studies, I decided to pursue a career in science. After some time, I became very interested in oceanography when I participated on my first oceanographic cruise. I was intrigued by this field because there were lots and lots of unknowns.

Since the beginning of my career I was attracted by the fascinating world of fishes. We are mostly familiar with the adult phases, but most of us would be hard pressed to recognize the equally important larval stages, which look very different from the adults. Unlike the adults, which live on different habitats, from the seafloor to the open waters, the small planktonic fish larvae rise up into the water column and drift with currents.

Understanding how these crucial stages of the fish life cycle follow a successful pathway in the stochastic marine environment have been my central interest during all of my scientific career. Throughout their life in the plankton stage, fish larvae must overcome a set of difficulties, for example, hydrographic barriers and discontinuities, drifting, lack of food, and predators. In this context, ichthyoplankton studies are a puzzle of questions that can be only answered in the framework of multidisciplinary projects. To carry out joint research with physical, biochemical, and biological oceanographers has been one of the main challenges of my professional work.

The only time I've ever been nervous and felt that things were going to be difficult because I was a woman was when I got married and decided that I wanted to start a family. I decided that I just had to go for it and hope it all worked out. Now I have a wonderful nine-year-old daughter named Anna. I am lucky. To be honest, my goal has been to balance both job and family. The cooperation of a nice set of colleagues together with the collaboration and understanding of my husband, who is also oceanographer, have contributed toward reaching this goal. Organization and participation in oceanographic cruises represent a long time away from my family. This activity is, perhaps, the only one that requires an extra effort as woman and mother. But, I recognize that my career has never been hampered due to the fact that I am a woman. It is right and just to remember and applaud the woman scientists who laid the foundation in Barcelona, in particular, and in the Catalan society in general, and facilitated the work of the new generations of scientists.

Oceanography takes a big chunk of my time. Going to sea is the most exciting part of my work. I love playing with my daughter and talking with my husband. We go out and do all sorts of things. I'm out of shape, but I still play piano and have a great time.

Katherine B. Schwager

Graduate Student, Graduate Program in Marine Science, University of California, Santa Barbara, CA, USA, kschwager@icess.ucsb.edu

My earliest distinct oceanographic memory is the smell of the South Street Seaport in the summer in Manhattan. Growing up in New York, I learned to explore beyond the city for sanity. Adventuring across the United States and overseas hooked me onto fresh mountains, forests, and waters. My pursuit to learn about and spend time in the ocean began the July after ninth grade when I visited Argentina, saw surfers for the first time, and decided to learn how to ride waves. After college, I flew to Cape Town because a teacher had taught me about South Africa and Apartheid and I wanted to find out for myself why she thought the country was such an interesting, dynamic, and beautiful place. In addition to researching social issues, learning about the culture, and camping in gorgeous game parks, I survived beginner surfing and dove in kelp for the first time as a volunteer at Two Oceans Aquarium. Everyday in South Africa was educational and packed with once-in-a lifetime experiences, making the return to New York for cubicle corporate work seem dry. Having always loved the ocean and eager for more adventures around it, I moved to San Francisco.

In San Francisco I heard about Santa Barbara City College's outstanding Marine Science and Marine Diving Technology programs; I moved there to pursue studying marine science, and while taking classes I was able to teach and work as an ocean scientist. A summer school teacher, I discovered that children and parents enthusiastically pay attention to the environment as long as science is presented in an experiential, colorful, and appropriate way. My passion for the ocean combined with teaching, diving and surfing leads me to pursue a career in oceanography.

Currently, I'm a graduate student in Marine Science at University of California Santa Barbara earning a master's degree studying marine hydrocarbon seeps off Coal Oil Point, Santa Barbara, and seeking a Ph.D. advisor to research local and international marine reserves. Hands-on, interdisciplinary aspects of biological oceanography and ecology interest me most. My short-term research goal is to focus on local marine reserves and fisheries, combining ecological and biological work with economics and social science perspectives. Long term, my goal is to apply firsthand scientific and community knowledge to creatively solve international ocean problems.

Katherine Schwager, offshore of Anvers Island, Antarctic Peninsula. Volunteering with the Palmer LTER (Long-Term Ecological Research) group Oct - Dec 2004, I used SCUBA and a dry suit to collect *Euphausia superba*, a shrimp-like crustacean vital to the food web. Penguins, seals, and whales consume krill; therefore, changes to krill populations may affect the marine ecosystem as a whole. This project collaborates with other LTER studies to investigate how krill populations may vary with changes in annual advance and retreat of sea ice. Photo courtesy of Cara Sucher.

The most rewarding aspects of becoming an ocean scientist include meeting mariners who love what they do, as I did on my recent opportunity to do research in Antarctica, and work with dedicated and enthusiastic professors. Experts abound who are willing to teach someone like me how to dive under ice, catch octopi, and observe distribution of both sedentary intertidal mollusks and transient underwater bubbles. I like the constant challenges of this work, and I'm driven and motivated to reach my goals. In such a dynamic field as marine science, there are many qualified graduate students vying for limited grants and advisors, but I've found that being a determined and open-minded person uncovers many opportunities. So far, it seems that being organized, curious, and fun-seeking is critical to becoming a good ocean scientist.

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Mary Scranton

Professor, Stony Brook University, Stony Brook, NY, USA, mscranton@notes.cc.sunysb.edu

I am a marine biogeochemist, by which I mean that I am interested in the interactions between organisms and the chemistry of the environment. I have always been interested in understanding the persistence of chemical species in places where they "shouldn't" be and the absence of chemical species in places where they "should" be. I also have enjoyed the opportunity to try to marshal my knowledge of the physics, chemistry, biology, and geology of a system to tease apart interrelationships.

Sampling the waters of the Cariaco Basin on the B/O *Hermano Gines*. Photo by Slava Epstein.

My dissertation topic, "The Marine Geochemistry of Methane," was chosen (after a large number of false starts) following a suggestion by my dissertation advisor, Peter Brewer. The topic appealed to me as interdisciplinary, at a time when biogeochemistry had not yet been invented. I had the opportunity during graduate school to collect samples on several cruises, including one to the Cariaco Basin, which continues to be the site of much of my research. During my National Research Council postdoctoral fellowship at the Naval Research Lab, I branched out into the study of hydrogen gas in the ocean. I have continued to explore how reduced gases can be abundant in oxic waters. Recently, my early fascination with anoxic basins led me to my current research, which is a time-series study of the biogeochemistry of the redox interface zone of the Cariaco Basin.

To me, the most interesting aspect of oceanography is the inter-connectedness of things, and the need to understand SYSTEMS rather than isolated aspects of an environment. The oceanographic community is also a very open one, and the opportunity to experience both the stresses and rewards of field work has been stimulating. However, the job of a female academic oceanographer is one of juggling...field work, doing science, writing papers and proposals, teaching, advising, committee work, commuting, housework, child rearing. When I entered the job market, I received no advice about how to begin a career, particularly in terms of expectations for start-up funds or balancing teaching and research. In those days, my department provided tiny start-up packages, so it was several years before I had equipment and there was no opportunity to buy something to develop data to be used to go in new directions. Once I got to the point where I had equipment, I also had a family and I often feel that I never really caught up. I am happy I made the choices I have made, particularly the choice to have a husband and a son, but the choice had consequences in terms of my overall publication rate and research productivity. By choosing a career in a university setting, where I can work with undergraduate and graduate students and can educate and mentor others as well as focus on my own work, I have been able to have a most rewarding and enjoyable life!

Evelyn B. Sherr

Professor of Oceanography, College of Oceanic and Atmospheric Sciences, Oregon State University, Corvallis, OR, USA, sherre@coas.oregonstate.edu

My husband Barry and I have been a research team for over 25 years. Our studies of the role of phagotrophic protists and heterotrophic bacteria in pelagic ecosystems have led us to Israel, the French Mediterranean, life on a barrier island on the Georgia coast, and finally to Oregon and the Arctic Ocean. My husband and I share a career, a position at OSU, and an office. We also collaborated in raising two boys, who are now young men.

My interest in marine ecology was fostered by growing up near the Atlantic Ocean in Florida; I was completely hooked by a film on oceanography shown in a high school physics class. I really don't remember any impediments to my getting a Ph.D. with an oceanographic thesis topic. I benefited from the National Science Foundation (NSF) Oceanographic Trainee Program at Duke University, which supported my graduate work and provided cruise time on the NSF trainee ship, R/V *Eastward*. The *Eastward* was officially classed as a motorboat because it was so small. The ship had such a round bottom that it rolled quite a bit even in moderate seas, not to mention the awful smell of diesel fumes wafting into the galley, or the fried food. We affectionately called the *Eastward* the "Barf Bucket." It was a test of the commitment of potential career oceanographers; it's the only ship on which I actually saw someone literally turn green.

My professors, fellow students and now colleagues, and all of our research collaborators since our graduate days have been positive influences; many have become close friends as well. The best things about oceanography for me are the very interesting scientific questions, travel to exotic places, and interacting with fellow oceanographers. There are lots more female students and professors in oceanography now than when I started, which is great to see.

Barry and Ev in Israel in 1980 at the beginning of their dual research careers.

Mary Silver

Professor, Ocean Sciences Department, University of California, Santa Cruz, CA, USA, msilver@cats.ucsc.edu

Most of my research career has been devoted to the study of marine snow with its associated biological communities and to the role of these particles in delivering microorganisms and organic matter to the deep sea. More recently (last decade) I have become fascinated with toxic phytoplankton and the passage of their toxins through oceanic food webs. Both of these major directions "came" to me through direct, personal encounters: marine snow through observations of masses of particles that interfered with my (and my student's) ability to observe zooplankton, and toxic algae through a mass kill of local seabirds by algal toxins. The scientific questions that arose for me followed the observations quite naturally, given my interests in both marine organisms and oceanography.

I have greatly enjoyed being an oceanographer, because it allowed me to study the natural world, work with students, collaborate with interesting colleagues, travel, and have a full, rich intellectual and personal life. I like the diversity of activities that comes with being a university professor and an active researcher: when I am weary of one aspect of my job I can refocus on something else. My career challenge, correspondingly, has been to complete tasks that are difficult but essential: early in my career I focused on teaching, not research and was almost denied tenure—but the pressure resulted in my completing a series of papers on marine snow, publications of which I am now quite proud.

Balancing activities within my career has probably been more difficult than balancing career with personal life. My children and family have always come first. I have clearly not spent as much time with my two children as a stay-at-home parent, and guilt about this has been my frequent companion. But family vacations and spending time together during the week have been key, as were good childcare accommodations (often requiring great creativity). Interestingly, my most productive scientific output came during times when my children were small: I "cut corners" all around, but major negative effects, surprisingly, are not evident.

As a graduate student, I often felt out of place, experiencing both an absence of other women students and faculty whose lives and "style" I could use as models. Today, happily there are many more women in the field and I am much more comfortable in this more diverse community. However, those of us who choose families and/or who still find ourselves in stereotypically feminine social roles, face challenges that require supportive networks of both work and outside friends for our personal well-being.

Bernadette M. Sloyan

Assistant Scientist, Woods Hole Oceanographic Institution, Woods Hole, MA, USA, bsloyan@whoi.edu

My research interests are driven by a desire to understand the ocean's role in climate and climate variability. To this end, my current research is focused on understanding the underlying ocean dynamics that influence (1) the size and structure of the Southern Ocean overturning circulation, and (2) the formation, property characteristics, and dispersal of mode waters, namely, Southern Ocean Subantarctic Mode Water and Antarctic Intermediate Water. I am approaching each research theme from a number of angles, and am pursuing these themes through collection and analysis of a wide variety of ocean observations—shipboard, floats and moorings, and remotely sensed data (satellite altimetry).

Throughout my high school education I enjoyed mathematics, physics, and chemistry. I was also very interested in learning about Earth's climate system, specifically how the different components (ocean, atmosphere, biosphere) interact. Physical oceanography allows me to apply my mathematics and physics skills to investigate questions concerning ocean circulation and ocean-atmosphere interactions. The use of these skills to explore environmental issues is one the enjoyable aspects of my research; the other is the exploratory nature of ocean science. Ocean circulation and its interaction with the atmosphere and biology is still poorly observed and understood. Going to sea to collect observations always reveals some novel results.

Combining the different stages of a science career and personal life can be a challenge. The difficulty has been to combine both such that neither suffers unduly. When my children were young I refrained from going to sea and concentrated on land-based observational studies. As the children are now older I am becoming more actively involved in the planning of and participation on research proposals that require me to go to sea. This change in my research direction has required me to reinvent myself within the ocean science community. Once again I have to establish a reputation as a capable scientist able to plan and successfully complete complex field programs.

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Deborah K. Smith

Senior Scientist, Woods Hole Oceanographic Institution, Woods Hole, MA, USA, dsmith@whoi.edu

I am a sea-going scientist. My field is geology and geophysics. I map the seafloor using many types of instruments, including hull mounted bathymetry systems, deep-towed side-scan sonar systems, and near-bottom camera systems. I also collect gravity data, magnetic data, earthquake data, and rocks. I've done field work in Hawaii and Iceland to understand how volcanoes work on land to use these insights to interpret the volcanoes we map on the seafloor. My major research focus has been to understand the underlying forces that build the oceanic crust and shape the seafloor.

I became interested in oceanography in the late 1970s when I spent some years sailing the oceans on a 30-foot-long sailboat. I already had an undergraduate degree in mathematics, but during the time sailing, I decided to go back to school to learn more about the oceans. I went to the City College of San Francisco and took classes in geology, biology, physics, and chemistry. I decided that I was really interested in marine geology. I got a second undergraduate degree in geology from San Francisco State University. After that, I got my Ph.D. at Scripps Institution of Oceanography, and went to Woods Hole Oceanographic Institution as a Postdoctoral Scholar in 1986. I have been on the scientific staff in the Department of Geology and Geophysics at Woods Hole since then.

During my career I have noticed several things that have changed on how we do science, including the following:

- Right after I left graduate school in the mid-1980s, it became common for women to go to sea.
- A little later it became common for women to be chief scientists of research cruises.
- The way scientists do science at sea has changed. When I was a graduate student we deployed and retrieved the instruments ourselves. We were responsible for making sure that if you were towing an instrument the wire angle was OK—the ship wasn't going to run over the wire or drift down on it. From my perspective, scientists are more removed from that now. It is someone else's responsibility—usually a technician or the ship's crew.
- We entered the digital era. Data are given to scientists in digital form rather than on paper.
- Technological advances in instrumentation have been huge. For example, we now have autonomous underwater vehicles (AUVs) that collect data close to the seafloor and return to the sea surface without being tethered to the ship in any way.
- Going to sea is no longer as if you've disappeared from the face of the Earth. It is more like sitting at your desk. That has been a very good change. It means that not only can you keep up with your work at home, but you can also keep in touch with your family and friends much more easily.

Debbie Smith looking at cliff dwellings in Bandelier, New Mexico during a drive from Albuquerque to Phoenix a couple of years ago.

Heidi M. Sosik

Associate Scientist, Woods Hole Oceanographic Institution, Woods Hole, MA, USA, hsosik@whoi.edu

Being an oceanographer is a fabulous challenge that has brought me many rewards. My research interests focus on the ecology of phytoplankton and on understanding what controls their patterns of distribution, productivity, and species composition in the ocean. This is a very interdisciplinary research area that involves knowledge of not only biology, but also ocean chemistry and physics. I am principally an observational scientist studying natural systems, but critical aspects of my research activities include engineering, mathematics, computer programming, theoretical analyses, and various types of modeling. For many years, I have been involved in the design and development of optical instruments that make new kinds of observations possible. For me, the breadth of necessary skills, knowledge, and modes of discovery makes this work fun and interesting.

Oceanography caught my attention as an undergraduate at MIT, while majoring in civil engineering. I had the opportunity to do a small research project involving phytoplankton in Penny (Sallie) Chisholm's lab. The project didn't really work out, but I was intrigued enough to jump at Penny's suggestion to consider a summer research fellowship at the Woods Hole Oceanographic Institution (WHOI). At the end of that summer, I had the chance to go on a three-week research cruise, after which I was definitely hooked! I returned to MIT, decided to stay for an extra year to complete a master's thesis, working jointly with Penny and Rob Olson (my summer advisor at WHOI); I then went on to get my Ph.D. in biological oceanography at Scripps Institution of Oceanography. Later, I returned to WHOI as a Postdoctoral Scholar and now have a tenured position.

How have I managed to balance career and family life? This is a question I have been asked probably more often than any about my research! I have a happy marriage (to Dan Kilfoyle, whom I met at MIT) and three children, now aged 14, 11, and 6 years. The most important part of my answer is that I have not managed this balancing act, rather Dan and I have done it together. This involves a lot of communication and a huge dose of mutual respect, both over career and family work. Dan has a demanding engineering career, but has negotiated for flexibility, such as working from home, and is a true equal parent. For me, it is especially important that we live with a simple set of priorities, some of which may be at odds with mainstream social pressures. We are not slaves to these priorities every minute, but we try to make creative choices based upon them, and I make a conscious effort to assess how we're managing against our own priorities, not against cultural standards. This is my recipe for balance, guilt resistance, and fun, with career life and personal life all mixed up.

Some of my current research is focused on coastal waters, where our understanding of the regulation of phytoplankton communities has been limited by the spatial and temporal scales associated with traditional monitoring approaches. To overcome some of these limitations, my colleagues and I have developed submersible autonomous flow cytometers that we deploy from small boats at coastal observatories. My research involves optical measurements of phytoplankton ranging from individual microscopic cells up to regional scale patterns observed from earth orbiting satellites.

Yvette H. Spitz

Associate Professor (Senior Researcher), College of Oceanic and Atmospheric Sciences; Oregon State University, Corvallis, OR, USA, yvette@coas.oregonstate.edu

As a physical and biological oceanographer, my interest resides in investigation of the main pathways in marine ecosystems, development of coupled physical-biological models, and data assimilation. My current research includes the use of data-assimilative models in conjunction with observations from long-term time series and remote-sensed ocean color data to model the dominant ecosystem pathways, estimate model parameters, and model errors for the North Pacific basin. In collaboration with colleagues from Belgium, a data assimilative model is applied to study eutrophication in the North Sea. My long-term interest in coastal dynamics and the response of the ecosystem to wind-driven circulation (e.g., upwelling) led me to study, via modeling, the ecosystem response to upwelling off the Oregon coast. Finally, I have recently been involved in a multi-principal-investigator project to study the coupling among the atmosphere, sea ice, ocean, bowhead whale, and subsistence whaling by the indigenous human populations of the northern Alaska Coast.

A career in oceanography was not one of my goals as a teenager. Indeed, I obtained my degree in physics from Liège University in Belgium. At that time, I was convinced that I would be a high school physics teacher. During the last year of my studies at the university, I discovered oceanography. I spent a summer month in Calvi, Corsica, where Liège University had an oceanographic research station. A senior thesis was required for obtaining a degree in physics, and I did one related to physical oceanography, with Professor Nihoul as my mentor.

My interest in physical oceanography did not stop after my B.S. degree. In addition to learning about circulation in the ocean, I decided that I needed to learn English (French is my first language). In 1987, I moved to the United States and got my master's degree in physical oceanography from Florida State University, then my Ph.D. at Old Dominion University. During my Ph.D. studies, I met a visiting professor, Linda Lawson, from East Tennessee State University. In collaboration with Linda Lawson and Eileen Hofmann, I applied data assimilation to estimate ecosystem model parameters. Even though this topic was not part of my dissertation research, it was the beginning of my career in coupled physical/ecosystem assimilative modeling. It was also one of the first applications of data assimilation in the field of ecosystem modeling.

On a horse is where you can find me if I am not at my computer.

In 1995, I came to OSU as a postdoctoral fellow under Mark Abbott's supervision. It is at that time that I acquired the necessary knowledge in the field of biological oceanography. While the transition from physicist to biological oceanographer has offered some challenges, I feel fortunate to have had the opportunity to approach the field of oceanography from different angles. My interest in teaching, however, never died and this July, I should become part of the teaching faculty in COAS.

Debra S. Stakes

Marine Science Systems Facilitator, Division of Marine Operations, Monterey Bay Aquarium Research Institute, Moss Landing, CA, USA, debra@mbari.org

I arrived in my present position through a long and circuitous journey that included two postdoctoral stints, eight years as an academic professor/researcher, and then 11 years at MBARI as a research scientist. Math and science were my forte in high school and college, but it was my awe of the Earth's processes that inspired me to stay in this field for so long. A movie in my fifth-grade science class about oceanographers exploring the last frontier was instrumental in my choice. I was ready to sign up right away when the narrator suggested that oceanographers do not need to focus on only one science, but rather blend them together, into an interdisciplinary toolset customized to unravel the mysteries of the oceans. Notwithstanding a brief fling with chemistry in college, I stayed true to my first love and went to graduate school in oceanography at Oregon State University.

This photograph captures the highly collaborative nature of my research. Geochemist Michael Perfit (University of Florida) sits to my left. Geophysicist Maurice Tivey (WHOI) sits behind me, and research assistant Tony Ramirez is to my right. We are deeply engrossed in planning a series of remotely operated vehicle dives to study the geology and volcanic history of the southern Juan de Fuca Ridge (Northeast Pacific Ocean) while sitting in a lab aboard MBARI's research ship the R/V *Western Flyer*. Photograph taken by intern Greg Moretti.

During my last year of graduate school in 1977, I was invited to be the archivist on the first *Alvin* expedition to the Galapagos Spreading Center where I witnessed the discovery of thermal vents and their unexpected inhabitants. Today, the growing understanding of how the ocean impacts Earth's crust, and vice versa, is profound, especially when you consider the potential microbiogeochemical linkages. I love fieldwork that pursues such processes in both relict and real-time systems. This has included a decade of work on the fossil hydrothermal system of the Oman ophiolite and numerous submersible expeditions to active vents on mid-ocean ridges.

A major life transition was when I walked away from a tenured faculty position to move to MBARI in 1993. Almost too old to have kids and five months pregnant, I shifted my research to accommodate MBARI's goals. Their corporate employee benefits model, the paid maternity leave, the option to work normal eight-hour days, and the choice to forego extended cruises for five years, supported me in having a family while maintaining a career in science. It is not the norm for many academic institutions, but it should be. Women should be applauded for balancing work and raising children. My family now includes a (former *Alvin* pilot) husband, a daughter, eight cats, and three horses.

As my current title suggests, I transitioned again, about a year ago, from doing my own research to supporting other scientists. I work at the interface between marine operations, science, and ocean technology. This new career has brought me renewed inspiration to play a role in transforming the face of ocean science to include the extended virtual presence provided by seafloor observatories.

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Linda Stathoplos

Chief Oceanographer, ORBIMAGE Inc., Dulles, VA, USA, stathoplos.linda@orbimage.com

As a teenager, I distinctly remember reading about Sylvia Earle diving into the deepest reaches of the oceans, and thinking to myself, "Wow! That is so COOL! Too bad I'll never do anything that cool." Then I had one of those slap-yourself-in-the-forehead moments. Why couldn't I do something that cool? So I decided then and there to become an oceanographer.

My college biology professor hired me to be her summer lab assistant at the Marine Biological Laboratory in Woods Hole, Massachusetts. I also got to collect data for Mussel Watch as a WHOI Summer Student Fellow. Spending summers in Woods Hole was like oceanography heaven.

After I received my B.A. in biochemistry from Swarthmore, I went to the South Pacific to live on a sail boat for several months. The amateur scientist captain and his crew were documenting the occurrence of ciguatera outbreaks around the Solomon Islands. We went SCUBA diving every day to map the coral reefs, and interviewed local populations about incidents of fish poisoning.

I returned home to attend graduate school in 1983. I earned my Ph.D. in biological oceanography at the University of Rhode Island's Graduate School of Oceanography in 1989. One of my favorite experiences was going to sea on a six-week cruise to the North Atlantic, SCUBA diving daily to help collect gelatinous zooplankton. I also collected living planktonic foraminifera to do shell protein analyses for my thesis work.

My husband and I moved to the Washington, D.C. area in 1990 for my postdoc at the Smithsonian. We had two children, and since they were born I have worked part time. I worked at NOAA's National Oceanographic Data Center for five years, and have worked at ORBIMAGE for over seven years. Our ORBIMAGE Oceanographic Solutions team makes products from satellite data and ocean models that portray near-surface ocean conditions. We deliver them to commercial fishing and environmental monitoring customers worldwide.

Sometimes I get discouraged comparing my professional accomplishments to those of my full-time peers, but then my daughter will show me her school newspaper column, or my son will proudly display his latest sculpture, and I remember I've found the right balance for me. And in 2002, I met Sylvia Earle and got to thank her personally for inspiring me to become an oceanographer.

What do I love about oceanography? Going to sea, saving data for future generations, viewing the Earth from satellites, helping manage living marine resources more effectively—everything!

The author in 1985, donning her dry suit in preparation for a SCUBA dive off the coast of Greenland. Gelatinous zooplankton were collected in jars to avoid damaging delicate structures. Inset: the author in 2005.

Deborah K. Steinberg

Associate Professor, Department of Biological Sciences, Virginia Institute of Marine Science, The College of William and Mary, Williamsburg, VA, USA, debbies@vims.edu

I am a biological oceanographer interested in zooplankton ecology and biogeochemical cycling, the biology of the deep sea, and detrital food webs. What lies at the basis of my interests is the organisms themselves; I never cease to be fascinated by the enormous diversity and beauty of plankton. Like many people I arrived in my field through a series of life experiences with the ocean starting in childhood. It was in college that I chose my field. While at the University of California, Santa Barbara, I had a series of fantastic research cruise experiences in the Sargasso Sea, the Antarctic, and blue-water SCUBA diving off California. By the time I graduated I wanted to be an oceanographer. In graduate school at the University of California, Santa Cruz under the exceptional guidance of Mary Silver, I learned how to be a researcher and an educator. An important part of my maturation as a scientist was my first position at the Bermuda Biological Station for Research. Here I worked with the Bermuda Atlantic Time-Series Study, part of a large interdisciplinary and international program in which I increased my network of colleagues significantly and became an independent scientist. Here, as a "soft money" researcher, I also learned how to deal with the career challenge of getting funding for my research. I responded to the challenge by getting help from my more senior colleagues, tapping into my newly expanded network, and most importantly perseverance!

Certainly, another challenge has been balancing my career with my personal life. My husband is also a professional and we have two young boys (6 years old and 11 months old). I worried about when to have our children, but soon realized there would never be a "convenient" time to have kids—there would always be a cruise or some important meeting I would miss. So we decided to start our family when it felt right. Importantly, both institutions in which I worked when I had my children provided good maternity leave and moral support. I learned the important lesson then that my professional world really could continue to turn without me for a little while...

I am fortunate to have had a number of terrific women mentors early in my career. Although I have also had equally wonderful male mentors and colleagues, it was key for me to see women who were successful in academic or research positions as I moved through the stages of my own education and career. I work with a supportive and fun group of women faculty in my present position at the Virginia Institute of Marine Science too. The professional and personal relationships with colleagues, the enthusiasm and growth of my students, and of course the adventure and science discovery, have all made oceanography tremendously rewarding.

Debbie Steinberg prepares for a zooplankton net tow aboard the R/V *Weatherbird II* in the Sargasso Sea.

Alina M. Szmant

Professor of Marine Biology, Center for Marine Science, University of North Carolina at Wilmington, NC, USA, szmanta@uncw.edu

I am a coral reef scientist. I grew up in Cuba and Puerto Rico in an era when women stayed home and raised families. In 12th grade, I went on a field trip to a field station where I learned about oceanography as a career. The following summer, I took a marine biology course at the same lab. Little did I know that the experience would change my life. I tried SCUBA, learned about coral reefs, and went sampling for pelagic fishes. I decided that summer I wanted to become a marine biologist.

I went to Scripps Institution of Oceanography (1966) for graduate school, and left with only a master's degree—but not before I participated in the Tektite II Undersea Habitat program. As part of the first group of women scientists—"aquagals"—to participate, we were acclaimed, paraded, and photographed; the 60 male aquanauts got barely any notice.

Later I followed my first husband to the University of Rhode Island Graduate School of Oceanography where I returned to graduate school. I had a daughter before I finished my Ph.D., and many thought my academic aspirations were over (this was 1978). When I accompanied my husband to Florida State University where he was accepting a job, they saw my belly, and a male faculty remarked to me "I guess you won't be needing a laboratory after all, will you?"

In fact, I was back in the lab two weeks after giving birth. I loved my research and juggled baby and research to finish my dissertation. When my marriage broke up, I accepted a soft-money faculty position at the University of Miami's Rosenstiel School (RSMAS) at a time when there was pressure to increase the number of women faculty, but there was still plenty of prejudice against us. Women now make up a double-digit percentage of the faculty! More than half the graduate student body has been women for a long time. But many drop out after finishing their doctorate because they want to start families and are afraid of the frazzled life they see women like me leading.

I credit my long-term success in oceanography in part to finding partners supportive of my aspirations. My second husband emotionally supported me through the (at times) exhausting effort that lead to promotion to full professor, having a second child at 42, and being away on long cruises. My advice to young women oceanographers who also "want it all" is to carefully choose your partner, and make sure he is willing to deal with diapers, toilet paper, and paying bills when you are away.

The good news is that the academic atmosphere is different from when I started 40 years ago. Women are more common in all ranks of oceanography, and few men would dare to be openly chauvinistic towards us. We still have the challenge of unequal responsibility for the family and a research system that is so competitive that many women (and men) change professions rather than sacrifice their personal lives to their work. My hope is that as more women rise to positions of prominence, a more reasonable set of expectations for success will lead to a more balanced gender ratio in our profession and a more balanced life for both male and female oceanographers.

Kazuyo Tachikawa

Research Scientist, CEREGE, CNRS/University Aix-Marseille III, Aix-en-Provence, France, kazuyo@cerege.fr

Fifteen years ago, I was a patent engineer at one of the biggest Japanese companies in Tokyo, but thinking of coming back to academia. I had stopped my studies at the master's level because of financial difficulties and uncertainty about my future. Working at that company made me realize that my passion was for the ocean sciences. Four years later, I left Japan for France to do my Ph.D. because I was already too old for the Japanese system, and I wanted to get some original experience in a foreign country.

Although I first struggled with communication problems and cultural gaps, I was impressed by a number of female researchers at the institute. I would not say that France is a utopia, but working conditions for women were well advanced compared to Japan: the child-care system and the generally accepted idea that women go back to a professional life even after having children. It is just natural to combine career and family! I married a Frenchman and decided to settle down in France. After several postdoctoral experiences, I finally obtained a permanent position as a CNRS (French National Center for Scientific Research) researcher. My current scientific interest is marine biogeochemistry and paleoceanography. I started my research activity by investigating trace metals and radiogenic isotopes in marine environments. A personal milestone was the postdoctoral stay in Cambridge (UK) where I became interested in the chemistry of biogenic carbonates. I currently work on foraminiferal test chemistry within a research team that specializes in paleoceanography.

The most serious difficulty that I confronted was that the age limit to apply for a young CNRS researcher position in France was 31 years old. The four years I spent in the company in Japan had delayed the completion of my academic training, thus I had to directly apply for a senior researcher position. It is regrettable that in the current system, which favors younger candidates, a person cannot take the time to first get experience outside of academia. Finally, I would like to cheer up Japanese colleagues who have been struggling to improve the working conditions for women. They still have a long way to go, but the improvement achieved during the last ten years has been amazing. When I was in Japan, women generally stopped their study at the master's level because there was almost no chance for them to get a permanent position in academia. Female Ph.D. students are no longer rare, although a serious disproportion still exists between male and female permanent researchers.

Onboard sampling during cruise P.I.C.A.S.S.O. on the research vessel *Marion Dufresne*. The retrieved giant piston (CALYPSO) core is cut to sections. Photo by Brooke Olson.

Liana Talaue-McManus

Associate Professor, Division of Marine Affairs, University of Miami Rosenstiel School of Marine & Atmospheric Science, Miami, FL, USA, lmcmanus@rsmas.miami.edu

My career in oceanography started inauspiciously with a fascination for plankton. As an undergraduate, I collected these and perfected the art of mounting them in balsam. For my Ph.D. thesis, I studied how a temperate copepod, *Acartia tonsa*, formed resting eggs in Narragansett Bay. I found that only the fall females, conditioned and reared during rapidly cooling waters, laid these eggs and did so increasingly as day length shortened.

Upon returning to my home institution at the University of Philippines Marine Science Institute, pressing coastal issues quickly broadened my research portfolio. This inevitably included designing policy that regulated the harvest of coastal resources and the multiple use of nearshore waters. I worked with a team of economists, community development specialists, and fellow oceanographers to outline a municipal management plan in dialogue with local stakeholder groups. In parallel, I continued to study how planktonic production supported multispecies fisheries, both nearshore and along the oceanic shoals of the South China Sea.

In the mid 1990s, I led a Philippine team to examine how people living in the catchments and along the coasts influenced sediment and nutrient fluxes to Lingayen Gulf. Colleagues in Malaysia, Thailand, and Vietnam, examined these interactions in their respective sites. This regional project initiated me into global change research on land-ocean interactions. Shortly thereafter, I analyzed environmental issues that affected the littoral states around the South China Sea.

Currently, my research interests include quantifying anthropogenic influence on material loadings at regional and global scales, and relating local ecological knowledge with participatory management at village and bay-wide scales. I remain fascinated with how social-ecological interactions manifest different but related properties at multiple scales. It is most rewarding to connect these relationships with policy so that society may chose to mitigate and prevent further environmental degradation. As current chair of a global change research program on Land-Ocean Interactions in the Coastal Zone (LOICZ), I am privileged to work with communities of coastal scientists worldwide on these interdisciplinary research foci.

My family from left to right: Tabitha (13 yrs), Lisa (17 yrs.), the author, Naomi (13 yrs.) and husband, John.

While exciting and groundbreaking, interfacing science and policy has not always been mainstream in the merit system for natural sciences. Slowly but surely, an increasingly globalized world is shifting a specialization-based analytical paradigm to one complemented by system-wide approaches. Integration and interdisciplinarity are just now gaining credibility.

Having chosen to go both for career and family, my life is a perpetual weave of surprises and challenges with the edges fraying occasionally. Some invisible glue keeps them from totally unraveling. My 81-year-old father provides the long-term supply to which my husband adds his seal of support. My daughters reward missing skating performances with patient tolerance. Lisa, my 17-year-old seems headed towards a marine science degree. I secretly cherish the emulation and hope she nurtures her passion no matter what.

Lynne D. Talley

Professor, Scripps Institution of Oceanography, University of California San Diego, La Jolla, CA, USA, ltalley@ucsd.edu

As a physical oceanographer specializing in observations and interpretation of water properties and circulation at ocean basin to global scales, I work at the interface of oceanography and climate science. I use observations to find patterns that can be understood in terms of basic dynamics, and use only the simplest models to help interpret my findings.

I ended up as an oceanographer because I enjoyed math and physics in high school, and had supportive teachers. I recall sitting in the Oberlin dorm lounge staring at the course catalog and deciding to major in physics, for no obvious reason other than thinking I could only learn physics through serious classroom study. I was heading towards specializing in low-temperature physics following several internships in college, but a copy of the Woods Hole Oceanographic Institution magazine *Oceanus* made its way to the Oberlin physics student lounge. So, I applied to graduate school in physical oceanography at WHOI/MIT as a shot in the dark—and then went there because Massachusetts had gone for McGovern in 1972!

At WHOI I heard about things I'd never had a clue existed—internal waves especially blew me away. Ultimately, I chose to study problem-oriented geophysical fluid dynamics, so worked with Joe Pedlosky for my thesis. After finishing my Ph.D., I had two postdoc offers, which were both great from the point of view of science. I felt that the choice would affect my science direction and truly couldn't choose. So I walked around Eel Pond, pulled out a quarter and told myself that I would stick with the result. Heads, and I had a wonderful experience at Oregon State with Roland deSzoeke.

I then went to Scripps and San Diego and here I am more than 20 years later. It's been a fantastic environment—the rich and broad group of scientists, great students, seminars, and, of course, the freedom that comes with tenure.

The rewards of being an academic ocean scientist are being able to think globally; looking at some weirdness in a data set and suddenly seeing something much larger than an error; flexible (not fewer!) work hours allowing family time; sitting in a seminar or teaching a class, seeing the next step, and then have a whole new problem open up.

The biggest challenges have been personal. At the beginning I had to work through shyness and face the frightening transition from diligent classroom student to creative colleague. The main challenge, though, has been balancing personal science, participation in international science, and being at home (son Max, now 14). All are important to me; I wouldn't change anything.

I have never felt inappropriately treated by academic colleagues in the United States. Only once, in another country, has discrimination had serious consequences for the science I was funded to do.

I am concerned that although the number of women in oceanography has increased greatly, we are not yet taking major leadership roles. I don't mean appointed positions or jobs, I mean leading the charge for large new programs, major new directions. Why do we seem to be content to work on small projects, or as part of a team, or occasionally running a committee, instead of dreaming the biggest dreams?

Lisa Tauxe

Professor, Scripps Institution of Oceanography, La Jolla, CA, USA, ltauxe@ucsd.edu

I am not an oceanographer. What has kept me occupied for nearly three decades is the magnetic properties of rocks and mud, sometimes at the bottom of the ocean, but also on land. In particular, I use the magnetism of rocks to address geological and geophysical problems. The applications are breathtakingly broad, from the direction of magma flow in a volcano, to how the ancient magnetic field behaved in the past, to the age of fossils lying in their muddy graves. I am also interested in how rocks get and stay magnetized and how to decipher their sometimes-cryptic recordings.

Lisa Tauxe at Fang Ridge on Mt. Erebus, Ross Island in McMurdo Sound, Antarctica. Mount Terror is in the background. Photo taken by Jasper Konter in January, 2004 during a paleomagnetic sampling trip.

I have been very lucky throughout my life. My parents tolerated my "tom boy'" ways and made it clear that girls could achieve whatever they were willing to work for. Growing up in Minnesota gave me a powerful urge to travel and I always liked being outside, so when I took my first geology course on the advice of my brother, I discovered my calling. I've been hooked ever since.

In college, I pleaded with a professor of anthropology to let me go on his expedition to Pakistan. He let me go, somewhat reluctantly I think, and it was one of those life-changing events. I discovered the pleasures and frustrations of working with magnetic recording in rocks (well, dirt really) and have never run out of interesting, challenging, and useful (I hope) things to do.

The greatest difficulty I faced in my career, one that nearly led me to quit, was what is known as "the two body problem": finding satisfying jobs for my husband and myself. I wrote a piece for *Eos* in 1992 describing the pain of that time, which is on my web site at http://magician.ucsd.edu/~ltauxe/CV/chaos.html. Things are much better now. We moved back to Scripps in 1996 after four years in The Netherlands. My husband and I have made peace with the past. And yes, things are much better for women in my field now. I was the first mom on the faculty at Scripps. When I came in to work after a brief leave (we didn't get "family leave" in those days), I was told by another faculty member that I should be "hauled in for criminal neglect" of my child. I am quite sure no new mothers on our faculty face THAT kind of comment any more.

The rising generation of women in the Earth and Ocean Science are talented, confident, and as my mother used to say, "going places." I don't think their generation will have special issues about women in oceanography because it will be so commonplace. I look forward to what they will discover.

Patricia A. Tester

Plankton Ecology and Physiology Research Leader, National Ocean Service, NOAA, Beaufort, NC, Pat.Tester@NOAA.gov

I am a native of Oklahoma and long before I received my undergraduate education in biology and chemistry at California State University-Sonoma I had decided to become an oceanographer. There were a few detours, one that included a two-year stint as the supervisor of the central quality control laboratory for a winery in Asti, CA, before I returned to graduate school to complete M.S. and Ph.D. degrees at the School of Oceanography, Oregon State University in Corvallis, Oregon. My dissertation research on zooplankton was completed at the Duke University Marine Laboratory in Beaufort, where, in 1979 I joined the staff of the National Marine Fisheries Laboratory (now National Ocean Service, NOAA).

My research efforts have focused on phytoplankton-zooplankton interactions and effects of toxic or harmful phytoplankton on the marine food web. During the summers of 1992 and 1993 I joined international research groups to study the effects of zooplankton grazing control of phytoplankton blooms in temperate water fjords and in the northern Adriatic Sea. Since 2001 I have worked with the Smithsonian Institution on the ecology of harmful algal species in Belize. In addition to authoring approximately 80 papers in journals and books, I am an adjunct professor, serving on graduate student committees at Old Dominion University, North Carolina State University, the University of North Carolina at Chapel Hill. I have sponsored four National Research Council postdoctoral associates since I helped initiate the program at the Beaufort Laboratory. I also serve on a number of state, federal, and international advisory committees on toxic/harmful phytoplankton algal toxins and public health. As a result of the research I initiated during a severe red tide bloom off North Carolina, the need for real-time satellite imagery of coastal waters was clearly demonstrated. Subsequently, the COASTWATCH program was instituted within NOAA. It provides sea surface temperature and ocean color imagery to a series of "nodes" throughout the coastal regions of the United States, including Alaska, and Hawaii for use by NOAA laboratories, collaborating researchers, and the public. Also, during this event, I presented testimony to the Small Business Administration, which helped to change the SBA's definition of "disaster." It is now amended to include red tides, thereby allowing the SBA to render assistance when "customary fishing waters are closed due to red tides, brown tides, and other natural events." In March 2000, I briefed both the Senate and House staff on the ecology and oceanography of red tides that affect marine resources. I was named to the Organizing Committee for the 10th and 12th International Conference on Harmful Algae and serve as the president of the International Society for the Study of Harmful Algal Blooms.

Pat Tester in an Oregon tide pool.

In 2002 to 2003, three members of my research group and I were honored to receive the Luigi Provasoli Award from the Phycological Society of America and the NOAA Administrator's Award for our research on harmful algae. When an opportunity arises, I enjoy hand spinning, weaving, and swimming or fishing at Cape Lookout. I live with my husband and an aging "banks" pony overlooking the marsh east of Beaufort, NC.

Debbie Thomas

Assistant Professor, Department of Oceanography, Texas A&M University, College Station, TX, USA, dthomas@ocean.tamu.edu

I was born to be an oceanographer. That is the only explanation for how I ended up here—a new assistant professor in an office in the Oceanography and Meteorology building at Texas A&M University. This decision arose from participation in my elementary school gifted program—we were assigned the fourth grade equivalent of a thesis project, and I selected oceanography (although I'm still not sure how a kid born and raised in Cincinnati, a 10-hour drive from the nearest coast, even knew the word oceanography). Within a few days I was a card-carrying member of the Cousteau Society and subscriber to *Oceanus*. And I had declared my future career to be oceanography. My father was a bit dismayed, to say the least—he had big hopes for me in the medical profession. My mother tolerated my decision, and she did a fine job on my class project (though I received no such help on my dissertation). Nevertheless, both have been proud of my career path for some time now.

Debbie at the bow of Texas A&M's R/V *Gyre*. Both Debbie and the *Gyre* turn 32 this spring.

My field of specialty within oceanography is paleoceanography, which makes me largely a geologist. I fell in love with geology after taking Earth Science during the eighth grade, and chose to major in geological sciences in college. I also wanted to play Division I college tennis, and quickly learned that I wasn't a strong enough player to be recruited by the few schools that offered an undergraduate oceanography major. So, I attended Brown University, then went on to the University of North Carolina, Chapel Hill for a M.S. in marine science, and Ph.D. in geological sciences.

As a paleoceanographer, I use the chemical and fossil content of deep-sea sediments to investigate ancient climate. This research has enabled me to become involved with the Ocean Drilling Program (ODP; http://www-odp.tamu.edu/) and the new Integrated Ocean Drilling Program (IODP; http://www.iodp-usio.org/default.html). I have had the spectacular opportunity to sail on two ODP expeditions aboard the *JOIDES Resolution* already: one to the northwestern Pacific Ocean and the other to the southeastern Atlantic Ocean. In addition, I will be sailing in the South Pacific aboard the R/V *Melville* from early February to late March 2005 (about the time you'll be reading this!) as part of a survey cruise for a prospective IODP expedition.

Clearly, one of the most exciting aspects of my profession is the opportunity to go to sea. However, research isn't the only exciting aspect of academic oceanography. I truly value my role as an educator and hopefully someday as a role model.

Ellen Thomas

Research Professor, Department of Earth & Environmental Sciences, Wesleyan University, Middletown, CT, USA, ethomas@wesleyan.edu

I never thought to be a paleoceanographer back in 1968 when I started studying geology at Utrecht University (The Netherlands). I might have chosen chemistry or biology, but geology was the only department where I was told that women were not welcome as students: that decided it. I showed them: I got a bachelor's and master's degree, then a Ph.D. studying benthic foraminifera. I married a volcanologist (Joop Varekamp) and we got our Ph.D.s on the same day in 1979, making headlines in the university paper. Then, there was the great move to postdocs at Arizona State University (thank you, Peter Buseck).

After counting and measuring 25,413 foraminifera, I wanted more from life, so I studied air pollution, with the eruption of Mount St. Helens leading to research with my husband. But, the foraminifera were more dear to my heart than dust, and I became a staff scientist at the Deep Sea Drilling Project (DSDP) in La Jolla, California. I learned the job on Leg 85 (equatorial Pacific) with the sink-or-swim method (i.e., no sea-going experience). I was lucky: I loved going to sea, even with the difficulty of maturing from pollywog to shellback during an equator crossing. When my husband was hired at Wesleyan on a tenure-track position, I kept working for DSDP at Lamont-Doherty Earth Observatory, driving our less-than-reliable 1966 Triumph sports car. The commute became too long once we had children, and I stayed home when my first child was born. In six months I climbed the walls and happily went off to Antarctica, leaving my husband holding the baby for two months. Since that time I have done research on soft-money: ocean-drilling-related research and projects with my husband on coastal salt marshes and Long Island Sound (yes, using foraminifera). We spent more than a year in Cambridge (UK) where I became a lecturer shortly after my second child was born, but there were no opportunities for my husband.

What do I think of my life, looking back now that I am 54? My research has been successful, but also great fun: I am still amazed that I am paid to do it. In spring 2003, I went to sea again, for more research on the deep-sea benthic foraminiferal extinction during extreme global warming at the end of the Paleocene. I can't explain why organisms in such a large habitat went extinct globally after happily surviving asteroid impact at the end of the Cretaceous, but I keep trying. A major frustration is that I have never been able to get a tenured position. Universities should do more to help dual-career couples, possibly on part-time positions: they get happy and enthusiastic professors, and students are inspired when they see that such careers work.

Ocean Drilling Program Leg 208, Walvis Ridge, Southeast Atlantic Ocean: the clay layer where unknown numbers of foraminifera died. Photo by Steve Schellenberg, UCSD.

Maya Tolstoy

Doherty Research Scientist, Lamont-Doherty Earth Observatory of Columbia University, Palisades, NY, USA, tolstoy@ldeo.columbia.edu

My research interests are quite broad, but include mid-ocean ridge earthquakes, the links between earthquakes and life (particularly at mid-ocean ridge hydrothermal vent systems), seafloor instrumentation, and the impact of anthropogenic noise on marine mammals. Much of this work involves listening to and analyzing sounds in the ocean through the use of hydrophones or ocean bottom seismometers. One area I am particularly interested in is mid-ocean ridge eruptions, which are a fundamental building block of our planet as well as a seminal event for life on the deep ocean floor.

Maya Tolstoy aboard the R/V *Keldysh* in October 2003 preparing to deploy ocean bottom seismometers at 9°50′N on the East Pacific Rise as part of the National Science Foundation Ridge2000 Integrated Studies Site program.

From the earliest time I can remember, I was fascinated by the power within our planet manifested by earthquakes and volcanoes. These events were both mind-boggling in their capacity to reshape our world and humbling with their complete disregard for anything human that was in their way. So I was drawn to trying to better understand these forces.

During my undergraduate work in geophysics at the University of Edinburgh, I spent a summer working at Scripps Institution of Oceanography. I had the opportunity to go to sea and immediately fell in love with the sense of exploration and wonder, and isolation of it. I returned to Scripps as a graduate student where I spent much of my time sailing the world's oceans to learn about seafloor volcanism and oceanographic instrumentation.

It is a great privilege to be able to spend your time exploring exciting places and questions, and learning things about our planet that no one has known before. The work is not without its challenges, including the struggle to keep raising grant money, overt hostility as well as subconscious discrimination toward women, and combining the responsibilities of a family with long periods of travel. These challenges have often been overcome by the support of specific individuals. This can be anything from someone making a call for you or providing you with a few words of wisdom, to making sure that you are included in a project or helping share your responsibilities at times when you are at sea. Mentorship and camaraderie have played a vital role in my career. Science, and particularly going to sea, is about teamwork, which is one of the things I enjoy most about it. Finding the right teammates is the best way to stay afloat. Finally, I'm blessed with very supportive parents who always told me I could do whatever I wanted, and a fabulous son who keeps me grounded (often literally) from day to day.

Marta E. Torres

Associate Professor, College of Oceanic and Atmospheric Sciences, Oregon State University, Corvallis, OR, USA, mtorres@coas.oregonstate.edu

I started my science journey as an undergraduate in chemistry at the University of Costa Rica, a small country in which the oceans are never too far away. I came to the United States in 1980 to get training as an oceanographer and was fortunate to find in Erwin Suess an excellent advisor, mentor, and friend. Dr. Suess fostered my interests in geochemistry and introduced me to issues related to submarine fluid flow. I have been studying geochemical fluxes associated with fluid transport in convergent and transform margins in the Eastern Pacific for the last two decades. I have pursued my research interests using a variety of tools, including conventional vessels, a deep-sea drilling platform (*JOIDES Resolution*), and remotely operated (ROPOS) and deep submergence vehicles (*Alvin* and *Nautile*). I have used mapping techniques, benthic instrumentation, and chemical analysis of fluids and minerals to enhance our understanding of the rates and episodicity of flow, interactions between fluid chemistry and subsurface biosphere, and chemical-rock reactions along flow paths.

Most recently, I have been involved in gas hydrate research. These deposits are commonly associated with areas of fluid transport in continental margins where natural gas originates from the decomposition of organic matter. Methane hydrate is a crystalline substance that looks like ice and forms when water and methane are combined at high pressure and low temperature. Within the sediments and at the seafloor, complementary microbial relationships produce and consume methane, thus affecting the carbon inventories and methane hydrate distribution. Additionally, oceanographic changes and earthquake activity can destabilize these deposits, resulting in submarine landslides and massive methane release. Methane is a greenhouse gas, and destabilization of methane hydrates may have affected Earth's climate in the past.

Oceanography is a truly interdisciplinary field. It is particularly fascinating and exciting because unraveling the complex and dynamic interactions at play within the ocean and its boundaries is fundamental to our understanding of the workings of our planet. Nevertheless, it poses special challenges when raising a family. Field programs associated with ocean research can imply long periods away from home, which are particularly stressful for parents of young children. In addition, the pressures to secure funding and maintain a productive research program are highly demanding of a scientist's time. When my son was born, 12 years ago, I decided to take a parental leave for two years, and have been working part time ever since. This was a difficult decision at the time, but not one I regret. It has undoubtedly slowed down my scientific career, but I have grown in other personal ways. I consider myself very lucky in that I have found a working balance for my career and family demands. I continue to maintain an active research program, dedicate enough time as a volunteer science advisor to the local schools, and travel around the state with my son's soccer team... Granted, I am the only soccer mom that reads proposals at half time, but that is not too bad a role model for the young players and their sisters.

Marta Torres inside the submersible *Alvin* during a dive program to the San Clemente fault zone in 2000.

Anne Tréhu

Professor of Geophysics, College of Oceanic and Atmospheric Sciences, Oregon State University, Corvallis, OR, USA, trehu@coas.oregonstate.edu

I am a seismologist who specializes in imaging the structure of the Earth's crust using seismic waves generated by small explosions. Because my work focuses on structures on the margins of the continents, I work both on land and at sea. Majoring in geology and geophysics as an undergraduate was a lucky accident—a passing interest paleoanthropology led me to courses in vertebrate paleontology in the geology department, which then led to junior and senior independent research projects on plate tectonics with Jason Morgan as my advisor. Jason was a very supportive advisor who made me realize that a research career was possible and would be great fun. The thrill of discovering something new always remains fresh, even after 30 years.

Fieldwork as a family affair. Programming IRIS Reftek seismographs in our garage with my "field assistant" Patrik in 1991. This project included onshore and offshore seismometers and was designed to image the structure of the Cascadia subduction zone, which is the pslate boundary between the Juan de Fuca and North American plates in the Northeast Pacific Ocean. This major fault system is ~45 km beneath my feet in this photograph and crops out on the seafloor ~ 100 km west of the coast (see Tréhu et al., *Science*, 1994, 265: 237-243).

I became interested in seismology in graduate school because it is a tool that can be used to address a wide range of Earth science and oceanographic problems at many different scales. After graduate school, I worked at the United States Geological Survey in Woods Hole, Massachusetts for five years before joining the faculty in the College of Oceanic and Atmospheric Sciences at Oregon State University. My husband (who is also a seismologist) and I were very lucky to obtain two faculty positions at Oregon State after spending two years commuting between Woods Hole and Lamont-Doherty Earth Observatory. We moved to Oregon in 1987 with a six-month-old baby, who is now about to enter college. Our son Marc was joined by Patrik in 1990.

Although the extensive travel, including long absences for fieldwork, lead to complicated plans to optimize logistics, my life is richer and more interesting because of the need to balance family life and work. The greatest challenge was organizing care for the kids when my participation in a two-month-long cruise with the Ocean Drilling Program overlapped by a month with my husband's fieldwork in Tibet.

Cindy Lee Van Dover

Marjorie S. Curtis Associate Professor, The College of William & Mary, Williamsburg, VA, USA, clvand@wm.edu

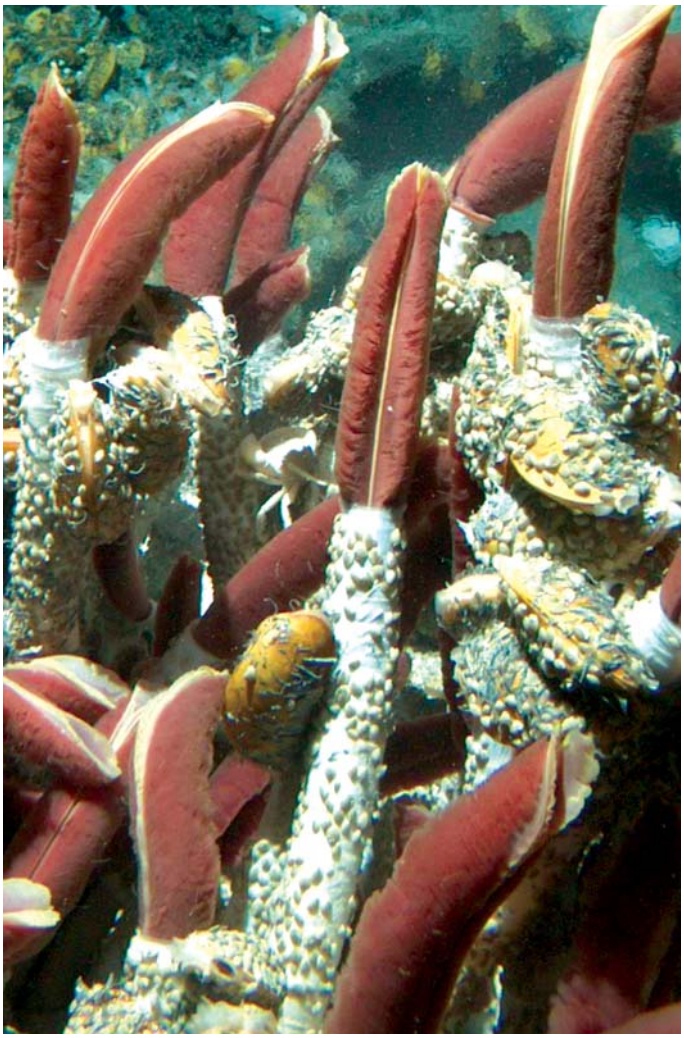
The existence of sulfide chimneys belching hot black fluids into the water column, and of strange animals living in abundance within noxious waters at the bottom of the sea—these were fabulous discoveries that changed the way we think about life on Earth and on other planets. For me, they were liberating, as they taught me to try to look at the world with a mind open to the unanticipated rather than a mind constrained by dogma.

My inclination toward the study of deep-sea biology was determined even before the discovery of deep-sea hot springs. I spent my summers as a child on the beaches of the Jersey shore, where I was fascinated by the remarkable animals that live in the intertidal zone. I was convinced that the strangest animals would be in the deep sea, though I never dreamt that such a thing as a giant, gutless tubeworm might crowd around black smokers along the ridge line of a submarine mountain.

Even in grade school, I knew of the submersible *Alvin* and the Woods Hole Oceanographic Institution. This was the dawn of space exploration, of Gemini and Apollo missions, but for me, it was the nameless, uncelebrated men who dove in *Alvin* who were my heroes. It seemed unlikely then that I would ever dive in *Alvin*, let alone drive it. Consider: My high school guidance counselor told me I was not cut out for college and should think about marriage and a family. Defiant of this advice, I chose college. From there, I was inexorably drawn to Woods Hole and deep-ocean science like a tubeworm to sulfide.

The day I completed my Ph.D. I joined the *Alvin* group as a pilot-in-training. Nothing before or since has ever been as challenging as learning how to work in the deep sea, or so satisfying as seeing so much of the deep-sea world that I study.

Much has changed for women in oceanography in the 20+ years that I have sailed on blue water. It has been a long time since I was the only woman on a research vessel, and it is rare that I find myself the only woman in a room full of men. One thing that has not changed: we are still so often noticed for what we have done as women. I do not wish to deny the value of role models, but I do celebrate those occasions when a woman is acknowledged for her work as an oceanographer, rather than as a female oceanographer.



Giant tubeworms and mussels, coated with limpets, live in cool (12°C), sulfide-rich waters of hydrothermal vents on the East Pacific Rise. Continuing discoveries of strange animals living in deep-sea chemosynthetic environments remind us that we do not yet know our own planet.

Penny Vlahos

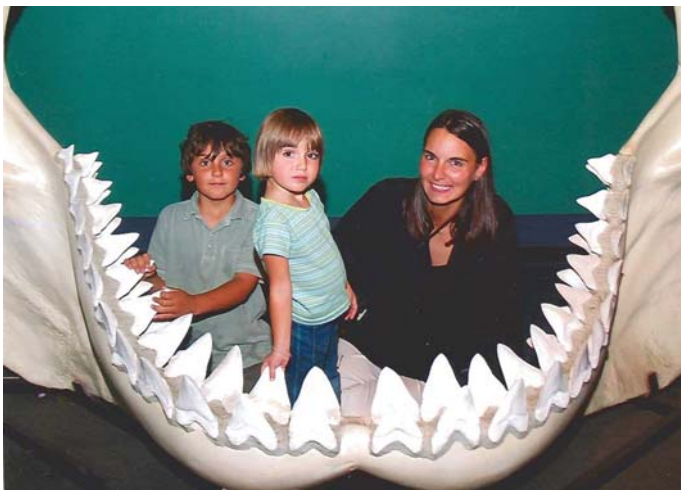
Assistant Research Professor, Department of Marine Sciences, University of Connecticut - Avery Point, Groton, CT, USA, penny.vlahos@uconn.edu

My research interests are in the geochemical cycling of carbon with an emphasis on the organic carbon pool. My training is in chemical engineering at the University of Toronto. This sparked an interest in environmental processes, fluxes, and energy transfer. I was particularly interested in the partitioning of organic compounds in the environment after working with my master's advisor Donald Mackay at U of T. I moved to Boston with my husband and then began my doctoral studies with Robert Chen at the University of Massachusetts. Within a short time we were out on the ocean aboard the R/V *Endeavor* measuring carbon off the Mid-Atlantic Bight and there was no turning back! I loved it!!

Most intriguing to me was the critical role the ocean plays in our climate and survival and how little we still knew. I felt fortunate to be at a place and time where so many unanswered questions were within our ability to pursue.

The most rewarding aspects of this career have been the interactions with other oceanographers, particularly some very talented young female oceanographers who are conducting exciting research. There is a strong sense of community and support among these women and they are gems! Another favorite part is the interactions with graduate and undergraduate students who are a pleasure to teach. It is very rewarding to convey ideas and watch students get it!

My husband George and I have two children. Our son Athan is 7 and daughter Katia is 4. We had both children during my doctoral studies. My schedule was flexible enough so that we could enjoy time together. I began a postdoc in 2001 with Annelie Skoog on a part-time basis at the University of Connecticut when Katia was 1. Annelie and the department as a whole have been very supportive and made me Assistant Research Professor in 2002.



Athan (age 7), Katia (age 4) and Penny exploring the oceans at the Mystic Aquarium in Mystic, CT.

Parenting is a full-time job, so juggling our careers with family has been our biggest challenge. My husband is a cardiologist and he has very demanding hours, too. My mom actually flies in from Toronto to help during busier times. It takes some creative thinking and being humble to make it work. It also takes "a village." Once we had made good friends in our new home it was so much easier to know there was backup for the unpredictable events. I cannot stress the importance of a culture that understands AND VALUES the flexibility that must come with balancing family and work.

Karen L. Von Damm

Professor of Geochemistry, and Earth Oceans and Space, University of New Hampshire, Durham, NH, USA,
kvd@eos.sr.unh.edu

I am variably referred to as a marine geochemist, aqueous geochemist, or chemical oceanographer. In my research I use the chemical content of natural waters as indicators of active processes that occur in the environment. Most of my recent work has been on mid-ocean ridge hydrothermal systems; hydrothermal fluids provide important (and unique) probes of what is occurring within the upper oceanic crust. The hydrothermal fluids are also the medium by which energy is transferred from Earth's interior to the exosphere, perhaps most visibly to the chemosynthetic communities found at these sites. So, another focus of my research has been to quantify how variations in the fluid compositions influence the biological communities at these sites. Finally, as a chemical oceanographer, I am trying to understand how seafloor hydrothermal fluids affect the chemistry of seawater. Until we understand the processes controlling the fluid compositions, we won't be able to calculate the fluxes, which is why I have put so much effort into trying to decipher the processes.

I wanted to be an oceanographer since the time I was in junior high school. I liked chemistry best, but pure chemistry seemed to me a little too abstract. I could never see myself just having a desk job, so I became an oceanographer who now spends, on average, at least a month a year at sea, and who uses chemistry in her work. I love going to sea, which is a good thing as I've spent at least two years of my life on the ocean, about two months of that time at its bottom.

I often view the data we collect as pieces of a big puzzle. Trying to put it together, and figuring out what it means is what I love best about what I do. It may be frustrating at times, but it's never boring. As I've become more senior in the field, the other thing I enjoy is bringing students to sea. It's fun (and rewarding) to see their excitement. I make a big effort to get people to the seafloor who have never been there before. I view it as opening doors for people about what they can possibly do with their lives, doors they never even knew existed.

Going to sea and attending professional meetings has changed since I was a graduate student. Often there were just one or two women on a ship, or perhaps one of fifty speakers at a meeting. Now I frequently sail as chief scientist, my science parties may be 50 percent women, and there are women officers and crew. Early on, the small numbers of women on the ships frequently made them a big center of attention, attention often not wanted. The social dynamics on ships and at meetings are now much closer to what they are in the larger world, and this is a good thing. I still think women have to "prove" themselves more, to be taken as seriously as their male colleagues. I find this to be true whether on ships, at meetings, or in the classroom. So, while the oceanographic sciences have changed, progress still needs to be made. I still find it somewhat amusing at meetings, as I usually publish under my initials, not my full first name, when introduced to other scientists, either new to the field or from overseas, they sort of stutter and say, "but you are a 'she'!" So, the preconceptions unfortunately remain, but continue to come crashing down.

Hydrothermal vent fluids are collected in titanium bottles. After an *Alvin* dive, Karen removes the heavy bottles from *Alvin's* basket so that shipboard chemistry can begin on them in labs aboard the R/V *Atlantis*.

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Bridget Wade

Research Fellow, Rutgers, The State University of New Jersey, Piscataway, NJ, USA, bwade@rci.rutgers.edu

My primary research interests are the application of microfossils in understanding climate and paleoceanographic change using deep-sea cores. I am especially keen to exploit high-resolution geochemical records for intervals in Earth's past that have generally been studied only at low resolution. My work has concentrated on the geochemical signal in planktonic foraminifera, a group of marine microscopic plankton. Over time, the shells of dead foraminifera accumulate in marine sediments and yield a long and valuable fossil record, which paleontologists can exploit to form a picture of ocean and climate changes that took place millions of years ago.

My interest in microorganisms as environmental tools was inspired during my undergraduate degree at the University of Leeds (UK) and a project on recent diatoms. I then undertook a master's at University College London, followed by a Ph.D. at the University of Edinburgh. I remained at Edinburgh as a postdoc, followed by a move to Cardiff University. I have had the privilege of working with wonderful people that have challenged my thinking and taught me a great deal. As an independent postdoctoral fellow, I have the opportunity to follow my own research interests, and have learned as much from techniques and ideas that did not work, as from those that ran smoothly.

I find the fieldwork aspect the most rewarding part of my work. I participated on Ocean Drilling Program Leg 199 (equatorial Pacific Ocean) and the Tanzania Drilling Project. Both of these drilling projects involved working with international scientists for a period of five to seven weeks. It was incredibly exciting to see the cores being recovered and to participate in an international scientific effort.

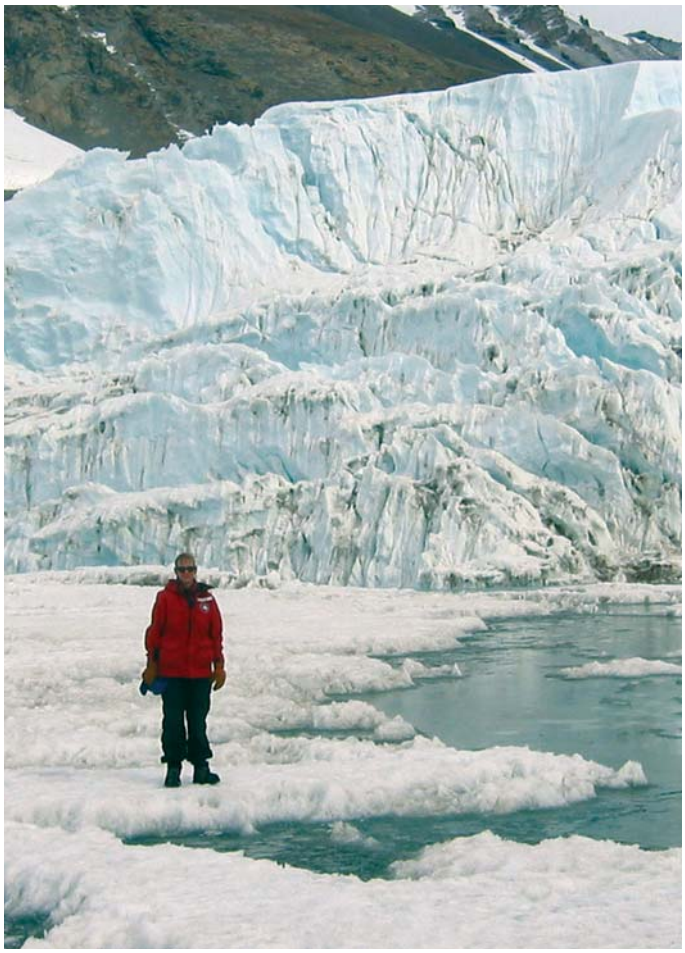
In 2004, I was awarded a Lindemann Trust Fellowship to work in the United States, and have recently moved to Rutgers, The State University of New Jersey. My present work focuses on climatic change during the Oligocene (34 to 24 million years ago). At Rutgers there is an abundance of faculty with interests in deep-time paleoceanography and climate change. I already feel very much at home. I am enjoying the mobility of my life at present and never seem to be in one place for more than four weeks, though moving three times in the last year has also had its challenges.

Describing sediment cores at Tanzania Drilling Project, Site 11 (October, 2004). A detailed study of foraminifera chemistry from these cores will be used to reconstruct past climate changes and document marine temperatures.

Bess B. Ward

William J. Sinclair Professor of Geosciences, Princeton University, Princeton, NJ, USA, bbw@princeton.edu

Although I had always assumed I would be a scientist, my initial interest in oceanography was probably at least partly romantic—the endless anonymity of the open sea. I really had no idea what oceanographers did, but I focused on zoology and chemistry as a likely combination in college. Michigan State University is a real center of excellence in microbial ecology today and it's hard to imagine that I graduated without a single course in microbiology. I did not have an advisor in my first year in graduate school at the University of Washington (I must have been a wild card admission), but when Mary Jane Perry announced in biological oceanography lecture that she needed an assistant on a cruise, I jumped at the chance. The other first-year students were reluctant to miss a whole week of classes, but I figured this is what I came for, give it a try. MJP took me on as a student after that, and steered me towards microbes and biogeochemistry. Although it rarely intersected with her own field of phytoplankton physiology and remote sensing, she taught me all the important stuff. The motivation for my thesis work on nitrification and nitrifying bacteria arose from a summer project for MJP: I learned Fortran and used it to crunch several years worth of data from the western North Pacific, which pointed to some nutrient interactions that looked like nitrification.



The processes of nitrification and dentrification occur just about everywhere in terrestrial and aquatic environments and sometimes the natural laboratory is surprisingly exotic. Our investigations into the environmental factors that control denitrification have led my group to the Arabian Sea, the Eastern Tropical North and South Pacific Ocean, and even to the permanently ice-covered lakes of the McMurdo Dry Valleys in Antarctica, where this picture was taken near the Taylor Glacier on the west lobe of Lake Bonney.

As a postdoc in the Food Chain Research Group and later as a researcher at Scripps Institution of Oceanography, I made many measurements of nitrification rates, and continued to use immunofluorescence to enumerate specific kinds of bacteria. It became clear to me then that molecular biology, although I knew little about it, would offer even better tools than biochemistry, so I enrolled in a biotech course, along with my wonderful technician Kay Kilpatrick, at San Diego State University. My first mol bio proposal was soundly trounced, but as it turns out, I'm still working today on the subject of that first proposal—diversity in denitrifying bacteria and regulation of denitrification. My first "real" job was at the University of California, Santa Cruz, where I continued to work on nitrification and slowly made progress on denitrification genes and enzymes. Now at Princeton, I continue those two main directions, combining molecular ecology with direct rate measurements using isotopes where possible, and emphasizing the connection between microbial diversity and ecosystem function. Professionally, the two-body problem has been my biggest challenge, and my lab group and faculty colleagues at Princeton are my greatest pleasure.

Patricia A. Wheeler

Professor, College of Oceanic and Atmospheric Sciences, Oregon State University, Corvallis, OR, USA,
pwheeler@coas.oregonstate.edu

I am a biological oceanographer interested in phytoplankton physiology and ecology especially with respect to carbon and nitrogen cycles in the ocean. In recent years, my research has focused on the production and utilization of dissolved organic carbon and nitrogen in a variety of ocean environments spanning the Arctic Ocean, the Northeast Pacific Ocean, and the equatorial Pacific Ocean. I have had the good fortune of doing much of this research as part of large, interdisciplinary programs with strong physical, chemical, and biological components that facilitate a more complete understanding of physical forcing factors and biological responses.

Pat Wheeler at the bow of the Russian nuclear icebreaker *Yamal* during the U.S.-Canada 1994 Arctic Ocean Section.

I chose to study phytoplankton physiology as a graduate student and was attracted to science by the excitement and satisfaction of posing questions and finding the answers through experimental, observational, and analytical studies. My entry into the field of oceanography was driven by the source of funding for work on marine phytoplankton and most of my work over the last 20 years has been supported by the National Science Foundation. My oceanographic expertise was developed through a series of postdoctoral positions and continued collaborations with colleagues within biological oceanography and especially across the disciplines of chemical and physical oceanography. For me, the most rewarding aspects of being an ocean scientist have been seeing and contributing to advances in understanding of nutrient and organic fluxes in the ocean, my continued education through on-going collaborative research projects, and the opportunity to visit many parts of the world as a result of field work and international conferences.

Much of oceanography is funded through "soft money." It has been a challenge to successfully compete for research funds. My strategy has been to pursue both individual "small" projects as well as to participate in large multidisciplinary projects. Much of my research has been conducted aboard research vessels. Long cruises can be a challenge, especially during rough weather. My response to rough seas is sea-sickness and weight loss, but it is a temporary (and therefore tolerable) condition.

My husband also has an academic position and is understanding of my career demands. When important deadlines come up, one of us calls for "work leave" and the other is on their own for a while. When I am away at sea, he does all the housekeeping and in exchange gets a T-shirt from each ship. However, his barber reminds him that he has a great deal: a wife who goes away to the North Pole and who likes to mow lawn when she is home.

I think that conditions are generally good for women in biological oceanography, partially as the result of a number of high-profile, successful women. I have been treated with great respect by colleagues at OSU, at national and international meetings, and while working at sea.

Jean Whelan

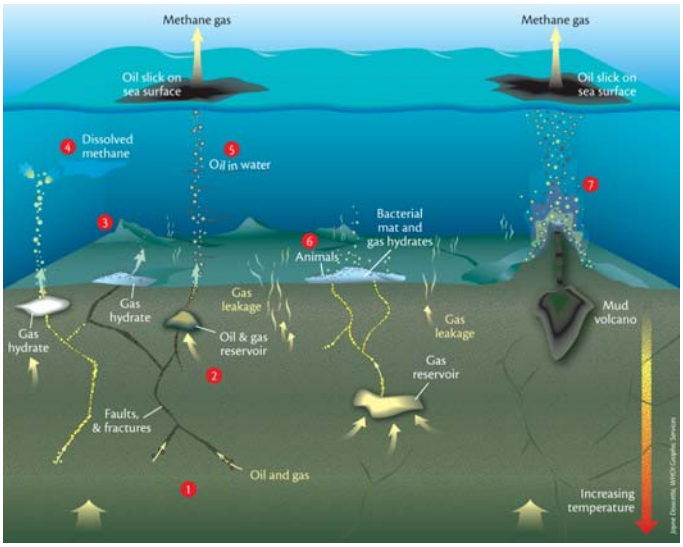
Senior Research Specialist, Woods Hole Oceanographic Institution, Woods Hole, MA, USA, jwhelan@whoi.edu

I obtained my B.S. and Ph.D. degrees in organic chemistry back in the early 1960s—the "dark ages" for women in science. Academic careers for women at research universities were not possible, so I began my career teaching in an undergraduate liberal arts school, which also happened to have a marine laboratory. Interesting discussions with a geology colleague about the possibility of using organic compounds to learn about marine science led to a sabbatical in John Farrington's lab at WHOI. There, I fell totally in love with marine science and was offered a position on the technical staff with Dr. John Hunt, a founder of petroleum organic geochemistry, as my mentor. I have now spent almost 30 extraordinary years at WHOI in one of the most interesting, exciting, and still continuously changing careers in the world.

I married my late husband, Bob Whelan, at about the same time that my marine science career was just beginning. Having two much-younger sisters as well as an older husband made me a realist about the difficulties of combining motherhood and a scientific career. For me, not having children has turned out to be a great decision even though I love kids—I've had many opportunities to "mother," from being "Auntie Jeanie" to my nieces and nephews, to explaining marine science informally to many kids and adults.

The greatest challenge of my career has been balancing my priorities between my professional and personal lives. My marriage focused me and made me more scientifically productive by limiting the amount of time I could devote to work.

A huge professional problem has been dealing with skepticism and sometimes antagonism by promoting new hypotheses too soon for follow-up work. For example, Dr. John Hayes recently pointed out that our lab was the first to demonstrate a "deep" biosphere in a paper published in the mid 1980s. I did not pursue this very interesting initial research because the necessary tools did not yet exist. My current research on the effects of ocean bottom natural gas seeps and hydrates on oceans is another example. The potential scope and impact of these seeps on the ocean may eventually prove to be huge (see figure). However, at the moment, I often feel like a megalomaniac medicine man in trying to present my current vision of how large and important these gas seep systems could be.



Jean Whelan's current research is investigating the complex world of gas seeps and methane hydrates in ocean sediments and their effects on ocean sediments, biology, waters, overlying air, and possibly global climate (see http://oceanusmag.whoi.edu/v42n2/whelan.html). Key processes shown in figure: (1) methane gas is created naturally under deep-sea sediments and in Earth's crust from organic matter subjected to heat and pressure, or by bacteria producing it as a metabolic end-product, (2) methane gas flows upward through faults and cracks in rocks, sometimes forming trapped pockets of gas reservoirs or leaking to the seafloor, (3) deposits of solid methane encapsulated in ice, called methane hydrates, often form at the low temperatures and high pressures at or below the seafloor, (4) methane bubbles usually burst and dissolve and are biodegraded by microorganisms, (5) sometimes, plumes of methane or oil-coated bubbles reach the surface; they can vent bubbles of methane, a greenhouse gas, to the atmosphere, and they also create natural oil slicks, which are now being used to locate new oil deposits, (6) methane seeping to the seafloor sustains thriving communities of exotic animals in the sunless depths, and (7) pockets of gas trapped beneath sediments can build up pressure until they explode to form "mud volcanoes;" on continental slopes, these mud volcanoes may trigger seafloor avalanches and tsunamis.

I came into WHOI at a time when my advancement to the tenured scientific staff was not possible. Subsequently, my technical staff position has evolved into a strange limbo between the scientific and technical staffs that has rewarded me well professionally and allowed me the flexibility to "be present" for family tragedies and celebrations. Currently, this position is evolving into a wonderful new role as a politically astute senior advisor to a number of very talented young oceanographers at WHOI and elsewhere.

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Lisa D. White

Professor of Geology, Department of Geosciences, San Francisco State University, San Francisco, CA, USA, lwhite@sfsu.edu

My scientific interests span the broad field of paleontology and paleoceanography. As a micropaleontologist specializing in diatoms, I am interested in the distribution of siliceous and related organic-rich sediments, including fossil cold seep systems, around the Pacific Rim. At SFSU I teach classes in oceanography, paleontology, and the history of life, and I also coordinate a geoscience education diversity program for San Francisco high school students.

When I was an undergraduate at SFSU, I enrolled in a geology class for a general education requirement and was fascinated by the subject matter. At the time I was an art/photography major and geoscience seemed like the right combination of art, science, and adventure. I had a first-hand introduction to the field of oceanography and marine geology while working at the U.S. Geological Survey during a summer internship program. The experience of working so closely with professional geoscientists on the characteristics of the California continental margin led me to graduate school at the University of California, Santa Cruz. While investigating the Miocene Monterey Formation of California, my scientific interests broadened to include micropaleontology, stratigraphy, and paleoceanography.

Investigating fossil cold seep limestones with student Kristin Hepper, Lake County, California.

Throughout my fifteen-year career, I have most enjoyed the opportunity to work with teams of international scientists to solve geoscience problems on a global scale. Twice I sailed aboard the *JOIDES Resolution* drillship on Ocean Drilling Program legs to the Japan Sea and Costa Rica margin. Because ocean science is very interdisciplinary, it often takes large, collaborative efforts to solve problems in this discipline. I think that all ocean scientists have a sense of adventure and are passionate about travel; my research trips have taken me to Russia, Israel, Egypt, Tahiti, Zimbabwe, and South Africa.

Some of my greatest professional challenges have not been in the field, but in the classroom. When I first stated teaching, I struggled with my shyness and initial classroom discomfort while trying to master new subjects well enough to teach. I responded to these challenges by learning a variety of pedagogical techniques that could help bring out the best in diverse learners. In the process, I became a better scientist because I was able to master a greater range of subjects and become a more effective communicator.

I am very encouraged by the number of women entering the geosciences now. More than half the undergraduate geoscience majors at SFSU are women, a trend that is quite common at many universities. Unfortunately, that proportion is not reflected among geoscience faculty or in our profession as a whole and the statistics are far worse for minorities entering the geosciences. I am working very hard to change this through improving geoscience education, particularly for urban and minority students.

Jill M. Whitman

Professor and Chair, Department of Geosciences, Pacific Lutheran University, Tacoma, WA, USA, whitmaj@plu.edu

Growing up I spent my summers on an island off the coast of Maine. Life there was connected to the ocean: the fluctuating tides, the waves and winds, the rocky point and the sandy beach, and the organisms in the ocean. When I went off to college and was searching for courses to take as a freshman, the one titled "Oceanography" immediately caught my eye. I took the course and have been hooked ever since.

In undergraduate and graduate schools I pursued my interest in the oceans through the study of geology and marine geology. Life was exciting during those years with passionate teachers, stimulating research opportunities, enthusiastic colleagues, and travel to new places—on field trips, attending professional meetings, and research cruises. I met my husband when I sailed as a sedimentologist on the drillship *Glomar Challenger* in the western Pacific!

I always enjoyed teaching and long ago realized that would be my path. After I finishing my degree in a research-intense graduate program, I came to a small undergraduate institution where I am now first and foremost a teacher. My life centers on students and the classroom: helping music, philosophy, and economics majors understand the importance of the oceans and science in their daily lives, exciting geoscience majors about geophysics and marine geology, and mentoring seniors on research projects. My focus is on how I can teach more effectively and encourage students to appreciate science and the oceans.

I have always been committed to service, on my campus and in my community. I have served as chair of the Environmental Studies program, a position for which the interdisciplinary study of oceanography prepared me very well. I was chair of the Puyallup River Watershed Council and on the Executive Committee the National Association of Geoscience Teachers, including a term as President. Presently I serve on the U.S. Science Advisory Committee for the Integrated Ocean Drilling Program, uniting my lifelong passion for the oceans and my experience as an educator. My focus is on helping to develop and guide the outreach and educational efforts of the drilling program.

Jill Whitman in her office. A former student created the colorful quilt behind her. It depicts a research ship pulling a magnetometer over a mid-ocean ridge.

It has been a challenge to balance family life, my husband and two now teenage sons, with the commitments of my professional life. They have been wonderfully supportive of my endeavors and maybe some of my passion for science and the oceans has rubbed off on the next generation.

Gisela Winckler

Doherty Associate Research Scientist, Lamont-Doherty Earth Observatory, The Earth Institute at Columbia University, New York, NY, USA, winckler@ldeo.columbia.edu

My academic background, including my master's degree and Ph.D., is in physics. In graduate school I was more attracted to crosscutting Earth science problems than to classical physical research like hunting down elementary particles. Luckily, I got a research assistant job at Heidelberg's Institute of Environmental Physics, an ideal place to combine basic physics skills with marine science. After my first research cruise to the equatorial Pacific, I was hooked; I knew that my decision to abandon traditional physics was the right one. For the next five years I studied extreme marine environments: brine-filled deeps in the Mediterranean, hydrothermal systems in the Red Sea, cold and hot vents along the North and South American continental margin, and gas hydrate systems off Oregon and in the Sea of Okhotsk. Being on the ocean was a magical experience, and I will always love going to sea.

After graduating, I worked for the United Nations in Vienna, and in 2001 I started a postdoc at the Lamont-Doherty Earth Observatory. My plan to stay for a year or two has turned into a longer journey; I am now a Doherty Associate Research Scientist at Lamont, and perhaps a permanent resident of New York City. Entrained in the Lamont-Doherty culture, I've become intrigued with cutting-edge paleoclimate problems, particularly at the interface between marine geochemistry, oceanography, and climate studies. Reconstruction of past climates is key to understanding the climate system's sensitivity to natural variability and anthropogenic perturbations, and thus to predicting future climate evolution. My toolkit centers on noble gas mass spectrometry. I collaborate with other geochemists, integrating the several trace isotopes and elements to unravel the stories locked up in ocean sediments. Now my focus is on figuring out how to use cosmic dust, labeled by the rare helium isotope ^{3}He, to understand how ocean sediments accumulate and archive Earth's climate history. This "stardust" signal gives us a new tool to evaluate fluxes of climate-relevant species, such as dust and productivity, in the past. I believe it may revolutionize paleoceanographic interpretation of sediment accumulation rates and ocean-sediment fluxes.

Being one of about 8 percent female students enrolled in physics in graduate school provided me with an early experience of a "minority feeling." Representation of women in Earth sciences is better than in physics, but there is still a lot of gender bias nonetheless. The hurdles we face in advancing our careers may be subtler than in the past, but their impact is tangible. For me, balancing my research with my personal life, which now includes a 14-month-old daughter and my scientist partner, is quickly becoming the greatest challenge of my career.

On board the R/V *Atlantis* in the Northeast Pacific Ocean. My dive with *Alvin* to an active gas hydrate site off the coast of Oregon was a magical experience and certainly one of the highlights of my scientific career.

Karen F. Wishner

Professor, Graduate School of Oceanography, University of Rhode Island, Narragansett, RI, USA, kwishner@gso.uri.edu

Oceanography has been an exciting and rewarding career. My research focus is marine zooplankton ecology and deep-sea biology, especially deep-sea zooplankton. I have studied distributions and feeding of deep-sea zooplankton, effects of the oxygen minimum zone on pelagic and benthic communities in the Arabian Sea and Eastern Tropical Pacific, biology of a seamount and submarine arc hydrothermal vent, and zooplankton of Georges Bank and the Gulf Stream including interactions with whales, fisheries, and the environment. I have worked on large multidisciplinary projects including SCOPEX, JGOFS, and GLOBEC. My work has contributed to understanding carbon cycling and trophic linkages, responses of zooplankton and benthos to physical gradients, and interactions of apex predators with zooplankton. Results are pertinent to broader topics of deep-sea ecosystems, global climate change, biodiversity, biogeochemical cycles, fisheries resources, hydrothermal vents, and endangered species.

Karen Wishner (photo by Tom Adams).

I got into oceanography opportunistically. As a sophomore at the University of Chicago, I worked on a marine field project in Costa Rica, then spent subsequent summers at the University of Oregon's Coos Bay lab and the Marine Biological Laboratory in Woods Hole. I arrived at Scripps Institution of Oceanography for graduate school expecting to do intertidal ecology, but then I saw the ships, went on a cruise, and discovered the excitement of sea-going oceanography. I was able to do an independent thesis on deep-sea benthopelagic zooplankton that meshed the zooplankton interests of my advisor John McGowan, the deep-sea biology expertise of Bob Hessler, and the technology and cruises of Fred Spiess and his Deep Tow group. I put a plankton net on Deep Tow (a near-bottom geophysical survey instrument) and was the first (and only) biologist on many geological expeditions. My first big employment opportunity came when Mary Silver recruited me to teach her biological oceanography class at Santa Cruz for a term. I then moved to the University of Rhode Island's Graduate School of Oceanography—the first woman tenure-track faculty member hired by that department—and the only faculty member to arrive on a motorcycle (a red Honda 400-4 SuperSport that I rode by myself across the country from California). My research at URI has taken me to many exotic locations and provided opportunities to observe and sample the deep sea directly from submersibles and remotely operated vehicles. I have had many wonderful collaborators (especially Marcia Gowing), technicians, students, and crewmates who have contributed to these endeavors, and the enthusiastic encouragement of my parents. One of the benefits of now being a full professor is the ability to participate in programs beyond one's individual research to broadly aid the next generation of scientists. I am proud to be a co-principal investigator on URI's ADVANCE initiative, an NSF-funded program to increase the recruitment and retention of women science faculty, so that others can follow their dreams.

Dawn Wright

Professor, Oregon State University, Corvallis, OR, USA, dawn@dusk.geo.orst.edu

As "Deepsea Dawn," I have immersed myself in two disciplines: marine geology and the emerging field of marine geography. After receiving my B.S. in geology from Wheaton College (Illinois) and my M.S. in oceanography from Texas A&M University, I sailed for three years as marine technician with the Ocean Drilling Program (ODP). Working with the diverse group of scientists, technicians, and staff at ODP motivated to obtain my Ph.D. in physical geography and marine geology from the University of California, Santa Barbara. I am currently professor of geography and oceanography at Oregon State University.

When in geologist mode, and with the help of the *Argo* remotely operated vehicle and *Alvin* submersible dives, I have focused my research on mid-ocean ridge fissures and the important clues they provide to the birth and death of hydrothermal vents and the nature of volcanic eruptions along fast-spreading ridges. I am also studying benthic complexity for habitat mapping of coral reefs in the Southwest Pacific, in collaboration with Marine Protected Area managers.

Dawn with her dog Lydia at Agate Beach on the central Oregon coast.

When in geographer mode, I devote my expertise to developing better ways of displaying, analyzing, and interpreting information I, and other oceanographers, collect from the seafloor. Through this work I've become one of the leading authorities on marine geographic information systems (GIS). Although GIS has been used in a wide variety of fields from landscape ecology to archaeology to climatology, it has only recently been adapted for oceanography. This is an exciting research frontier for GIS, in terms of the necessity for data structures and analytical procedures that will better visualize and analyze data in two, three, and four dimensions.

I was a member of the National Academy of Sciences' National Needs for Coastal Mapping and Charting Committee and now serve on the editorial boards of three geographic information science journals. My most recent books include *Marine and Coastal Geographical Information Systems* (Taylor & Francis, 2000), *Undersea with GIS* (ESRI Press, 2002), and *Place Matters: Geospatial Tools for Marine Science, Conservation, and Management in the Pacific Northwest* (OSU Press, in press).

What continues to inspire me are my colleagues, particularly my woman colleagues. I enjoy hearing or reading about their discoveries, which spur me on to keep striving in my own research and teaching. While I have seen many more women come in to my fields than when I first started, it is still somewhat of a novelty to see women achieving in certain areas. For instance, at my institution there is still a very small percentage of women who have made the rank of full professor, and I remain the only female African-American of this rank on the entire campus. But, an additional inspiration are my students and the courses that they are charting for themselves in ocean science. Fingers crossed!

Elizabeth Wright

Associate Professor, School of the Art Institute of Chicago, IL, USA, ewrigh@artic.edu

I am an oceanographer/geologist teaching at the School of the Art Institute of Chicago. This makes me an odd fish, occupying an unusual niche in the academic ecosystem. I began normally, with a degree in math and geology and immediate progression to graduate school at Scripps Institution of Oceanography (SIO). Three research cruises later, I accepted that I am prone to seasickness, and began to work on the ocean islands of Samoa.

In the field with my children Micah (left) and Kaethe (right).

My interests include the igneous petrology and geochemistry of Pacific volcanoes. In Samoa I studied mantle heterogeneity; in the Philippines, contributions of subducted sediments to arc volcanism. Then came a collaboration with archaeologists to source basalt and glass artifacts geochemically, and to trace prehistoric trade routes within Polynesia. In recent years, my research has turned to geoscience education of non-majors. I now chair the Geoscience Education Division of the Geological Society of America.

The best part of oceanography is working in the field. Oceanographers go to exciting places to do interesting things and meet fascinating people. The next best part is conveying that excitement to students. When I arrived at SIO in 1980, the oil companies were booming, and research money was easy to get. My first cruise was dubbed NOFAC, because there were no faculty along—the co-chief scientists and all the scientific party were students. Money is much tighter now. It's harder than ever to support a lab of students and techs each year.

In 1980, women had just achieved full access to research at sea. But students, especially women, were still at the mercy of big-name researchers for opportunities and credit for their work. It was a feudal system: students allied themselves with a (usually male) faculty protector in order to do their work unimpeded by other faculty "raiders." More young and female faculty members (and the retirement of an older generation) may have shifted that paradigm.

My biggest career challenge is staying active in my field without the advantages of laboratories, money, or even nearby colleagues. I have to go elsewhere for a research "fix." I did five years of heavy administration, chairing the Faculty Senate and my department—which had its own rewards: it's exhilarating to be in charge of all the Liberal Arts as well as the natural sciences. But, during that time, my research turned to geoscience education, which is easier to do on site. Now I am at a point of discernment: Do I want to move more into administration? More geoscience ed? Or back toward the stuff of science?

Every career decision involves personal considerations. I am in Chicago in the first place because of my partner's profession. I have chosen not to pursue lengthy field seasons since my children's births. My position at the Art Institute stretches my mind, though not in the areas of my degrees. I am fortunate to be tenured in such an unusual position, but my experience is not completely relevant to my science colleagues. In that sense I am somewhat estranged from my profession. But, that sacrifice has paid off in abundance for my family. I am fortunate to have a job I love that keeps me connected to a field I love.

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Send all correspondence to: info@tos.org or The Oceanography Society, PO Box 1931, Rockville, MD 20849-1931, USA.

Şükran Yalçın-Özdilek

Science and Letters Faculty, Biology Department, Mustafa Kemal University, Antakya Hatay, Turkey, syalcin@mku.edu.tr

My research area is freshwater fish biology and ecology. Quite by accident, I have also been doing research on the nesting ecology of sea turtles since 2001. Two sea turtle species, *Chelonia mydas* (endangered) and *Caretta caretta*, come to our beach to nest, which is located about 40 km from my university.

I did not know much about sea turtles four years ago. In 2001, the Ministry of Environment asked the local government, university, and non-governmental organizations to focus on the Samandağ sea turtles, especially their conservation needs. And with this, my studies involving the sea began. When I examined the beach, I saw the extremely poor condition of the sea turtles in the area. I felt that someone should care for the turtles, so I formed a volunteer student group immediately. We worked at the beach without any funding or support from potential sponsors. At the end of the first year, we observed that the number of nests was very low compared to the ones described in earlier studies in the area. Illegal sand extraction was destroying the turtle nests. In the following years, the government and TUBITAK (Turkish Scientific and Technical Research Foundation) supported our studies. We implemented not only conservation strategies with volunteer students that year and after, but also scientific research on the ecology of turtles. Now, the number of the nests is increasing despite the fact that the hatchling success is decreasing. The physical and chemical properties of the beach shape the hatchling success.

During the 2002 turtle nesting season at Samandağ Beach. From left to right: Bektaş Sönmez (volunteer student), Cengiz Eraslan (Turkish Ministry of the Environment representative), Münteha Sağaltıcı (volunteer student), and Şükran Yalçın-Özdilek.

Although my study area is far from the ocean, the most rewarding part about being an ocean scientist is to be able to study the "world" from my little corner of Turkey. Turtles come to our beach from the sea, which is one of the furthest nesting areas for them. They carry sea elements into the beach, enriching it. It is really fascinating.

My greatest career challenge was to obtain my Ph.D. I faced enormous difficulties in Turkey, but have been able to successfully prepare my own projects since then. I cooperate well with other scientists and form harmonious working teams even under challenging conditions. I repeatedly knock on the doors of local administrators, and environmental and other relevant groups to get their help and support.

I married in 2003, and at first, balancing my career and personal life was not too difficult. My career had always been more important to me than my personal life. I now spend more time with my family. My family always respects me because I am a hard-working woman in the area of sea-turtle conservation and local media always pay attention to this effort. My husband, an environmental engineer, supports me in the field.

The conditions for women scientists in Turkey have hardly changed. To be women in the field is still difficult because the equipment and skilled workers, especially technicians, are generally insufficient. However, to be woman can be an advantage if you have no equipment. For example, during my Ph.D. field studies, local residents helped me while they were fishing, and now they help me by collecting sand samples from the beach during sea-turtle nesting studies.

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Jeannette Yen

Professor, School of Biology, Georgia Institute of Technology, Atlanta, GA, USA, jeannette.yen@biology.gatech.edu

What is a biological oceanographer doing in land-locked Atlanta? Instead of teaching plankton ecology, I teach an introductory course in organismal biology to over 200 diverse undergraduates, an animal behavior course to intriguing juniors and seniors, and a sensory ecology course to an interdisciplinary group of curious graduate students from engineering, biology, and chemistry. I think back more than 20 years ago, when I studied under Bruce Frost at the University of Washington, where Robin Ross needed a cruise buddy and introduced me to the colorful and lively *Euchaeta*. Wow, I could have been a neurophysiologist—but why sit alone in the dark in front of a CRT screen, listening to spike chatter, when I can go out to sea with a team and hear the ocean roar? Eight years later, the neurophysiological approach returns to our research, continuing the learning experience as part of the cycles in life.

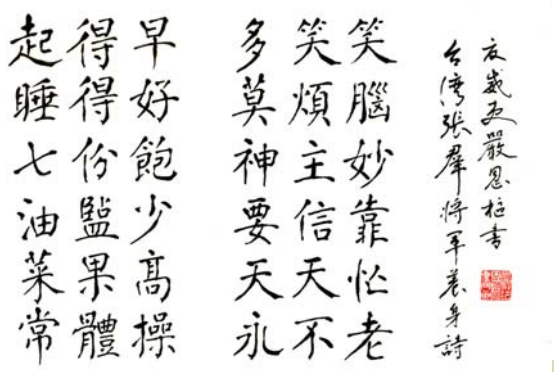
For me, the Ph.D. was the ticket. I could see the world because copepods live in the highest lakes and deepest ocean basins in the polar to tropical seas. The reward was to experience the culture, food, and social richness while studying copepods. I have been to all seven continents. What more could I ask for? And yet there always are questions that the mysterious *Euchaeta* posed. Its sharp sensory array begged to be studied as a model receiver for three-dimensional signals. To define these signals, I had the good fortune to work with the master in plankton signal visualizations: Rudi Strickler. Finally, this fall 2004, we presented our work: *Footprints in the Sea*, as a piece of art to the Gallery of Fluid Motion, where fluid dynamicists show the incredible beauty of fluid motion, just as Edgerton showed it simply—in the splash of a water drop.

The Yen family, where I sit in my father's lap, in the summer home of my uncle I.M. Pei.

This is an exciting and challenging time for me. I have given seminars in physics, nonlinear science, applied mathematics, and mechanical and civil engineering. Now, there are engineers here at Georgia Tech who know what a copepod is and why it is important to study them. They are even applying their expertise to get the copepod to solve fascinating problems in fluid flow, chaos, and biologically inspired design. Together, we address one of the grand challenges for the physical scientists: to apply their approach to biological problems. Here, at this strongly male-dominated engineering institute, I actively participate in the advancement of women in science. It is this integration of the sciences and ways of thought that I find most rewarding. As a small Asian woman, I have learned that I must make my stand (however quietly and patiently that I do it). I don't give up, I keep my eyes and mind open. My mottos are by Henry David Thoreau and in the poetry of the meditative calligraphy of my Dad.

This article is a tribute to my mother, who passed away too soon. Mom let me do what I wanted because I was raised by her example. I pay attention to these wise mentors.

'I have learned this at least by my experiment:
that if one advances confidently in the direction of his dreams,
and endeavors to live the life he has imagined,
he will meet with a success unexpected in common hours.'
Henry David Thoreau, 1854



Xiaojun Yuan

Doherty Research Scientist, Lamont-Doherty Earth Observatory of Columbia University, Palisades, NY, USA, xyuan@ldeo.columbia.edu

Xiaojun Yuan and her children spent a vacation in Beijing in summer 2004. She has been working at Lamont since 1995. Xiaojun lives with her husband Kaiyuan Zhang, son Thomas, and daughter Amy in Tappan, New York.

I was curious about the mysteries of the ocean and attracted by the beauty of tropical fish in the coral reef when I was in high school. Oceanography consequently became my first choice for college. I received a bachelor's degree in physical oceanography from Shangdon College of Oceanography, China, in 1982. After spending four years at the National Research Center for Environmental Forecast in Beijing, I came to the United States and worked with Dr. Namias at Scripps Institution of Oceanography. We studied the persistence of sea surface temperature anomalies in the North Pacific and its influence on the climate variability of the Northern Hemisphere. A year later, I enrolled in the Ph.D. program at Scripps under the supervision of Professor Talley. I investigated oceanic fronts in the North Pacific using historical conductivity-temperature-depth (CTD) measurements together with surface fluxes. Upon receiving my Ph.D. in 1994, I moved to New York and started postdoctoral studies with Dr. Martinson at Lamont-Doherty Earth Observatory of Columbia University. I then focused on Antarctic sea ice and its relationships with global climate. Lamont boosted my career development. I was promoted to Doherty Associate Research Scientist in 1998 and to Doherty Research Scientist in 2004.

Currently, I conduct a broad range of studies. I have investigated Antarctic sea ice and its relationships with regional climate modes and remote forcing. My studies have identified a major climate mode, the Antarctic Dipole, in the air-sea-ice system of the Southern Ocean and established its connection with El Niño-Southern Oscillation (ENSO) variability through diagnostic analyses and mechanism studies. Collaborating with Dr. Chen, we built the first generation Antarctic sea ice forecast model. As a member of the NASA Ocean Vector Wind Science Team, I investigate the effect of scatterometer winds on estimations of air-sea fluxes and on ocean general circulation model (OGCM) simulations. I am also the lead principal investigator of the U.S./Chinese ship-of-opportunity sampling program, which has been monitoring upper ocean thermohaline variability in the Southern Ocean since 1998.

The greatest challenge in my life is balancing career and family. While pursuing my research interests, I want to be a good mother as well. After years of struggling with the two full-time jobs, I am sincerely appreciating the opportunity provided by this unique career. I enjoy working on my laptop outside my daughter's music lesson room or on the bleachers of my son's swim competition as much as working in my office or meeting with leading scientists in international conferences. Life is full of challenges and excitement.

Adriana Zingone

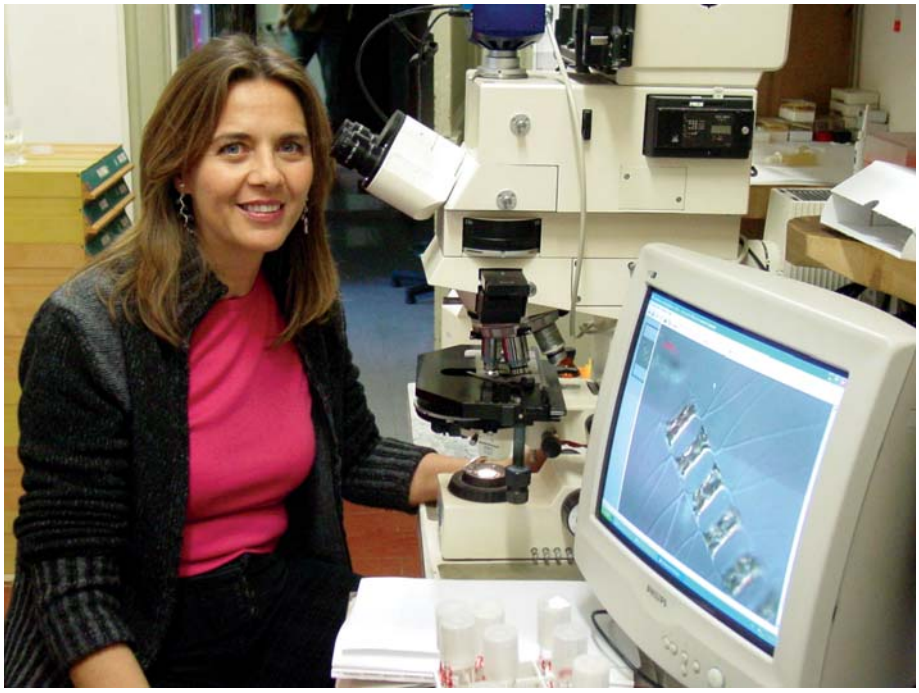
Senior Research Scientist, Marine Botany Laboratory of the Stazione Zoologica 'Anton Dohrn' Naples, Italy, zingone@szn.it

My scientific interests focus on the unicellular microalgae that change the color of the oceans. I am attracted by several different aspects of marine phytoplankton, from morphological diversity to spatial and temporal patterns and, ultimately, to the interactions between phytoplankton and their environment. The opportunity to keep on learning and understanding is a real privilege. I especially appreciate having such an intimate relationship with the sea and with marine life, to see with my own eyes what is beneath that blue surface, and to perceive how much life there is where most people would only see water.

I have always been fascinated by biology, yet it was almost by chance that I was offered the opportunity to work on a master's thesis having to do with phytoplankton. It was very hard for me to start a career as a scientist in Italy at a time when a Ph.D. program had not yet been set up, nor were any fellowships available. I pursued with tenacity any chance to continue in this field until finally, after more than ten years, it became clear that I could work on phytoplankton for the rest of my life. Another great challenge of my career was to chair the Intergovernmental Oceanographic Commission (IOC) Intergovernmental Panel on Harmful Algal Blooms (IPHAB), which launched me into the universe of cooperative international organizations and acronyms. I was often confronted with difficulties, yet the wish to contribute towards building something worthwhile was a great support in this activity. But, the greatest challenges to me are those of today: a scientific question, a research project, a presentation at a conference, a new student—I will never get used to or live these events as routine.

Women are often asked how they balance their career with the personal life, for example, with family—a question that is hardly asked of any man. In fact, for anybody, being very dedicated to work does not allow for work and personal life to be easily balanced. I enjoy staying at home with my family as much as I enjoy working, and I need to stop working as much as I need to get to work and forget about family troubles. A real problem is that there is barely any time left for all other interesting things that life offers.

Now, as in the past, in my country there are no substantial barriers for women who undertake a career in oceanography, yet to be respected and influential requires more of women than of men. In science, just like in life, women are generally more concentrated in doing than in showing off, although positive and negative exceptions are very common for both women and men.



It is such a common experience that, as your career proceeds, there is less and less time to do basic laboratory work. However, time spent at the microscope, for me, is always a very refreshing opportunity.

Patrizia Ziveri

Associate Professor and Research Scientist, Department of Paleoecology and Paleoclimatology, Free University, Amsterdam, The Netherlands, patrizia.ziveri@falw.vu.nl

My main scientific interests are the export production, transport, and sedimentation of biogenic carbonate particles onto the deep seafloor and the effect of climate change on the ecology of specific marine organisms. My research is focused on one of the most important pelagic calcifiers, coccolithophores, present in the ocean since the Mesozoic (about 220 million years ago—Late Triassic). These unicellular phytoplankton differ from all other phytoplankton in that they surround themselves with calcium carbonate structures called coccoliths. Integration of the carbonate chemistry and ecology of these organisms provides proxies for past biological productivity, surface water history, and intermediate water dynamics.

I chose this field of study because I was interested in understanding the physical and biological processes that control the ecological and chemical signals preserved in pelagic carbonate sediments.

The most rewarding aspects about being an ocean scientist are working with fellow researchers and students, and building a consensus on scientific problems of mutual interest. Another rewarding and challenging aspect is participating on oceanographic cruises that have fascinating scientific objectives.

A major career challenge was to achieve species-specific separation in coccolith samples and to interpret the geochemical significance of subsequent isotopic results. As with foraminifera, calcite produced by different species of coccolithophores have different stable isotope fractionation ("disequilibrium"), thus adding both complication and usefulness to the system. To understand the species specific differences is fundamental for more accurate paleoreconstruction.

Balancing career and personal life is a constant challenge; day by day and decision by decision I have always done what I felt was right in this regard. As a woman in science, maintaining a strong sense of independence can be particularly challenging. Accepting this path has come at a price, including temporary separation from my family and working harder and more efficiently.

I do not think the conditions for women are very different now from when I began my career (early 1990s). Because of this reality, I have had to work harder to achieve independence and generate reasonable scientific output. I strongly advocate some of the important new "women-friendly" options that have been put into place recently, including flexible working hours, allowing my child in the office/university environment, and the availability of daycare facilities on campus. My department was particularly receptive and helpful towards me as a new mother. Improving conditions further in these important aspects of life would encourage more women to go farther in their scientific careers.