

### Statement of Copyright

*REVELing in Seafloor Exploration* by Véronique Robigou and Kathleen Heidenreich is excerpted from *Current: The Journal of Marine Education*. © 2003 by Current: The Journal of Marine Education. Publication of the National Marine Educators Association (NMEA). All rights reserved. No part of these articles may be reproduced in any form or by any means without the written permission of the journal and NMEA. For more information on how to subscribe to the journal or to find out more about NMEA, please visit the web site at [www.marine-ed.org/](http://www.marine-ed.org/).

# current

THE JOURNAL OF MARINE EDUCATION

Volume 18 • Number 4 • 2003

**CURRENT LOG** *We're thrilled to be publishing a general issue filled with articles on a wide range of marine topics. We were overwhelmed and pleased with the positive response, and numerous articles and activities submitted. Our goal is to continue to publish one general issue per year, so keep your eye out for next year's deadline! I hope you find an article that will be of interest in your classroom whether you're an informal educator, educational researcher, or just want to learn more about the world of water.*

*Please also mark your calendar for NMEA's 2003 Call for Papers deadline! All session proposals must be received no later than 5 p.m. on February 1, 2003. If you have any questions about concurrent sessions, please contact Vicki Clark at [vclark@vims.edu](mailto:vclark@vims.edu). To find out more about the 2003 national conference on July 20-24 in Wilmington, North Carolina, please visit our website at [www.marine-ed.org/nmea2003!](http://www.marine-ed.org/nmea2003!)*

*Cheers,*

*Lisa Tooker  
Editor*

## CONTENTS

- |    |   |    |  |
|----|---|----|--|
| 2  | <b>Reviving the Naturalist's Journal</b><br>BY TOM HOWICK AND JOE DIRNBERGER  | 36 | <b>Communicating for Conservation: Inspiring Positive Change for the Aquatic and Ocean Realms</b><br>BY TANJA GRONHOLM AND BILL MOTT     |
| 7  | <b>Understanding Marine Bioinvasions: Classroom Experiments with Macroalgae</b><br>BY LINDA J. WALTERS  | 39 | <b>The NEPTUNE Project</b><br>BY NANCY PENROSE AND MARK STOERMER   |
| 11 | <b>Ocean Wilderness Network</b><br>BY MAUREEN WILMOT  | 45 | <b>Minorities at Sea Together (MAST): A Model Interdisciplinary Program for Minority College Students</b><br>BY BENJAMIN E. CUKER, PH.D. |
| 13 | <b>REVELing in Seafloor Exploration</b><br>BY VÉRONIQUE ROBIGOU AND KATHLEEN HEIDENREICH  | 52 | <b>Book Reviews</b>  |
| 18 | <b>Sustainable Seas Expeditions' Project Ocean Steward 2000 Online Workshop Evaluation</b><br>BY KRISTINA BISHOP AND HOWARD D. WALTERS                | 53 | <b>Lobsta Love</b><br>BY DRU CLARKE  |
| 28 | <b>Learning the Metric System: Calculating Fish Distributions, Densities, and Means Using Candy Fish</b><br>BY MARY CARLA CURRAN                      | 54 | <b>Carbon Cycles On A Distant Coral Shore</b><br>BY MARK DE CROSTA   |
| 32 | <b>Marine Education for Multicultural Audiences: Understanding the Asian-Pacific Islander Perspective of the Marine Environment</b><br>BY ALAN RAMMER | 55 | <b>NMEA 2003 Call For Papers</b>   |
|    |   | 56 | <b>The BRIDGE Data Activity: More Than Mud</b><br>BY LISA AYERS LAWRENCE   |

## REVELING IN SEAFLOOR EXPLORATION

BY VÉRONIQUE ROBIGO AND KATHLEEN HEIDENREICH

**NOT A DREAM...A REALITY.** *Deep blue water all the way to the horizon, the world famous manned-submersible ALVIN, research with international teams of scientists, 20 foot waves, long hours “flying” above the seafloor, remotely operated vehicles (ROVs), extraordinary chemosynthetic organisms thriving thousands of meters below the ocean surface, a window into the deep biosphere... This is “the once-in-a-lifetime experience” of risk-taking, highly motivated teachers doing deep-sea research in the Northeast Pacific Ocean.*

### REVEL - RESEARCH AND EDUCATION: VOLCANOES, EXPLORATION AND LIFE

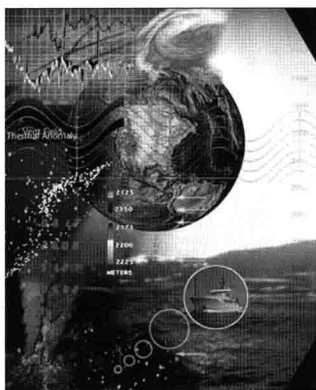


Figure 1. The REVEL facilitates collaboration among researchers, teachers, students, and the community to explore the Earth and ocean systems.

REVEL is a program for science teachers sponsored by the National Science Foundation (NSF). Teachers are selected to participate in funded-seagoing research cruises, and to contribute to ongoing scientific research. During the first five years of the program, the research focused on scientific issues ranging from the origin of life to new aspects of biotechnology related to the study of mid-ocean ridges. The interdisciplinary research spanned from earth sciences to astrobiology including oceanography, chemistry, physics, biology, computer sciences, mathematics, and engineering to cite a few of the scientific disciplines represented in the study of mid-ocean processes. REVEL is a collaborative partnership between researchers, teachers, students, schools, research institutions, and the community. (see Figure 1)

#### The goals of the program are:

- To involve science teachers in authentic, oceanographic research experiences as part of their professional development.
- To integrate seagoing research and, more specifically, mid-ocean ridge exploration and discoveries into the classroom in innovative ways, reflecting today's scientific process.
- To portray the complexity and relevance of science and scientific exploration to students, their communities, and the general public.

- To develop a collaborative community of life-long learners passionate about the understanding of the Earth and its oceans as a system in which biosphere, geosphere, hydrosphere, and atmosphere are all interconnected and related.

The REVEL Project was born from the realization that the passion researchers share for solving scientific problems stems as much from “doing research” and experiencing the scientific process as it does from investigating the oceanic realm, where these researchers spend countless hours of their lives. The scientific process is an exciting, complex, and long-term endeavor. It encompasses the understanding of previous knowledge on a specific scientific issue, the struggle to delineate an original idea, and the search to secure funding to test hypotheses to support that idea. In addition, data collection in an environment as remote and extreme as the bottom of the ocean is particularly challenging. The design and production of sophisticated deep-sea technology is constantly evolving. The success of seagoing research projects depends on the combination of the technological and human skills of the multiple users of research vessels, including research teams, the ship's crew, and marine engineers. Often international teams with competing or conflicting national mandates work together in an uncomfortable or even dangerous ocean environment. And despite the challenges, these teams collaborate toward the same research goals. Researchers who tend to have high levels of enthusiasm to explore uncharted territories and new ideas are also very persistent. These researchers analyze gigabytes of data, finance their research, and present their progress through years of dedication. In parallel, passionate teachers demonstrate infinite patience in the classroom and provide a safe but challenging learning environment to culturally diverse students. The teaching career is also a long-term investment to prepare students year after year for the future. Teachers require high levels of flexibility to adapt to the constraints of the state and school districts finances, curricula requirements, ever-evolving testing models, and education reform recommendations. Through it all, teachers foster life-long learning practices in their students.

Despite the well-documented cultural differences between these two professions (Morrow, 2000), teachers and researchers share the same life-long enthusiasm for learning and cutting-edge research, be it in the mechanisms of DNA replication in marine flat worms or in the various learning styles of students. REVEL merges inquisitive, energetic, and committed science teachers with interdisciplinary researchers to facilitate long-term learning from each other. Through the scientist-teacher collaboration educators augment their scientific knowledge and keep current with cutting-edge discoveries. And, by participating in the scientific research process, teachers gradually introduce the research thinking process in the classroom as a relevant teaching and learning pedagogical tool (Manduca, 1997). Scientists are exposed to a variety of learning-styles that teachers routinely incorporate in their classrooms and can then be better prepared for the increasing diversity of the students entering today's universities. In addition, researchers actively contribute to K-12 education and the science education reform to help prepare society for the technical challenges of the future.

In 1996, with support from the School of Oceanography at the University of Washington and from the State of Washington, Dr. John R. Delaney and Ms. Véronique Robigou invited nine science teachers to participate in a NSF-funded, international cruise on the research vessel (R/V) *Thomas G. Thompson*. The 7th to 14th grade science educators studied underwater volcanism for three weeks on the Juan de Fuca Ridge in the Pacific Ocean. The program and its website (<http://oceanweb.ocean.washington.edu/outreach/revel>), one of the first seagoing websites were launched (Robigou and Delaney, 1997). For the next five years, the National Science Foundation (NSF) Geosciences Directorate, Division of Ocean Sciences supported the program. The REVEL Project grew into a professional development program for science teachers in 7th to 12th grades. The program provided educators with research experiences, seagoing fieldwork, and pre- and post-cruise workshops. In 2000, forty-seven science educators from four states and one Canadian province had participated in the program. Tens of researchers from eighteen U.S. research institutions, and several Canadian and European institutions have interacted and collaborated with the REVEL teachers (or REVELers) to bring deep ocean exploration into their classrooms.

In 1998, the REVEL Project became a collaborative partnership. The Pennsylvania State University research group led by Dr. Charles Fisher contributed additional research cruises to the program on the R/V *Atlantis* and new opportunities for scientific collaboration between teachers and scientists (Hourdez et al., 2000). Pennsylvania teachers and their students were able to participate in seafloor exploration and deep-sea ecology. As a result of this collaboration, two teachers (1998 and 1999) were provided a "once-in-a-lifetime" experience of diving to the seafloor in the manned submersible ALVIN (see Figure 2).

Collaboration with Mr. Myles Gordon and Dr. Maritza MacDonald from the department of education at the American Museum of Natural History augmented the professional education aspect of the program and facilitated the inclusion of New York educators into REVEL. Finally in 2000, collaboration with the NSF-funded Marine Advanced Technology Education Center brought the seafloor into Spanish-speaking classrooms in California.

Today, REVEL is in part funded by the NSF Directorate of Geosciences, Division of Ocean Sciences and the Directorate for Education and Human Resources, Division of Elementary, Secondary, and Informal Education. This support reflects the strong integrated commitment of oceanographic research and science education as recommended by the Centers for Ocean Sciences Education Excellence (COSEE) NSF initiative (McManus et al, 2000; Cook and Rom, 2001).

### THE FUTURE OF REVEL

Building on the lessons learned through the initial REVEL partnership, the 2002-2005 program will partner with the NEPTUNE Project described on page 39 by Nancy Penrose and Mark Stoermer:

1. To facilitate the active participation of teachers in cutting-edge, seagoing ocean research;
2. to recruit science teachers through the entire nation;
3. to provide multiple years of REVEL activities to teams of teachers; and
4. to evaluate REVEL as a model for teachers experiencing research.

The new REVEL partnership will provide many science educators, their students, and the community with opportunities to become involved in Earth and ocean research in real-time. These educators will be invited to study the processes that shape an entire tectonic plate via a cabled observatory on the Juan de Fuca plate in the Northeast Pacific Ocean (<http://www.neptune.washington.edu/>). Through this seafloor observatory linked to the Internet, students will have

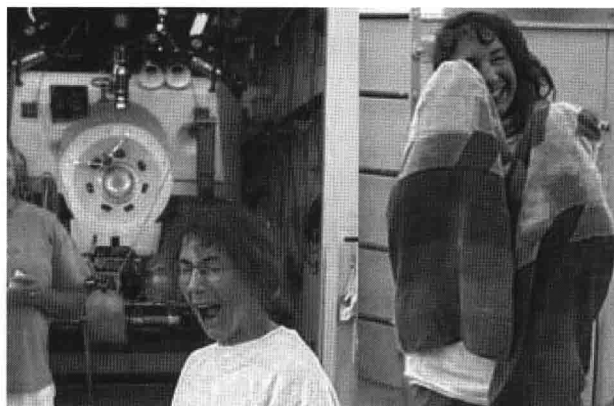


Figure 2: Kathie Robertson is the first science teacher to visit the seafloor at 2,550 meters depth in the submersible, ALVIN.

access to data, images, and experiments examining the relationships among plate tectonic deformation, fluid expulsion, chemical fluxes, and microbial productivity at plate boundaries. The environments that students and educators will investigate are the spreading center where the ocean floor is forming, the transform fault zone along which tectonic plates move by each other, and the subduction complex under which the oceanic plate plunges under the North American continent. REVEL will provide teams of teachers recruited throughout the U.S. with research experiences, collaborating with the research community, studying the natural processes associated with these dynamic underwater environments. And this cadre of teachers will design, produce, and test relevant, usable and Standards-based material and activities for students.

Pairs of teachers from the same school or the same school district can apply to participate in REVEL via the website starting in January 2003 for the programs offered in 2003, 2004, and 2005. The selected teams must participate in REVEL research preparation at the University of Washington prior to their research experience. Through the year, teachers will collaborate with scientists on a research project, and participate in all research activities at sea and/or on land (Taylor, 1999). Teachers must meet additional requirements such as communicating during their field experience with classrooms and the general public via the Internet, contributing to the seagoing daily website, participating in post-seagoing research and education workshops, and becoming mentors for future participants. Most importantly, teachers must share their experiences with their school boards, with other teachers in their school districts, and at professional conferences. Educators will use this experience with many students not limited to their classrooms and with their local communities for years to come. The first teams of teachers will be selected by the end of March 2003 and previous REVELers who have become mentors (see sidebar: *Kathleen Heidenreich: From REVELer to REVEL Mentor*) will assist them with preparation for their involvement in the program. The new REVELers attend an orientation workshop to become familiar with the program. The teachers learn about the science project in which they will be involved and they are briefed about the conditions of working at sea. The typical field season for research at sea in the Northeast Pacific is from early May to early October, and one teacher of each selected pair spends from two to four weeks working at sea during this period. The teachers at sea become active members of the seagoing research teams (see sidebar: *Cindy Maldonado – REVEL 2000*).

After the field experience, many REVELers continue to collaborate with researchers. Some have co-authored published papers in scientific journals alongside researchers and high school students (Hourdez et al., 2000). All REVELers participate in post-cruise workshops and once back in school, teachers are responsible for bringing their ocean and seagoing research experience into the classroom by

developing activities about their experience that fit within their district's science curriculum. Teachers are also expected to present their experiences at local events, and contribute to workshops and in presentations during state, regional, and national education meetings.

REVELers have a chance to explore a remote, still unknown environment where very few people have a chance of ever going. Many REVELers describe their experience at sea and working with researchers as "life-altering." Through the years these daring teachers have experienced extraordinary events, and contributed to new scientific discoveries. Past REVELers participated in the 1997 and 2000 discoveries of new hydrothermal vent fields and the 1998 unique recovery of large, sulfide-rich, hydrothermal chimneys from the seafloor. The NOVA program "Volcanoes of the Deep" that aired on PBS in 1999 documented this out-of-the-ordinary expedition; and the sulfide chimneys retrieved from the seafloor are now exposed in the Hall of Planet Earth at the American Museum of Natural History in New York. In 1999, REVELers went on to collect a yet unknown, deep-sea mussel species endemic to hydrothermal environments. All teachers have conducted research adding to the success of cutting-edge scientific projects. For years to come, REVELers share their enthusiasm for and knowledge of the oceans, and transfer their love of learning to hundreds of students.

#### SPECIAL THANKS

Special thanks to Dr. John Delaney for understanding the vision of REVEL and helping the program become reality. Thank you to Drs. Charles Fisher, Deborah Kelley, Russell McDuff, and Kim Juniper for hosting the program on their research cruises and facilitating teachers' access to mid-ocean ridges scientists coming from all over the world. Many thanks to the crew and captain of the research vessels *Thomas G. Thompson* and *Atlantis* for their invaluable contribution to the program. Without their enthusiastic support since 1996, REVEL would never have sailed. And many thanks to the pilots and engineering teams of the submersible, ALVIN; the ROVs, *JASON* and *ROPOS*; and the AUV, ABE. Finally, the REVEL Project is in debt to all REVELers who since the inception of the program contributed enormous amounts of time and energy to the success of ocean research adventures.

**VÉRONIQUE ROBIGOU** is a marine geologist working on mid-ocean ridges hydrothermal systems. She directs the REVEL Project at the School of Oceanography of the University of Washington in Seattle. Her education interest also includes preparing students for multilingual and multicultural marine sciences studies for a better understanding of the world's oceans and their impact on the life of people.

**KATHLEEN HEIDENREICH** teaches Life Science and Oceanography at Chinook Middle School in Lacey, Washington. She is active in NAME and has been NMEA's Awards Chair for 11 years.

## KATHLEEN HEIDENREICH: FROM REVELER TO REVEL MENTOR

Social Studies teachers don't have to dream about seeing the Parthenon or the Great Pyramids. Tours to these "wonders of the world" are easily accessible through travel agencies. There are many aspects of the ocean easily accessible through snorkeling and SCUBA diving, but the deep ocean is accessible to only researchers.

I was one of nine teachers chosen for the first REVEL cruise in 1996—the larvae of the program, if you will. I had been teaching about the alien world of hydrothermal vent communities for 11 years, and now, through REVEL, I had the opportunity to experience scientific exploration firsthand—this was beyond my wildest dreams.

In 1996 the scientists were using the Canadian remotely operated vehicle (ROV) *ROPOS* aboard the University of Washington's research vessel (R/V) *Thomas G. Thompson*. The ROV is operated from a control room on the ship and I spent many hours in the control room "discovering" along with the researchers. I felt the disappointment of discovery when Véronique found that the famed *Godzilla* sulfide chimney had crumbled during the previous months. I felt the thrill of discovery when Dr. Debbie Kelley (UW) discovered the new Mothra vent field (\*).

Six years later, the thrill of the experience still energizes my teaching. How can you not be energized by something that has affected you so deeply and continues to be a source of amazing discovery and exciting material to teach?



Figure 3. Kathleen in her survival suit during the 2002 mentor REVEL cruise.

The connection with REVEL does not end when the participants disembark from the ship. Workshops and electronic communications allow the REVELers to learn (from researchers) about new developments, discoveries and technology, and to re-live the experience through the sharing of ideas and lessons used in our classrooms. The REVEL teachers, even those who we have never met, develop a unique camaraderie and sense of community through this continued involvement.

REVELers have presented their experience and hydrothermal vents science at numerous conferences, workshops, and classrooms across the country. Students, educators, and the general public who were reached through these presentations are eager for more information about the strange communities, thriving deep in the ocean.

My personal connection with REVEL has led to various "opportunities," including consultation on the Turnstone, "Ocean Explorer," book series for middle school science. Currently, I am working with a team of writers from the University of South Florida to develop teaching materials to accompany the new IMAX film (temporary working title: *Voyage to the Abyss*) about hydrothermal vents that will be released in June 2003 ([www.stephenlow.com](http://www.stephenlow.com)). I was extremely excited when I was recently asked to be a REVEL mentor. In this capacity I will be guiding future participants through the REVEL experience—pre-cruise, aboard ship, and post-cruise.

I am continually learning about deep ocean science and new discoveries and am eager to share that knowledge with other educators. So little of the ocean has been explored. I would like to think the excitement about the ocean that I bring to my students will result in future ocean explorers and discoverers.

*\*Four chimneys from Mothra were retrieved from 2500 meters depth in 1998. Two are on display in the Hall of Planet Earth at the American Museum of Natural History in New York.*

## CINDY MALDONADO - REVEL 2000



Figure 4. Cindy Maldonado spent three weeks on the R/V *Atlantis*.

**First Day** ...About 22 hours to reach our destination. Yes, I have gotten seasick but I am doing better now...There is no way I could have typed this yesterday. About 2:30 in the morning we hit the ocean and the ship rocks and rolls mightily...All REVELers are sick...

**Exciting Day** You would totally love being aboard. Right now it is 3 in the morning. And I am tired. I have been working on CTD all night...It's been fun! Gotta run. We are pulling the package in and I need to go out on deck and help.

**Difficult Day** I usually leave (the daily lectures) feeling overwhelmed and stupid...So, I find a quiet, warm place and read and take notes on what I am reading. And I may start to get a clue!

**Long Rewarding Day** I am so tired...Stayed up until 6:30 am doing CTD work. Found a vent! This is very exciting! We pinpointed the location of a hydrothermal vent field that before this cruise they only thought existed. The next step is to dive (in ALVIN) for direct observations.

**Confident Day** I am getting psyched for my research presentation. I am going to treat these "brains" (researchers on board) as if they were eighth grade Earth Sciences students. They will have to point things out on the map, calculate things for me and all, just like in class.

**ALVIN Day** I watched ALVIN surface today. It was like watching an *Apollo* splashdown. I couldn't believe how tense I was and how grateful when these guys climbed out of the sub. They go down more than 2 km and come back to the surface. It is astonishing!

**Last Day** I am going to cry. I've had such a great time! Isn't that sick? I've worked like a dog, gotten dirty, been seasick, always sleep deprived, and I am so glad I did it!

### REFERENCES

Cook, S.B. and E. L. Rom, "The Centers for Ocean Sciences Education Excellence (COSEE) Initiative: a history and a vision," *Current*, Vol. 17, No.2, p.3-4, 2001.

Hourdez, S., J. Lamontagne, P. Peterson, R. E. Weber, and C. R. Fisher, "Hemoglobin From A Deep-sea Hydrothermal Vent Copepod," *Biological Bulletin*, Vol. 199, p. 95-99, 2000.

Manduca, C.A., "Learning Science Through Research," *Geotimes*, October 1997, p. 27-30, 1997.

McManus, D. A., S. H. Walker, B. Cuker, P. Goodnight, S. Humphris, P. Keener-Chavis, D. Reed, V. Robigou and J. R. Schubel, Center for Ocean Sciences Education Excellence (COSEE), *COSEE Workshop Report* sponsored by the National Science Foundation in cooperation with the University of Southern Mississippi, Institute of Marine Sciences, pp.69, 2000. ([www.cosee.org](http://www.cosee.org))

Morrow, C.A., Scientist involvement in Education and Public Outreach, *Making the Case* in "Resources for scientists in education and public outreach" CD-ROM, 2000.

Robigou V. and J.R. Delaney, "REVEL. Research and Education: Volcanoes, Exploration and Life." *RIDGE Events*, Vol. 8, No.1, p 5-7, 1997.

Taylor, M., "Teachers REVEL in undersea research", *Northwest Science and Technology*, Vol. 1, 17, 1999.

### CREDITS

Photographs courtesy of the REVEL Project.

FOR INFORMATION AND ACTIVITIES RELATED TO THIS ARTICLE THE BRIDGE RECOMMENDS:

Please see page 44, following *The NEPTUNE Project* for related links.