USGS

Sound Waves

Coastal Science and Research News from Across the USGS

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Fieldwork

USGS Scientists Investigate Surf-Zone Hydrodynamics at San Francisco's Ocean Beach

By Li Erikson, Patrick Barnard, and Dan Hanes

Researchers from the U.S. Geological Survey (USGS)'s Pacific Science Center in Santa Cruz, Calif., recently conducted a study of surf-zone hydrodynamics at Ocean Beach in San Francisco, Calif. Ocean Beach is on the west side of San Francisco, within the Golden Gate National Recreation Area. The field effort is part of an ongoing study that began in April 2004 to document, analyze, and simulate the processes that control sand transport and sedimentation patterns along Ocean Beach and the mouth of San Francisco Bay. This study is part of the USGS project "Coastal Evolution: Process-Based, Multi-Scale Modeling."

The recent surf-zone study was conducted over 5 days approaching spring tides in late January 2006 (maximum measured tide range was 2.2 m). Five current profilers—upward-looking Aquadopps from Nortek—were mounted on aluminum frames and placed on the sandy seabed at nine sites in the surf zone. The frames were manually deployed and retrieved at low tide by brave USGS scientists **Patrick Barnard**, **Dan Hanes**, **Jodi Eshleman**, **Li Erikson**, **Peter Ruggerio**, and **Josh**

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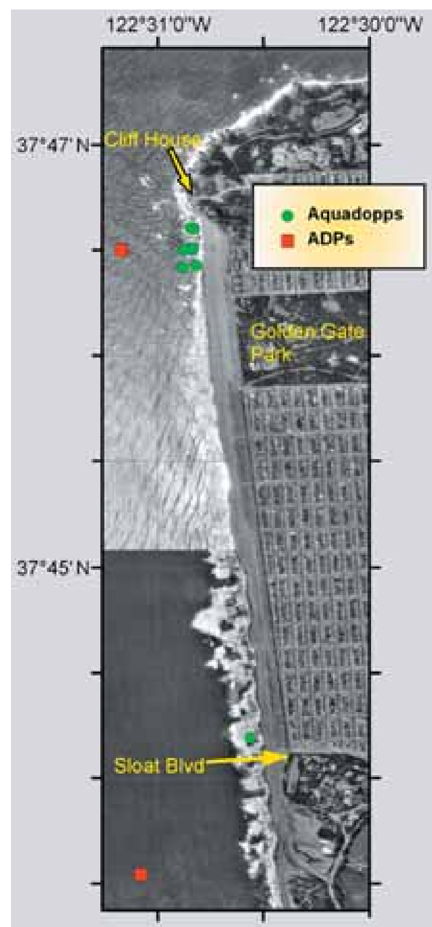
*Nortek Aquadopp current profiler mounted on an aluminum frame (constructed by **Kevin O'Toole** at the USGS Marine Facility in Redwood City, Calif.). Two handles facilitate moving the apparatus. Sand anchors on the handle ends and tapered "feet" protruding from the frame bottom and embedded in the sand help keep the frame and instrument steady in the waves. Photograph by **Patrick Barnard**.*



*Locations of instruments used to measure wave heights and currents during the surf-zone study in January 2006, superimposed on two aerial photographs (upper half from California Spatial Information Library [CSIL] at URL **http://casil.ucdavis.edu/casil/usgs.gov/doqq-archive/37122/**; lower half from San Francisco Bay Area Regional Database [BARD] at URL **http://bard.wr.usgs.gov/htmldir/doq_html/sf_coqs/sfsouth.html**). Aquadopps, Aquadopp current profilers; ADPs, acoustic Doppler profilers.*

***Andrew Schwartz** (left) and **Dan Hanes** maneuver an Aquadopp current profiler and its frame in the surf. Photographs by **Patrick Barnard**.*

Sound Waves

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Submission Guidelines

Deadline: The deadline for news items and publication lists for the June issue of *Sound Waves* is Friday, May 12.
Publications: When new publications or products are released, please notify the editor with a full reference and a bulleted summary or description.
Images: Please submit all images at publication size (column, 2-column, or page width). Resolution of 200 to 300 dpi (dots per inch) is best. Adobe Illustrator© files or EPS files work well with vector files (such as graphs or diagrams). TIFF and JPEG files work well with raster files (photographs or rasterized vector files).

U.S. Geological Survey
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Need to find natural-science data or information? Visit the USGS Frequently Asked Questions (FAQ's) at URL **http://www.usgs.gov/search/faq.html**

Can't find the answer to your question on the Web? Call 1-888-ASK-USGS

Want to e-mail your question to the USGS? Send it to this address: ask@usgs.gov

Fieldwork, continued

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Logan, along with **Andrew Schwartz** of the Washington State Department of Ecology (DoE). To keep the instruments in place on the seabed within the high-energy surf zone, the frames were stabilized with two sand anchors on either side of the frame along the direction of breaking waves. In addition to sand anchors, tapered "feet" protruding from the bottom of each frame were buried in the sand. The Aquadopp current profilers collected time-series measurements of depths (pressure) and currents in the north-south and east-west directions at 10-cm intervals through the water column.

Concurrent with the Aquadopp measurements, a video camera encased in a protective housing and mounted on the roof of the Cliff House restaurant was used to film the northern section of Ocean Beach (just south of the Cliff House; see Ocean Beach Webcam at URL **http://www.evsboca.com/usgs/default.htm**). The camera's field of view encompassed

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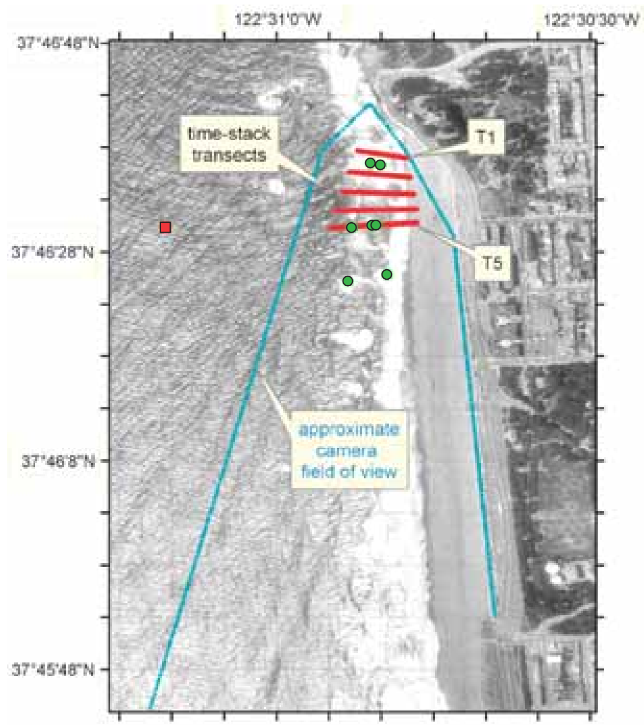

Aquadopp current-meter (green dots) and acoustic-Doppler-profiler (ADP) (red square) sampling locations near the north end of Ocean Beach. Also shown are the camera's field of view and cross-shore transects sampled for the time-stack analysis (T1 through T5).

*Video camera mounted on top of the Cliff House restaurant at the north end of Ocean Beach. DSL, digital subscriber line. Photograph by **Ann Gibbs**.*

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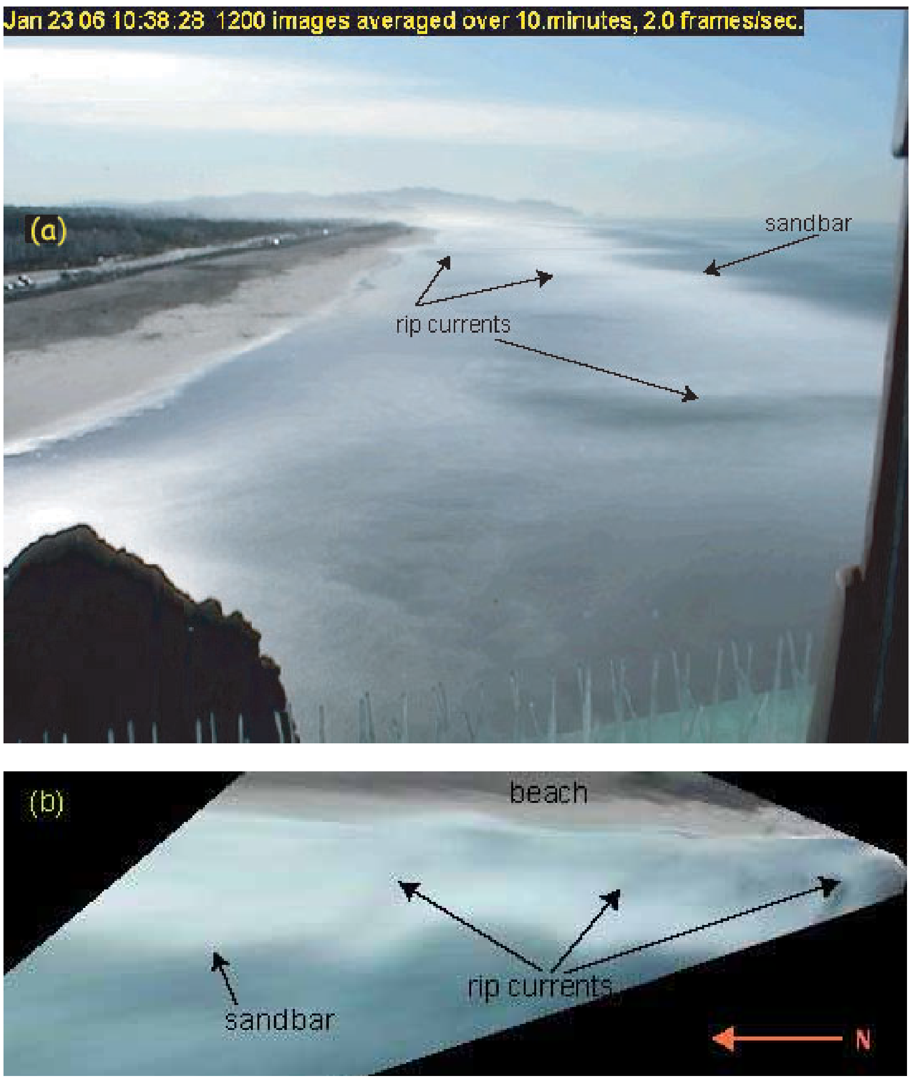
the locations of the northernmost Aquadopp instruments. Two variations of video images were generated (employing a system developed by Erdman Video Systems; see URL **http://www.video-monitoring.com/**) and are currently being analyzed: (1) time-averaged images encompassing the camera's entire field of view and (2) "time stacks" along five cross-shore transects numbered T1 through T5.

Time-averaged images were created from consecutive video images averaged over 10-minute intervals. Because waves do not break consistently in the exact same place, a more easily discernible and stable image of the wave-breaking region is obtained with a suite of averaged images. The time-averaged images are analyzed for spatial determination of sand-bar dynamics and the presence of rip currents.

"Time stacks" are composite images created by extracting a line of pixels along each of the five transect lines in a video frame and pasting the lines of pixels side by side. The same set of pixels were extracted from consecutive video frames, taken at a rate of two frames per second, and stacked vertically to produce an image with time on the vertical axis and cross-shore distance (of the five transects) on the horizontal axis. Time-stack images are analyzed for maximum runup length (that is, maximum inshore distance of the leading edge of the waves), swash period, and cross-shore current velocities. Runup height (maximum elevation above sea level at the leading edge of the waves) is calculated by combining the data from time-stack images with high-resolution measurements of foreshore elevations (see below). A technique for obtaining alongshore current velocities from the cross-shore time stacks is being developed. Current-velocity measurements obtained with the Aquadopps are used to verify the cross-shore and alongshore velocities determined from time stacks.



Typical time-averaged images showing sand bar (broad, light band) and rip currents (narrow, slightly darker bands perpendicular to the shore). a, *oblique view from the camera's actual position;* b, *overhead, or map, view produced by rectifying image* a.

In addition to data collected with the Aquadopp current profilers and the rooftop video camera, a suite of parameters related to surf-zone mechanics were also measured:

- currents and wave heights outside the surf zone were measured with two acoustic Doppler profilers (ADPs),
- foreshore elevations were measured with a global positioning system (GPS) mounted on an all-terrain vehicle (ATV), and
- sediment-grain sizes were measured with a camera system developed by **Dave Rubin** of the USGS (see article in *Sound Waves*, April 2003, at URL **http://soundwaves.usgs.gov/2004/03/research.html**).

Field support for the various measurements was provided by the same people who maneuvered the Aquadopp current profilers (see above), along with **Ann Gibbs**, **Gerry Hatcher**, and **Liron Friedman** from the USGS Pacific Science Center; **Jeff Hansen** from San Francisco State University; and **Lindsey Doermann** from the DoE.

For more information about our work at Ocean Beach, visit URL **http://walrus.wr.usgs.gov/coastal_processes/**. For more information about the "Coastal Evolution: Process-Based Multi-Scale Modeling" project, of which the Ocean Beach study is a part, visit URL **http://walrus.wr.usgs.gov/research/projects/CEM.html**.

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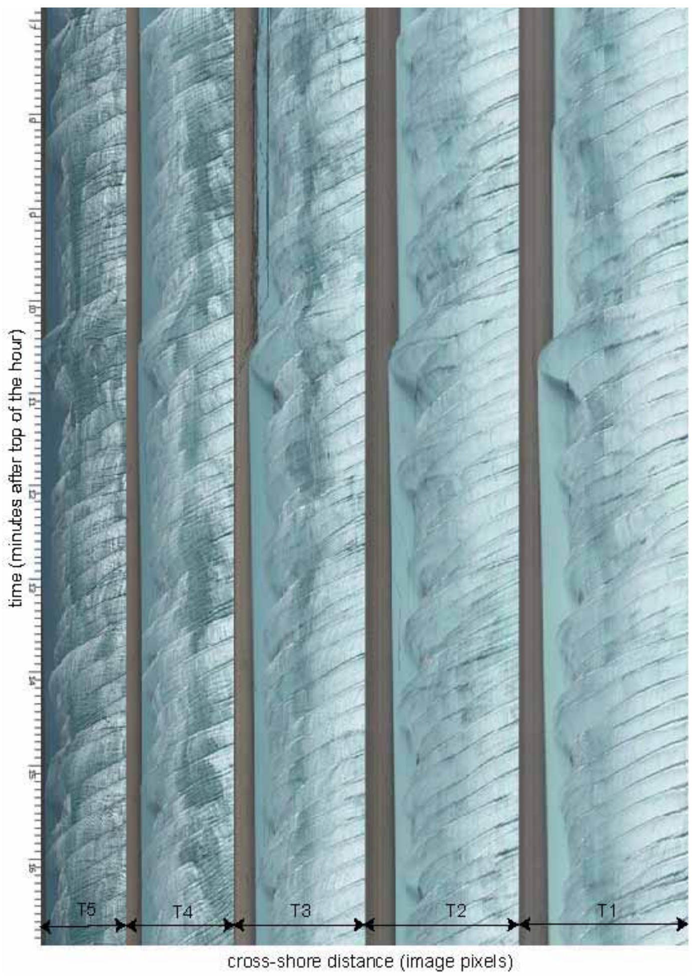
(Ocean Beach continued from page 3)



Typical time-stack image obtained during the surf-zone study at Ocean Beach. Image was created by extracting a line of pixels along each of the five transect lines (T1 through T5) in a video frame and pasting the lines of pixels side by side. The same set of pixels were extracted from consecutive video frames, taken at a rate of two frames per second, and stacked vertically to produce an image with time on the vertical axis and cross-shore distance (for each transect) on the horizontal axis. Shoreline is on the left in each transect.

Jeff Hansen *with an all-terrain vehicle (ATV) equipped with a geographic positioning system (GPS) used to measure topographic profiles of the foreshore.*

Research

Scientists Recreate Ground Shaking from the 1906 San Francisco Earthquake

By Stephanie Hanna

On March 28, 2006, scientists unveiled results from the most comprehensive study to date of how hard and how long the ground shook in the 1906 San Francisco earthquake.

Over a 2-year period, scientists from the U.S. Geological Survey (USGS), Stanford University, Lawrence Livermore National Laboratory, URS Corp., and the University of California, Berkeley, simulated ground shaking caused by the 1906 earthquake, using a new three-dimensional geologic model of the San Francisco Bay area. The simulations, which can be viewed at URL **http://earthquake.usgs.gov/regional/nca/1906/simulations/**, have great potential for research, hazard-loss estimation, and public education.

The simulations show how the 1906 earthquake spread from its offshore epicenter, about 2 miles west of the San Francisco Zoo, and grew to cause strong shaking and damage along more than 300 miles of the San Andreas Fault. Understanding the huge geographic extent of the earthquake's impact is important for the San Francisco Bay region's citizens and decisionmakers.

"We want to emphasize that a large earthquake such as 1906 is not just a San Francisco quake but a northern California earthquake," said **Brad Aagaard**, the USGS geophysicist who led the effort. "Earthquakes greater than magnitude 7 are going to cause intense shaking over a large area—everyone needs to be prepared."

Multiple studies that use the new simulations to assess the likely impact of such a quake occurring today were among the scientific results presented at the 100th Anniversary Earthquake Conference,

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held April 18-22, 2006. The conference was the science, engineering, and policy centerpiece of a suite of activities commemorating the centennial anniversary of the 1906 San Francisco earthquake (for a complete list of activities, visit URL **http://1906centennial.org/activities/**).

The new simulations use a three-dimensional geologic and seismic-velocity model, released last October by the USGS (see URL **http://quake.wr.usgs.gov/research/3Dgeologic/**), as well as a model for how the fault ruptured in 1906.

"For the new fault-rupture model, we re-analyzed century-old surveying and seismographic data," said **Seok Goo Song**, a geophysics graduate student at Stanford University. "Our model confirms that the rupture was about 300 miles long with a magnitude of 7.8 to 7.9. Our work gives new insights into the strength of strong ground shaking in large earthquakes."

The simulated ground motions were compared with ground motions reported in a famous report on the 1906 earthquake written by **Andrew C. Lawson** and published by the Carnegie Institution of Washington in 1908 (Publication 87, v. 1, reprinted 1969), which USGS scientists recently mined to create detailed maps of ground-shaking intensities in that earthquake (see URL **http://pubs.usgs.gov/of/2005/1135/**).

"These simulations give us a much more realistic and detailed picture of the strong shaking levels used for hazard-loss estimation and disaster-preparedness exercises and longer-term planning," said **Mary Lou Zoback**, a USGS seismologist and co-coordinator of the Earthquake Hazards Program in northern California. "These easily understood simulations should increase public awareness of our hazard."

The scientists have also calculated the ground motions for the 1989 magnitude 6.9 Loma Prieta earthquake, which occurred beneath the Santa Cruz Mountains and caused damage from Watsonville to San Francisco.

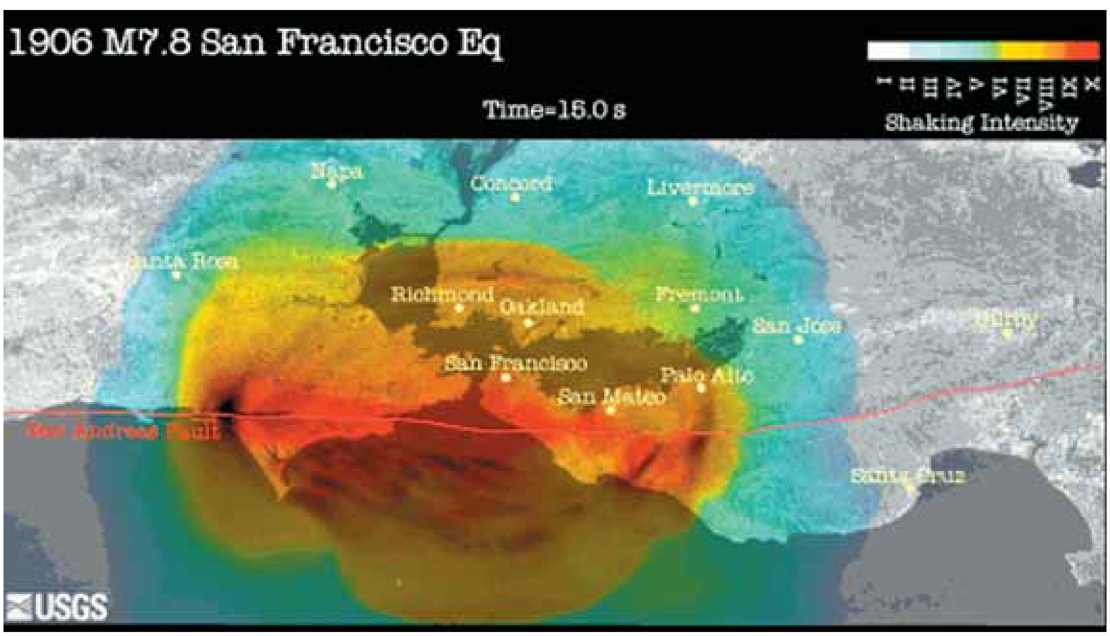
"It's not that the ground motions in 1906 were significantly larger than those in 1989—it's that the area experiencing intense shaking was much, much greater," **Aagaard** said. "We don't know whether the next rupture will look like the 1906 earthquake, but we know that many of the same areas hit hard in 1906—like San Francisco, Santa Rosa, and the Santa Cruz Mountains—will be hit hard again in the next large earthquake on the San Andreas Fault."

"When the 1906 event reoccurs, we'd expect tremendous damage to structures around the Bay Area," said **Rich Eisner**, regional director of the Office of Emergency Services. "We need to rebuild now to reduce our vulnerability before an earthquake hits."

"I'm excited about the future potential of these computer models as much as anything," said **Rob Graves**, a seismologist at URS Corp., an international engineering consulting firm, and project participant. "With earthquakes, we've had to learn from the past to understand or perhaps predict the future. If we can build confidence in these models' ability to simulate earthquakes, we may have a way to essentially predict earthquake effects and present different earthquake scenarios."

The simulations were run on computers at the USGS and Lawrence Livermore National Laboratory (LLNL), as well as the Southern California Earthquake Center's facilities at the University of Southern California. LLNL scientists **Shawn Larsen**, **Anders Petersson**, and **Arthur Rodgers** took advantage of access to the world's 45th-fastest computer in running their simulations of the earthquake.

To see the 1906 and 1989 simulations, visit URL **http://earthquake.usgs.gov/regional/nca/1906/simulations/**. For other USGS information about the 1906 San Francisco earthquake, visit URL **http://earthquake.usgs.gov/regional/nca/1906/**. ☸



Frame from the recently released computer simulation shows where and how hard the ground was shaking 15 seconds after the start of the 1906 San Francisco earthquake. Red colors indicate greater shaking. The earthquake lasted about 60 seconds, during which it spread to cause shaking and damage along more than 300 miles of the San Andreas Fault. (See URL ***http://earthquake.usgs.gov/regional/nca/1906/simulations/****.)*

USGS Scientists Help Girls Expand Their Horizons at Science Workshops in Santa Cruz, California

By Ginger Barth, Carissa Carter, Nadine Golden, and Carol Reiss

On Saturday, March 4, 2006, U.S. Geological Survey (USGS) geoscientists **Ginger Barth**, **Carissa Carter**, **Nadine Golden**, and **Carol Reiss** presented two workshops representing careers in Coastal and Marine Geology and Geophysics at the 6th annual Expanding Your Horizons in Science, Mathematics and Engineering conference at the University of California, Santa Cruz (UCSC). The conference, open to girls in grades 8 through 12, included participation in the girls' choice of two hands-on workshops. A total of 15 workshops were offered, with topics as diverse as finding genes, mapping the ocean floor, neonatal nursing, satellite design, and organic farming. More than 200 girls attended the all-day event (for additional information, see URL **http://eyh.ucsc.edu/**.)

The workshop developed by **Barth**, **Reiss**, and **Golden**, "Echo to Image: Revealing Hidden Landscapes Beneath the Sea," featured concepts in marine geology and geophysics. Girls looked at USGS bathymetric maps of the California margin, considered how looking down through layers of sediment is like looking backward in time, and used slinkies (coil-shaped toys) to create compressional waves like the sound waves used to map the sea floor. They also simulated seismic profiling by measuring depth to a volcano model buried in a pan of vermiculite, and they compared their results to a real seismic-reflection profile of a buried seamount in the Bering Sea. A final segment on drawing contour lines led the participants to create their own volcano maps. To wrap up, the vermiculite was removed, and the girls compared their profiles and contour maps with the real three-dimensional volcano model, with great satisfaction.

Girls who chose this workshop were predominantly 10th graders. They were polite, interested, and enthusiastic. All of the participants—including the university-student helpers and the conference organizers—were quite excited to see what beautiful

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Girls enjoy using slinkies to create and visualize compressional waves, models for the sound waves used to measure and map undersea topography.

Students pleased with the results of their contouring, an exercise in which they transformed their plot of depth soundings into a contour map of the hidden volcano.

A pair of students use a wooden skewer to measure the distance from the "sea surface" (top of a pan of vermiculite) to the "sea floor" (a plastic model of a volcano hidden by the vermiculite). This exercise gave them a feel for how marine scientists map terrain that is hidden from view by seawater.

Three of the USGS scientists who participated in the Expand Your Horizons conference at the University of California, Santa Cruz. Pictured here is the "Echo to Image" team (left to right): ***Ginger Barth*** *(team leader),* ***Carol Reiss****, and* ***Nadine Golden****; not pictured is* ***Carissa Carter****, who developed and led the "Sands, Storms, and Slope Failure" workshop.*

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landscapes lie beneath the sea, how physics and geology are intertwined in marine exploration, and how real people have a diversity of jobs exploring our Earth.

"Sand, Storms, and Slope Failure," the workshop developed by **Carter** along with UCSC graduate student **Christie Rowe**, was a hands-on lesson on landslides, one of the surficial processes particularly relevant to Santa Cruz County. Students experimented with various "slope" materials: sand, dirt, and gravel. First, they calculated the angle of repose for each material in dry and wet states. Using their results, they built upon the experiment and added "rain" to the top of each slope until failure occurred. This exercise inspired lively discussion about the amount and intensity of rain needed to cause slides in different materials, pore-space and pore-pressure considerations, and the varieties and styles of landslides.

*USGS scientist **Carissa Carter** (right) watches as students adjust their carefully engineered slope in preparation for adding "rainfall" (water) to see how much rain the slope can withstand before it fails (failure was defined as the first movement of one of the green houses or red hotels).*

The workshop culminated in the girls working in groups to engineer slopes that would resist failure, and then measuring how much rain each slope could withstand. Using the knowledge from the earlier exercises, they mixed and layered substrates and engineered retaining walls and drainage networks. They positioned plastic models of houses and hotels on each slope. Failure was defined as the first movement of any house or hotel, and so building placement was also a factor—sometimes only the toe of a slope will fail, damaging houses at or near the base of the slope, while houses nearer the top remain unscathed. Overall, the girls developed sophisticated solutions that engineers actually use to combat slope failure in Santa Cruz County.

Materials for the landslide experiment are easy to obtain, and the content can be modified for a variety of audiences to include more or less qualitative and quantitative content. In general, the 8th through 11th graders at this workshop were adept at the calculations. They were excited about the concept, and many asked questions about the types of classes to take in order to pursue careers in the geosciences.

USGS GIS Specialist Shares Tools and Technology with Local Community

By Ann B. Tihansky and Kristine Martella

Kristine Martella, a geographic-information-system (GIS) specialist at the U.S. Geological Survey (USGS) office in St. Petersburg, Fla., has been busy participating in numerous outreach efforts, spreading the word about GIS tools and technology. As a contractor with IAP World Services, Inc., **Kristine** is affiliated with the USGS National Wetlands Research Center in Lafayette, La., but is now stationed in St. Petersburg. Here, she not only contributes GIS expertise to USGS studies in Tampa Bay (see URL **http://gulfsci.usgs.gov/tampabay/**), but also manages to share her knowledge throughout the Tampa Bay area. She participated in GIS Day on November 16, 2005, a day set aside internationally to engage people in learning and caring about geography (URL **http://www.gisday.com/**). She has presented her GIS lessons at the USGS Open House in St. Petersburg, at nearby middle and elementary schools, and at a recent LEEF (League of Environmental Educators in Florida) conference. She also has plans to teach educators at upcoming WETMAAP (Wetland Education Through Maps And Aerial Photography) workshops.

***Kristine Martella** (right) and **Mike Holmes** showcase USGS science at GIS Day.*

Kristine has introduced GIS concepts to fourth through eighth graders at such events as the USGS St. Petersburg Open House, a science festival at St. Paul's Catholic Church School in St. Petersburg, and an ongoing mentoring program between the USGS and Stewart Middle School in Tampa, Fla. **Lynn McDaniel**, the science coordinator at Stewart Middle School, was excited to have USGS participation in her school's classrooms: "The USGS has many resources for educators,

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and there are many exciting fields in science. When USGS scientists visit the classroom, it really helps the students understand how and why their science classes are important." Interaction with scientists can expand students' visions of their futures, too, as **McDaniel** pointed out: "A visiting scientist is a real-world example of how science can lead to an exciting career that many students may not have considered before."

As part of the wetland education program with Stewart Middle School, **Kristine** started out explaining the basics behind GIS. Students created their own landcover GIS layers in the Tampa Bay region, using USGS topographic maps, transparencies, and markers. When each of the students had interpreted a different piece of information, such as roads, vegetation (including wetlands), and hydrology, they overlaid the transparencies and saw how geographic elements can be interrelated. **Kristine** now has the students using a Web-based mapping tool called an interactive mapping system (IMS), which can be accessed from the Gulf of Mexico Integrated Science Web site (URL **http://gulfsci.usgs.gov/**). This Web site contains four IMSes, two digital libraries, and an array of information and links for the Gulf of Mexico region that can be used by anyone with Internet access. Specifically, the students are using the Tampa Bay IMS (URL **http://gulfsci.usgs.gov/tbay_ims/**), which is helping them gain a greater appreciation for wetlands in the Tampa Bay region. As the wetland education program continues through the semester, other USGS scientists will share their expertise with the students.

Fourth graders concentrate on mapping their own GIS coverages.

For GIS Day (November 16, 2005), **Kristine** and **Mike Holmes** created an exhibit showcasing USGS research that relies on GIS applications. Their booth was part of a GIS Day celebration at the University of South Florida in Tampa, where more than 160 visitors, including high-school students, were exposed to the latest in GIS applications. **Kristine** and **Mike** displayed USGS products that demonstrate the power of GIS for interpreting many types of data in both time and space; examples included maps of hurricane effects in the Gulf of Mexico, real-time water-resources data from across the Nation (URL **http://waterdata.usgs.gov/**), and a Hydrologic Data Web Portal focusing on water-resources data from southwest Florida (URL **http://hdwp.er.usgs.gov/**). Examples of mapping efforts based on lidar (light detection and ranging, a technology that uses lasers for precise elevation information) are available online at URL **http://gulfsci.usgs.gov/tampabay/data/1mapping/lidar/**, part of the Gulf of Mexico Integrated Science Web site (**http://gulfsci.usgs.gov/**).

Kristine has enjoyed these opportunities to share her knowledge: "Working with the kids is great...once they get the initial concepts, they're eager to apply their knowledge to things that interest them, such as fishing spots and locating their favorite parks. Engaging the public in geographic concepts gives them a broader appreciation and understanding of science and policy, and the cause and effect that policy can have on our natural resources." ❆

***Kristine** helps a young geographer orient her coverage.*

Ocean Science Is Academic to Spoonbill Bowl Participants in Florida

By Lisa Robbins, Martha Loyd, and Ann Tihansky

On Saturday, February 11, a Regional National Ocean Science Bowl, known as the Roseate Spoonbill Bowl, took place in St. Petersburg, Fla. Four U.S. Geological Survey (USGS) employees from the St. Petersburg office participated in the full-day event: **Lisa Robbins**, **Jack Kindinger**, **Laura Fauver**, and **Martha Loyd**. The event was hosted by the University of South Florida (USF)'s College of Marine Science on its campus and within the nearby Fish and Wildlife Research Institute of the Florida Fish and Wildlife Conservation Commission (URL **http://research.myfwc.com/**).

The event was kicked off with a talk about fascinating research in the distant world of Antarctica by USF professor **Jose Torres**. From there, the students from 12 different high schools within west Florida participated in fast-paced rounds of *Jeopardy*-like questions concerning the ocean. **Jack Kindinger** served as a coach for Seminole High School. A team of expert judges, including **Lisa Robbins**, **Kent Fanning** (USF), **Yonggang Liu** (USF), **Pam Hallock** (USF), and **Suni Pyrtle** (USF), also helped to grade written answers. **Laura Fauver** participated as a scorekeeper, and **Martha Loyd** participated as a "runner" for Lake Brantley School to provide information back and forth to judges. Durant High School won first place and will represent Florida's west coast when they proceed to the national competition in Monterey, Calif., in May 2006. Mitchell High School's team B won second place, with Seminole High School's team A in third place and Seminole High School's team B in fourth. Lake Brantley High School won the Sportsmanship Award.

Beth Fisher, a student at USF College of Marine Science, led the organization of the event and, according to **Peggy Wise**, coach from St. Petersburg High School, **Beth** did an outstanding job: "The professionalism and organization of the NOSB were unparalled [in comparison with] any academic event I have attended. I have been telling friends and educators alike about the educational experience you afforded the students. Thank you to all who helped organize and execute this exceptional event." The USGS traditionally participates in this event and this year supplied the participating students with USGS materials and Spoonbill Bowl buttons. All the USGS participants agreed that this continues to be an inspiring event.

Durant High School Spoonbill Bowl winners show off their hard-earned trophy.

The competition required concentration and teamwork.

Spoonbill Bowl contestants intent on getting it right.

Student teams from 12 high schools in west Florida entered the academic competition. The winners gain a chance to travel to the National Ocean Science Bowl Championship in Monterey, Calif., in May 2006.

USGS Emeritus Geologist David Scholl Selected as AGU Fellow

U.S. Geological Survey (USGS) emeritus geologist **David W. Scholl** has been selected as a Fellow of the American Geophysical Union (AGU), an honor accorded to only 0.1 percent of the AGU membership each year. The selection recognizes **Dave's** 40 years as a leading contributor to our understanding of convergent plate boundaries and sediment-hosted gas hydrates.

***Dave** and granddaughter **Tess** at a celebration of **Dave's** 70th birthday. Photograph by **Florence Wong** (USGS).*

Dave Scholl is one of the most distinguished marine geologists in the USGS. At age 71 and a USGS Scientist Emeritus since 1995, **Dave** maintains a remarkable cruise and lecture schedule and continues to add to an enviable publication record: a total of 187 peer-reviewed papers, including 19 publications from the past decade. **Dave's** sustained research record includes many world-class discoveries made with his USGS colleagues. Here is a partial list:

1. **Dave** was among the first to recognize a peculiar type of seismic reflection, which he named bottom-simulating reflectors (BSRs) and which are now considered to be diagnostic expressions of the bottom of gas-hydrate intervals in marine sediment around the world. He and USGS colleagues first recognized and named the reflection anomalies called VAMPs (short for velocity amplitude) in the Bering Sea, believed to be caused by chimney-like gas columns capped by gas-hydrate deposits.
2. He pioneered the exploration of the process of oblique subduction beneath the Aleutian Island arc by forearc block rotation, including the formation of submarine rift valleys in the arc platform that govern ocean circulation between the Pacific Ocean and the Bering Sea, and the segmentation of slip in large interplate thrust earthquakes.
3. He discovered the Meiji sediment drift in the northwestern Pacific Ocean, a huge sediment body between the Aleutian Islands and the Emperor Seamount chain that lies far from potential continental sediment sources and may have implications for the reconstruction of Pacific Plate motions.
4. An early critic of the assumed fixity of the Hawaiian-Emperor hotspot, **Dave** helped lead the Ocean Drilling Program (ODP)'s Leg 197 cruise, which showed that such fixity is incompatible with paleomagnetic and radiometric age data from ODP drillcores from the Emperor Seamount chain—another discovery with implications for the reconstruction of Pacific Plate motions. This research is reported in a 2003 paper in *Science* (v. 301, no. 5636, p. 1064-1069).
5. Along with **Roland von Huene** (a USGS marine geophysicist, now retired), **Dave** pioneered research on the rates of basal subduction-erosion, a process by which material from the base of a continental plate is eroded and carried toward the mantle by the descending oceanic plate. **Dave** and his colleagues showed that many subduction zones are sites of subduction-erosion, a concept at odds with the commonly held assumption that all subduction zones are sites of accretion.

In addition to his scientific research, **Dave** has managed, shaped, and guided major national marine programs at the USGS. Today, his leadership and guidance have resulted in his appointment to the Science Planning and Policy Oversight Committee (SPPOC)—the top advisory committee for the Integrated Ocean Drilling Program (successor to ODP; see URL **http://www.iodp.org/**). Despite his high level of activity, **Dave** remains a generous mentor and teacher and an active contributor of service to both the USGS and AGU.

Dave and 44 other 2004 AGU Fellows were selected on January 14, 2006, by the AGU Fellows Committee (the full list is available on the 2006 AGU Newly Elected Fellows Web page at URL **http://www.agu.org/inside/fellows06.html**). AGU members who are selected as Fellows have attained an acknowledged eminence in a branch of the geophysical sciences. Congratulations to **Dave** on his selection to this distinguished group! ❅

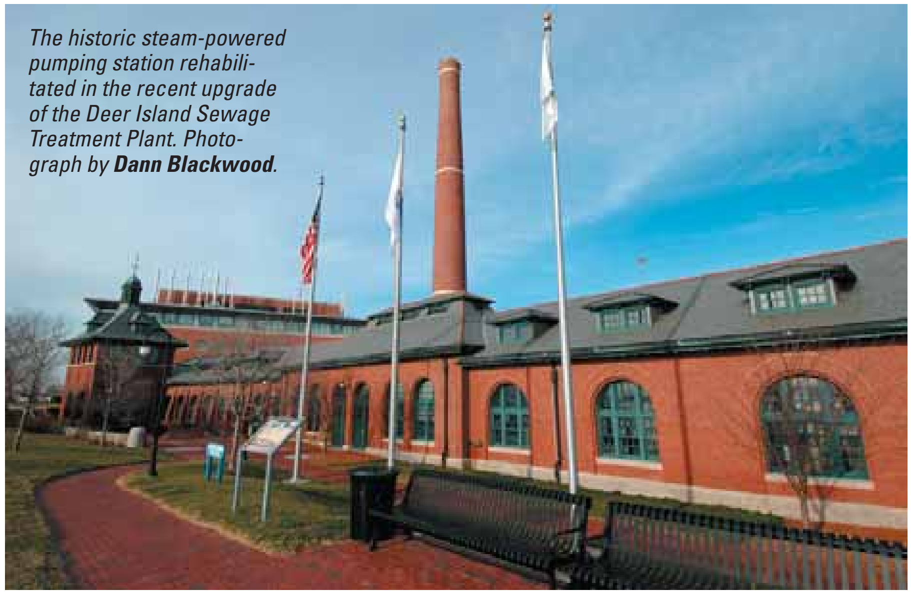
Boston Harbor Pipe Dreams Come True! USGS Visits the Deer Island Sewage Treatment Plant and a Cleaner Harbor

By Sandy Baldwin

How long after a flush does it take that water to end up in Massachusetts Bay? How clean is it once it reaches its final destination? What really happens in the "eggs" out on the island? These were some of the burning questions going through my mind as the Mass Bay Project Team from the U.S. Geological Survey (USGS)'s Woods Hole Science Center visited the Massachusetts Water Resources Authority (MWRA)'s wastewater-treatment plant on Deer Island in Boston Harbor on January 17, 2006. **Charles Tyler**, a program manager in the process operations group for MWRA on Deer Island, conducted an exceptional tour of the facility, emphasizing the processes and scientific background that make the plant a major part of an environmental success story. Multidisciplinary research by the USGS in Boston Harbor and Massachusetts Bay has helped predict and document this success.

The Deer Island Sewage Treatment Plant continues longstanding use of the island for sewage disposal. The first big, steam-powered pumping station was constructed on Deer Island in the late 1800s, and a new, more elaborate primary-treatment facility was built in the 1960s. In the 1990s, hundreds of engineers and thousands of construction workers brought into being the secondary-treatment plant that now serves greater Boston. Today's 150-acre wastewa-

(Sewage Treatment continued on page 12)



*The historic steam-powered pumping station rehabilitated in the recent upgrade of the Deer Island Sewage Treatment Plant. Photograph by **Dann Blackwood**.*

***Charles Warren Tyler**, an MWRA program manager, leads a tour of the Deer Island Sewage Treatment Plant. Photograph by **Dann Blackwood**.*

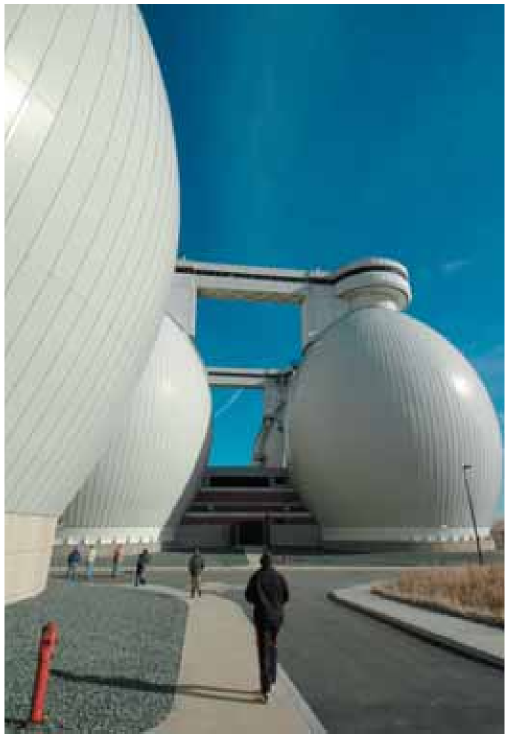
*➤**Dann Blackwood** and **Tim Milbert** peeking into a gravity thickener used to consolidate the sludge from primary treatment for later digestion in the egg-shaped digester tanks. Photograph by **Sandy Baldwin**.*

*This diffuser on display at the Deer Island Sewage Treatment Plant is like the 55 diffusers that are underwater along the last 1.5 miles of the sewage outfall tunnel, which extends 9.5 miles eastward from the treatment plant and Boston Harbor into Massachusetts Bay. Photograph by **Dann Blackwood**.*

(Sewage Treatment continued from page 11)

ter-treatment facility serves 43 communities and 2.5 million people.

The waste generated by homes, businesses, and runoff requires five main treatment steps, which together eliminate 80 to 90 percent of the contamination. To begin the process, raw sewage is pumped to various headworks in the Boston area, which remove large debris (such as logs, sticks, and rocks) and gritty material (such as sand and eggshells). From the headworks, the sewage flows to Deer Island. The next treatment step removes solids in the primary settling tanks, or clarifiers, where 50 to 60 percent of total suspended solids and as much as 50 percent of pathogens and toxic contaminants are removed. Stage three begins the secondary-treatment phase, employing microorganisms and pure oxygen to consume 80 to 90 percent of the remaining organic and toxic wastes. Much of the microbe-rich sludge that settles to the bottom is recycled back to the secondary aeration process, but some is removed and mixed with the concentrated primary sludge, then heated, consolidated, and anaerobically digested (that's what happens inside those eggs!). The resulting stabilized sludge, called "biosolids," is shipped to MWRA's pelletizing facility in Quincy, where it is further processed into fertilizer that is useful for garden-soil enhancement. In the fourth stage, the treated wastewater is chlorinated (known as disinfection), then dechlorinated to protect marine life from harmful effects of residual chlorine. Finally, the effluent begins the 9.5-mile trip 250 feet beneath the sea floor through a 24-foot-diameter tunnel to the 100-foot-deep waters of Massachusetts Bay. It takes about 12 hours for wastewater to travel from a household in Boston through the secondary treatment plant, out the tunnel, and into the bottom waters of Massachusetts Bay. The sewage effluent is rapidly diluted as it is released through 55 diffusers, evenly spaced along the last 1.5 miles of the tunnel. Extensive environmental monitoring by MWRA confirms that water quality of the bay is not compromised by the discharge. Steps to control odor are taken throughout the treatment process, leading one visitor to remark of the odor, "There isn't any" (see URL **http://www.bostonphoenix.com/boston/news_features/other_stories/multipage/documents/03301020.asp**). That's good news for the town of Winthrop, which has the plant in its backyard.



*A few of the 12 egg-shaped digesters using heat and microorganisms to break down solids and toxins from the effluent at the Deer Island Sewage Treatment Plant. Photograph by **Dann Blackwood**.*

***Sandy Baldwin** standing underneath one of the digesters, or "eggs," holding 3 million gallons of sludge. Photograph by **Dann Blackwood**.*

Since 1989, USGS oceanographers **Mike Bothner** and **Brad Butman** and their team from the USGS, the Woods Hole Oceanographic Institution, and the U.S. Coast Guard have worked with MWRA staff on monitoring and research to better understand and predict the fate of contaminants introduced to Massachusetts' coastal waters. USGS research has defined the regional framework of sediment and contaminant transport in this coastal system and has specifically helped guide management decisions concerning site selection for the present outfall and the design of a court-ordered monitoring program. While walking down the plant's miles of passageways, which have enough concrete to repave the Massachusetts Turnpike, I felt a sense of pride to be involved in the efforts to clean up Boston Harbor. The scale of the plant is overwhelming, as is the amount of effort and manpower focused on restoring the harbor to cleaner conditions.

For a synthesis of USGS research in coastal waters off Boston, please see the recently published "Processes Influencing the Transport and Fate of Contaminated Sediments in the Coastal Ocean—Boston Harbor and Massachusetts Bay" (USGS Open-File Report 2005-1250) at URL **http://pubs.usgs.gov/of/2005/1250/**. Additional information about the USGS work is posted at URL **http://woodshole.er.usgs.gov/project-pages/bostonharbor/**. To learn more about the Deer Island Sewage Treatment Plant, visit URL **http://www.mwra.state.ma.us/03sewer/html/sewditp.htm**. ❁

Coastal Geomorphologist Joins Western Coastal and Marine Geology Team

The U.S. Geological Survey (USGS)'s Western Coastal and Marine Geology (WCMG) Team recently welcomed **David Finlayson** to the USGS Pacific Science Center in Santa Cruz, Calif. **David** is a USGS Mendenhall Postdoctoral Fellow (see URL **http://geology.usgs.gov/postdoc/**) who will be working with WCMG scientists **Guy Gelfenbaum**, **Eric Grossman**, **Jessie Lacy**, and **Jon Warrick** on the Coastal Habitats in Puget Sound project.

David is a coastal geomorphologist with a specialization in large-scale surface-process analysis. He earned B.S., M.S., and Ph.D. degrees at the University of Washington (UW), working with **Ralph Haugerud** (USGS) and **Harvey Greenberg** (UW) as an undergraduate, **David Montgomery** (UW) and **Bernard Hallet** (UW) as an M.S. candidate, and **Jeff Parsons** (UW) and **Miles Logsdon** (UW) as a Ph.D. candidate. **David's** M.S. thesis focused on the bedrock erosion of Himalayan rivers, and his Ph.D. thesis focused on the dynamics of sand and gravel beaches in Puget Sound and how the morphodynamics of these beaches influence the structure of intertidal habitat. For **David's** work as a Mendenhall postdoc, he has proposed examining how the low-tide terraces of Puget Sound are formed and what impact these terraces have on the structure of eelgrass meadows growing on the terrace. He uses geographic information systems (GISes) extensively in his work to analyze and integrate data from remote imagery, high-resolution topography, and numerical models.

David Finlayson

David has relocated to Santa Cruz from Seattle, Wash., with his wife, **Leslie**, and their 2½-year old daughter, **Madrona**. If you are in Santa Cruz, come by Room C16 to welcome him to the USGS! ❅

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