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Sound Waves

Coastal Science and Research News from Across the USGS

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Fieldwork

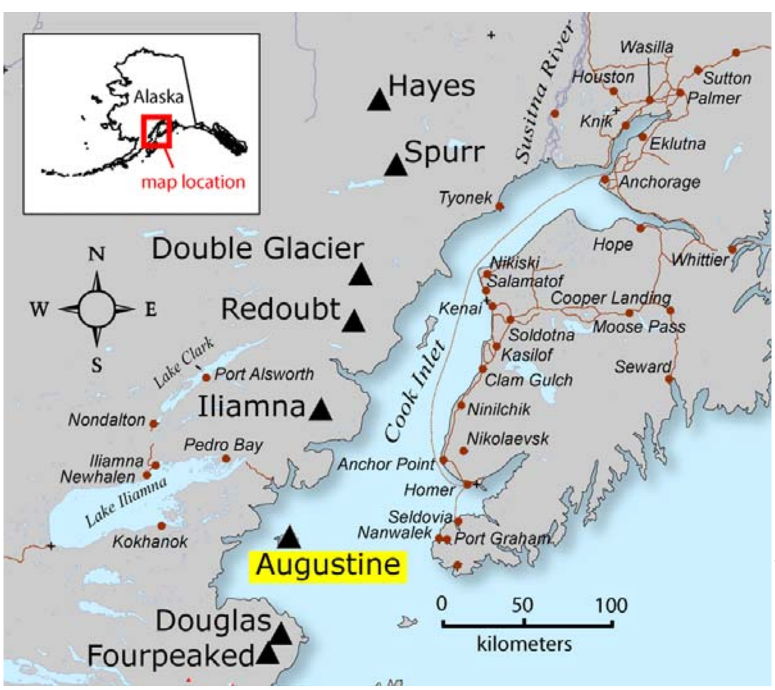
Eruption of Augustine Volcano Being Monitored by State-of-the-Art Submarine Seismometers

By Uri ten Brink

Five ocean-bottom seismometers were deployed on February 8, 2006, around Augustine Island in Cook Inlet, Alaska, to assist the Alaska Volcano Observatory (AVO) in monitoring volcanic activity on the island (see URL **http://www.avo.alaska.edu/activity/Augustine.php**). The instruments were deployed by **Uri ten Brink** of the U.S. Geological Survey (USGS)'s Woods Hole Science Center in Woods Hole, Mass.; **Victor Bender** of the Woods Hole Oceanographic Institution; **Michael West** of the Geophysical Institute, University of Alaska, Fairbanks; and **Cyrus Read**, contractor at the USGS Alaska Science Center, Anchorage. The scientists deployed the instruments from the U.S. Coast Guard cutter *Roanoke Island*, a 110-ft Island-class patrol boat out of Homer, Alaska. The cutter's crew, under

(Augustine Volcano continued on page 2)

*Augustine Volcano, viewed from the north on February 8, 2006. Photograph by **Uri ten Brink**.*



*Location of Augustine Volcano, other volcanoes, and selected communities around Cook Inlet, Alaska. Image courtesy of AVO/Alaska Division of Geological and Geophysical Surveys; created by **Janet Schaefer**. Available online at URL **http://www.avo.alaska.edu/activity/Augustine.php/**.*

*Augustine Volcano's summit enshrouded in gas, steam, and clouds on February 8, 2006. Photograph taken from a helicopter by **M.L. Coombs**; courtesy of AVO/USGS.*

Sound Waves

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Contents

Fieldwork 1
Research 7
Outreach 9
Awards 13
Staff and Center News 13
Publications 14

Submission Guidelines

Deadline: The deadline for news items and publication lists for the May issue of *Sound Waves* is Friday, April 14.
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).

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Need to find natural-science data or information? Visit the USGS Frequently Asked Questions (FAQ's) at URL **http://ask.usgs.gov/faqs.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

(Augustine Volcano continued from page 1)

the command of Lieutenant Commander **Benjamin Berg**, helped stage the operation. Assisting with logistics on land was **Scott Pegau** of the Kachemak Bay Research Reserve, Homer. The ocean-bottom seismometers will be left at the bottom of Cook Inlet for 6 weeks, during which time they will record the seismic activity that accompanies the volcanic eruptions.

The current eruption of Augustine Volcano, which forms the bulk of Augustine Island, began in early December 2005. Observers saw vigorous steaming from the volcano's summit, and residents of coastal communities 80 to 120 km (50-75 mi) away reported strong sulfurous odors. High-intensity, high-frequency seismic signals recorded December 1-17 are now interpreted as signs of forceful emissions of steam and other gases from the volcano, which is commonly obscured from view by darkness and cloudy weather. The difficulty of seeing Augustine Volcano means that monitoring with seismometers, which sense earthquakes caused by magma and other fluids moving beneath and within the volcano, is sometimes the only way to detect and record eruptive activity. In early February, we assembled in Homer to deploy ocean-bottom seismometers as supplements to AVO's seismic network on the island.

Nature makes its presence known in Alaska. On our first morning in Homer, on February 5, we were woken up by what felt like a violent explosion. At first we thought the volcano had exploded, but the cause turned out to be a magnitude 5.3 earthquake located almost directly under the town and unrelated to the current volcanic activity on Augustine.

The weather along the south coast of Alaska is stormy this time of the year and is constantly changing. The deployment was postponed until a relatively calm weather window presented itself on February 8. Visibility was unlimited when we left port at 9 a.m., and snow-covered mountains glistened in the rising sun. A following sea with waves of only a few feet made our 3-hour transit to Augustine Volcano at a speed of 26 knots quite enjoyable. Augustine was in full view, with steam rising from its peak, and flanks covered with ash and fresh pyroclastic flows.

We deployed the ocean-bottom seismometers in a counterclockwise direction, beginning in the lee of the weather. At the first site, in a channel northwest of the island, we lowered a bucket attached to an anchor to test bottom conditions. Overly soft bottom materials, such as deposits of volcanic ash, can complicate the release of the instrument from its anchor. To our relief, no sediment was recovered by the bucket.

After deploying the first instrument, we moved in a counterclockwise direction around the island to deploy the other four instruments. Each site required about 15 minutes to carry out final instrument prep, deploy the seismometer overboard, and test acoustic communication with the device. Transit times between sites ranged from 20 to 70 minutes, depending on sea conditions. Ice floes were encountered southwest of Augustine and slowed the transit, because the cutter's skin can easily be dented by ice. As the afternoon wore on, clouds began to cover the volcano above 450-m (1,500 ft) elevation, and waves built up. Freezing sea spray started accumulating on deck by the time we de-

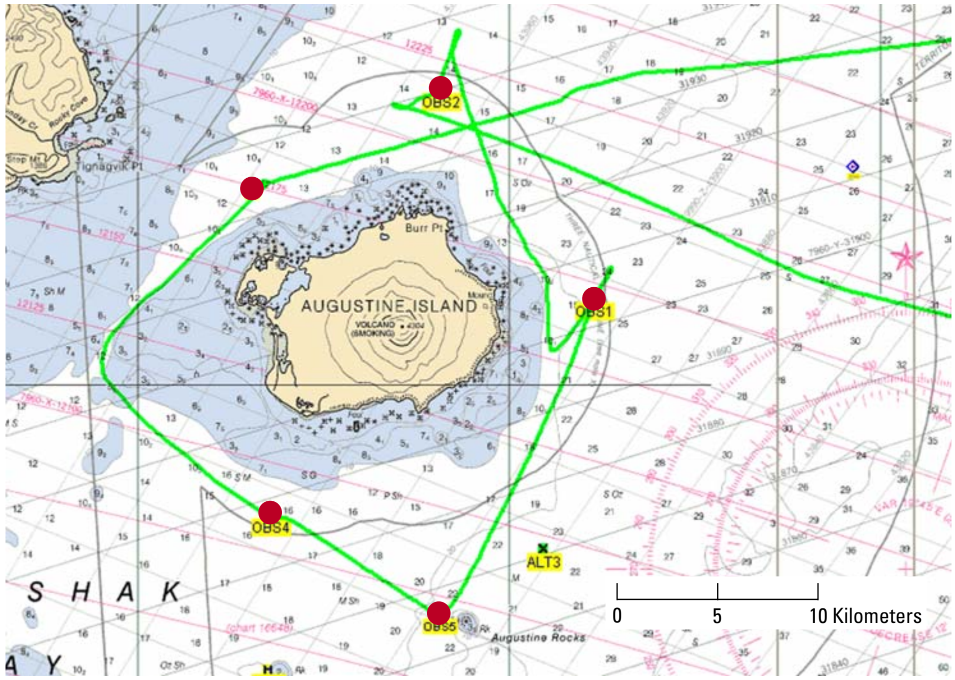
(Augustine Volcano continued on page 3)

Science-team members ***Vic Bender*** *(left foreground) and* ***Cyrus Read*** *(right foreground) prepare an ocean-bottom seismometer while U.S. Coast Guard cutter* Roanoke Island *crew members stand by to assist with deployment. Photograph by* ***Uri ten Brink****.*

(Augustine Volcano continued from page 2)

ployed the last instrument at 5 p.m. The cutter could no longer keep station long enough for us to lower a transducer to test acoustic communication with the seismometer on the bottom, and so we omitted this step for the last instrument. The trip back to Homer took 4.5 hours against rising seas. A snow blizzard started after we arrived safely in port.

Augustine Volcano is part of the Aleutian Arc, a curving line of volcanoes that extends from the Alaska Range westward to Russia's Kamchatka Peninsula. Like many Aleutian Arc volcanoes, Augustine is on a small island (approx 13 km east-west by 11 km north-south) that greatly restricts placement of AVO's onland seismometers. The constricted geometry of the onland seismic network limits the accuracy with which it can be used to locate the hypocenters, or points of origin, of volcano-induced earthquakes. Each seismometer records the time when energy from an earthquake reaches it, and the hypocenter is located through an iterative process of modeling a likely location, comparing the arrival times predicted by the model with the arrival times recorded at each station, and refining the estimated location until one is found that provides the best match between predicted and recorded arrival times. For greatest accuracy, the seismic network needs to have a much larger spread, or aperture, than the depth of the earthquake. (The aperture is the distance across the network, similar to the aperture of a telescope, which is the diameter of its lens.) The small ring of seismic stations that can be set up on Augustine Island works well for locating shallow (less than 5 km deep) earthquake hypocenters but is not accurate for deeper earthquakes, thus precluding the detection and tracking of volcano-induced seismicity in the middle to lower crust. Seismometers set up across the water from the island, on the shores of Cook Inlet, would be in a good position for locating deeper earthquake sources but too far away to sense many of the small earthquakes that accompany eruptive activity.



Approximate locations of ocean-bottom seismometers (OBSes) deployed on February 8, 2006. Red dots, OBS locations; green line, ship's path. Scale is approximate. Modified from image provided by U.S. Coast Guard cutter Roanoke Island.

The siting of seismic stations on Alaska's volcanic islands is further restricted by strong noise generated by ocean waves, which masks seismic signals. This noise is often amplified by the unconsolidated pyroclastic deposits that make up the flanks of many Aleutian arc volcanoes. Seismic stations on the volcanic islands are also vulnerable to damage by eruptive activity, such as pyroclastic flows; several of AVO's permanent seismic stations on Augustine have been knocked out by the current eruption.

An ocean-bottom seismometer being deployed. Photograph by ***Uri ten Brink****.*

Ocean-bottom seismometers help to solve these problems. Because they rest on the ocean floor, ocean-bottom seismometers are beyond the range of noise generated by ocean waves and are unlikely to be hit by material ejected from the volcano. They can be placed far enough from the volcano to allow accurate determination of deeper earthquake sources but still close enough to detect small earthquakes. The deployment of ocean-bottom seismometers around Augustine Island will improve AVO's ability to accurately determine the location of volcano-related seismicity and the nature of the volcano's internal structure. These improvements will further our understanding of the subsurface components of the magmatic system and the processes that precede and lead to eruptions.

An ocean-bottom seismometer, or OBS, is a self-contained data-acquisition system that free falls to the ocean floor and records seismic data generated by earthquakes and manmade sound sources

(Augustine Volcano continued on page 4)

(Augustine Volcano continued from page 3)

(see URL **http://woodshole.er.usgs.gov/operations/obs/**). The OBS is designed to be naturally buoyant and is held at the bottom by a small weight. It can be placed on an ocean floor as deep as 6,000 m (18,000 ft). When the time comes to recover the OBS, an acoustic signal is sent from the surface ship to the OBS to release its weight. The OBS then rises to the surface and is picked up by the ship, and the data are downloaded onto a computer. At a weight of about 100 lb each, OBSes are easy to ship and can be deployed and retrieved from a wide range of vessels. The USGS has an agreement with the national OBS facility at the Woods Hole Oceanographic Institution (see URL **http://obslab.whoi.edu/**) to build and maintain 16 OBSes within the facility. Five of these OBSes and modest amounts of funding are available for both USGS and non-USGS investigators to conduct rapid deployment in response to an earthquake or volcanic eruption in the coastal ocean and its vicinity (see URL **http://woodshole.er.usgs.gov/operations/obs/rmobs_pub/**). The recent operation off Augustine Island was the first OBS rapid response to a potential natural disaster in U.S. waters.

The Alaska Volcano Observatory—a joint program of the USGS; the Geophysical Institute of the University of Alaska, Fairbanks; and the State of Alaska Division of Geological and Geophysical Surveys—monitors Aleutian Arc volcanoes and provides warnings to local communities and affected industries (see URL **http://www.avo.alaska.edu/**).

USGS and Florida State University Scientists Collaborate on Submarine-Ground-Water-Discharge Study in the Northern Gulf of Mexico

By Peter Swarzenski

During the week of January 30, 2006, scientists from the U.S. Geological Survey (USGS) joined scientists from Florida State University (FSU) to begin an investigation of the links between submarine ground-water discharge and climatic (seasonal) change. Submarine ground-water discharge—the flow of ground water directly into seawater—can strongly influence coastal ecosystems, with the potential for harmful effects if the ground water contains high levels of contaminants or excess nutrients.

For the recent study, part of a multiyear project funded by the National Science Foundation, USGS scientist **Peter Swarzenski** and his SGD team members **Chris Reich** (USGS) and **Jason Greenwood** (ETI Professionals, Inc.) traveled from their office in St. Petersburg, Fla., to the FSU Marine Laboratory at Turkey Bayou on Florida's northwest coast (south of Tallahassee; see URL **http://www.marinelab.fsu.edu/**). There they worked with FSU professor of oceanography **Bill Burnett** and his team of students (**Natasha Dimova**, **Benjamin Mwashote**, **Rick Peterson**, and **Isaac Santos**) at a study site near the lab. USGS participation in the study was twofold:

Submarine-ground-water-discharge site at FSU Marine Lab; the small boat was used as a platform for thermal-seepage-meter dataloggers, as well as for an instrument making time-series measurements of ^{222}Rn. Also visible are well casings from a series of shallow wells that extend offshore along a shore-perpendicular transect.

1. To conduct a series of intercalibration experiments using two new types of autonomous seepage meters—devices that can measure direct ground-water discharge at a particular point. The USGS seepage meters are equipped with electromagnetic flow meters (for more information on these seepage meters, see URL **http://coastal.er.usgs.gov/sgd/publications/seepagemeterpdf.html**), whereas the FSU seepage meters use thermal flow meters. Intercalibrating the two types of instruments will allow us to compare high-resolution data collected with each type of meter.
2. To study the subtle response of the freshwater/saltwater interface to water-level changes over several tidal cycles, using a new, high-resolution (56 electrodes with 2-m spac-

(Submarine Ground Water continued on page 5)

(Submarine Ground Water continued from page 4)

ing) resistivity array that collects data at regular intervals (time-series data). Such an approach can produce very high resolution snapshots of the dynamic mixing processes that occur within the freshwater/saltwater interface.

On February 2, **Peter Swarzenski** was invited to present the recent results of submarine-ground-water-discharge studies at a seminar hosted by the FSU Department of Oceanography (see URL **http://www.ocean.fsu.edu/**).

Preliminary results suggest that during this dry-season, 5-day experiment, fluctuations in the submarine-ground-water-discharge rate as measured by one electromagnetic seepage meter appeared to respond almost predictably to water-level changes, with discharge increasing during times of low water levels (low tides).

In the coming months, additional analyses, including time-series measurements of ^{222}Rn, ^{223}Ra, ^{224}Ra, ^{226}Ra, ^{228}Ra, and possibly thoron (a radioactive isotope of radon, ^{220}Rn, with a half-life of just 55 seconds!), will complement the resistivity and seepage-meter work. These isotopes are much more abundant in ground water than in surface water and therefore serve as effective tracers of ground-water discharge. An advantage of geochemical tracers over seepage meters is that they provide a regional-scale estimate of submarine ground-water discharge, rather than the extremely local coverage provided by seepage meters.

The scientists plan to deploy instruments at the site again during the wet season (July-September) to gather data for comparison with those they collected during the recent dry-season experiment.

For more information about submarine ground-water discharge, see "Submarine Ground-Water Discharge and Its Influence on Coastal Processes and Ecosystems," in *Sound Waves*, June 2004, at URL **http://soundwaves.usgs.gov/2004/06/research4.html**; "Submarine Groundwater Discharge: An Unseen Yet Potentially Important Coastal Phenomenon" at URL **http://edis.ifas.ufl.edu/SG060**; and "Submarine Ground-Water Discharge" at URL **http://coastal.er.usgs.gov/sgd/**.

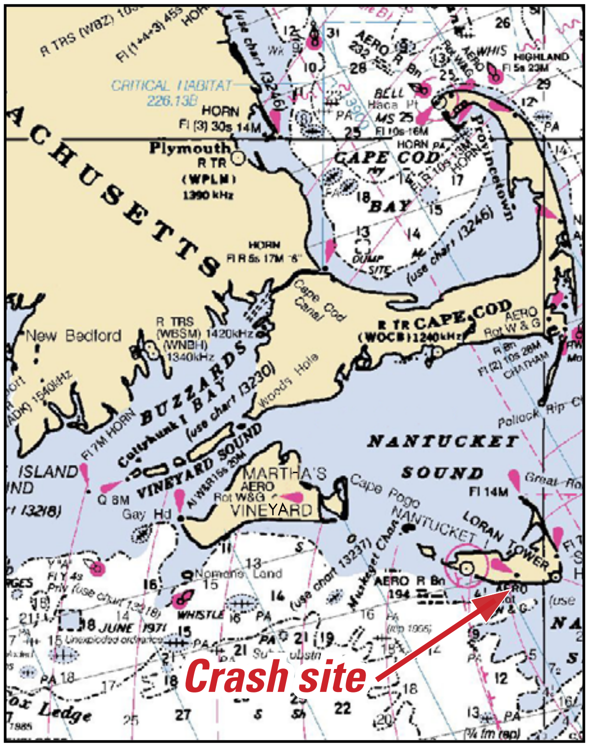
Time-series resistivity cable, showing electrode spacing (one sand bag per electrode) across the freshwater/saltwater interface.

Two electromagnetic-seepage-meter control panels on the beach close to the FSU Marine Lab.

USGS Sea-Floor Mapping Group Assists Woods Hole Oceanographic Institution in Searching for Airplane Wreckage

By Bill Danforth and Ann Tihansky

George F. Baker III, a philanthropist and important supporter of the Woods Hole Oceanographic Institution (WHOI), disappeared while attempting to land his twin-engine Beechcraft Baron BE55 airplane at the Nantucket, Mass., airstrip under a cloudy drizzle on December 1, 2005. He was 66 years old and an experienced pilot who had been flying since he was 18. Weather conditions are believed to have contributed to the crash. The cloud deck was very low, 300 ft or so; it may be that **Baker** dipped below this to gain visibility of the airstrip and became disoriented. Although the roof of his plane was recovered on the beach and U.S. Coast Guard divers recovered a first-aid kit and a tube of aviation grease, search efforts were called off before the plane and **Baker's** body could be found. On December 5, personnel from WHOI made a second attempt to find the wreckage using *REMUS* (Remote Environmental Monitoring UnitS), an autonomous underwater vehicle. *REMUS* supports various instruments: sidescan sonars (600 and 900 kHz), acoustic Doppler current profilers (ADCPs), and a conductivity-temperature-depth sensor (CTD), to name a few. The *REMUS* team was unable to locate the wreckage at the site offshore where the plane was believed to have entered the water, indicating that it might be elsewhere to the north or west. After the *REMUS* search, **Dick Pittenger**, WHOI Vice President for Marine Operations (Ret.), contacted the U.S. Geological Survey (USGS) and asked the Woods Hole Science Center's Sea-Floor Mapping Group to survey a larger area, using sidescan sonar to locate the wreckage so that it could be recovered.



Crash-site location.

***Bill Danforth, Chuck Worley**, and **Emile Bergeron** prepare to deploy the sidescan sonar off the stern of WHOI's research vessel* Tioga*. Photograph by **Ann Tihansky**.*

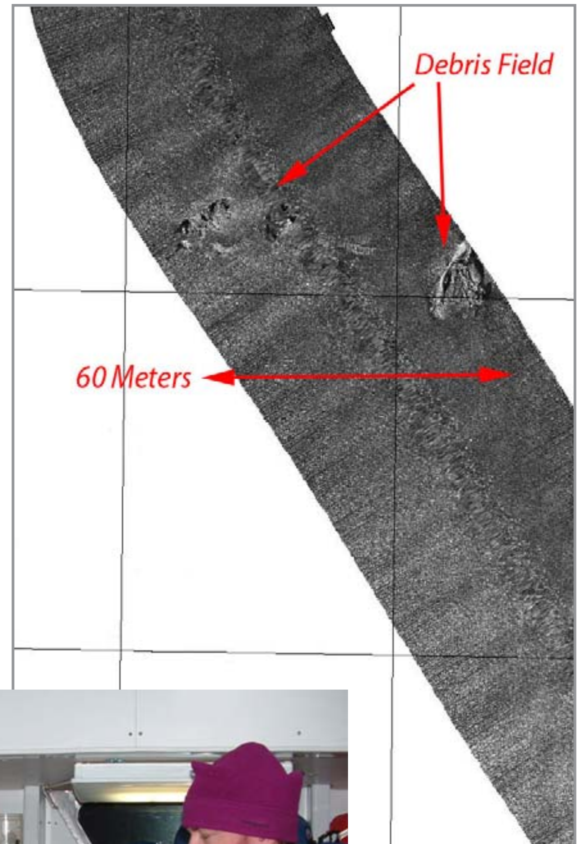
When the weather permitted, on a cold and clear December 8, 2005, USGS personnel **Bill Danforth**, **Chuck Worley**, **Emile Bergeron**, **Wayne Baldwin**, and **Ann Tihansky** set out to conduct a broad sidescan-sonar survey of the area where the plane was believed to have crashed, offshore of the Nantucket Island airfield. The equipment, a Klein 3000 dual-frequency (100 and 500 kHz) sidescan sonar, was deployed from WHOI's new 60-ft coastal research vessel *Tioga*, crewed by Captain **Ken Houtler** and mate **Ian Hurley**. Together, **Bill Danforth** and **Ken Houtler** used the known locations of existing wreckage, previously searched areas, and their familiarity with the dominant winds and water currents to predict where the wreckage would most likely be resting. They began with a large search pattern, running parallel to shore both east and west of the Nantucket airstrip, with the sidescan sonar set to insonify a 200-m swath. Two large items were identified in the 500-kHz sonar images of the sea floor in approximately 30-ft water depth at the eastern end of the designated search area. One piece was approximately 30 ft long and the other approximately 24 ft long. The images and positions were provided as an ArcView project with supporting text and graphics to **Dick Pittenger** of WHOI, who shared them with the Massachusetts State Police. Police divers investigated the debris, but the identified targets did not contain evidence of a plane crash. The sidescan-sonar imagery revealed no other debris in the area large enough to warrant investiga-

(Airplane Search continued on page 7)

(Airplane Search continued from page 6)

tion by the divers. A much larger search would have to be conducted to try to locate and recover the airplane wreckage.

WHOI and the **Baker** family were grateful for the assistance provided by the USGS. **Robert B. Gagosian**, president and director of WHOI, wrote in a letter to **William Schwab**, team chief scientist at the USGS Woods Hole Science Center, "I can assure you that the **Baker** family deeply appreciated these efforts and was reassured that everything possible was being done to find **George's** plane." He also commended USGS staff efforts: "Although the recovery is not yet complete, the professionalism and compassion which the staff of the USGS Woods Hole Science Center demonstrated during this operation reflects well on both them and the USGS."



Sidescan-sonar image showing debris fields. These turned out not to contain the airplane wreckage.

***Emile Bergeron** prepares the sidescan sonar for the trip out to Nantucket. Photograph by **Ann Tihansky**.*

***Chuck Worley** points out the locations of possible targets identified in sidescan-sonar images. Photograph by **Ann Tihansky**.*

Research

USGS Report of Methane Hydrate Off Southern California Sparks Media Interest

By Jim Hein, Bill Normark, and Helen Gibbons

A U.S. Geological Survey (USGS) cruise conducted off southern California in July 2003 unexpectedly recovered methane hydrate from the summit of a mud volcano, in a piston core taken at 800-m water depth (see "USGS Scientists Discover Gas Hydrate in Southern California During Cruise to Study Offshore Landslides, Earthquake Hazards, and Pollution" in *Sound Waves*, November 2003, at URL **http://soundwaves.usgs.gov/2003/11/**). USGS researchers studying that core, and other samples collected during the cruise, recently published their findings in the February 2006 issue of *Geology* (v. 34, no. 2, p. 109-112). The publication set off a flurry of media coverage, mostly focused on the discovery of the methane hydrate, an icelike crystalline solid in which methane gas molecules are trapped. Methane hydrate, which occurs in the pores of permafrost and sub-seafloor sediment in many places around the globe, is of interest as

- a potential energy source (various nations are trying to determine how to mine it economically),
- a possible trigger of undersea landsliding (methane gas released during dissociation of the hydrate, caused by changes in the temperature or pressure conditions that allow it to

(Methane Hydrate continued on page 8)

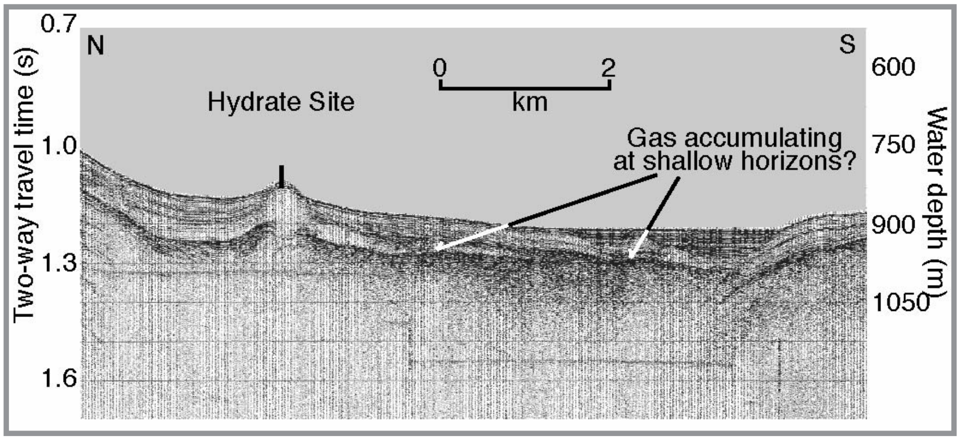
(Methane Hydrate continued from page 7)

form, has the potential to destabilize surrounding sediment),

- a possible contributor to abrupt global climate change (widespread dissociation of methane hydrate—triggered, for example, by rising sea level and consequent changes in sub-sea-floor pressure—could release large amounts of methane gas, a key contributor to the atmospheric warming known as the greenhouse effect), and
- an unknown variable in the global carbon mass balance (we do not know how much carbon is stored in methane hydrate worldwide, nor how much carbon is trapped in pockets of gas beneath impermeable methane hydrate "caps").

(Visit URL **http://woodshole.er.usgs.gov/project-pages/hydrates/** for additional information about methane hydrate and URL **http://walrus.wr.usgs.gov/cabrillo/tierra/methane_hydrate.html** for additional information about the 2003 discovery off southern California.)

The mud volcano where the methane hydrate was discovered is in the Santa Monica Basin, just 24 km (15 mi) offshore from Los Angeles, the second largest urban region in the United States. Approximately 300 m in diameter at its base and 30 m high, the feature is formed by mud, gas, and fluids moving upward from the sediment fill and perhaps from deeper sources as well, probably along fault ruptures. Other mud volcanoes in the region may likewise host methane hydrates. The proximity of the recently discovered methane hydrate to shipping lanes from Los Angeles and Long Beach would make this deposit particularly difficult to mine.



Seismic-reflection profile collected by the Geological Survey of Canada in 1992. The mud volcano from which methane hydrate was recovered in 2003 is labeled "Hydrate Site." Note that internal reflectors are not visible in or below the mud volcano; they are obscured by gas contained in the sediment and by deformation of the sediment as it was squeezed up to form the mud volcano. South of the mud volcano are additional areas where deeper reflections are not visible, probably because of gas accumulating along horizons as shallow as 60 m below the sea floor. The width of the black line above the mud volcano represents the 30-m-diameter circle within which core samples were collected in 2003.

The mud volcano was discovered in 1992 by USGS scientist **Bill Normark** and his colleague from the Geological Survey of Canada (GSC), **David J.W. Piper**, who spotted it in seismic-reflection data collected during a cruise aboard the GSC research vessel *Parizeau* to study turbidite sedimentation in the Santa Monica Basin. The mud volcano also appears on the seaward edge of multibeam-sonar data collected by USGS scientists **Jim Gardner** and **Peter Dartnell** in 1998. When **Normark** and USGS scientist **Jim Hein** conferred to pick sampling sites for the 2003 cruise, the mud volcano was an obvious choice for collecting samples that **Hein** planned to analyze for chemical evidence of fluids and trace metals moving up to the sea floor along faults.

This discovery core shows white methane hydrate mixed with dark mud. The core penetrated and recovered a sample of the upper 2.1 m (5 ft) of a mud volcano 24 km (15 mi) off the southern California coast in the Santa Monica Basin; for details, see the February 2006 issue of Geology *(v. 34, no. 2, p. 109-112). Photograph by **James Conrad**, USGS.*

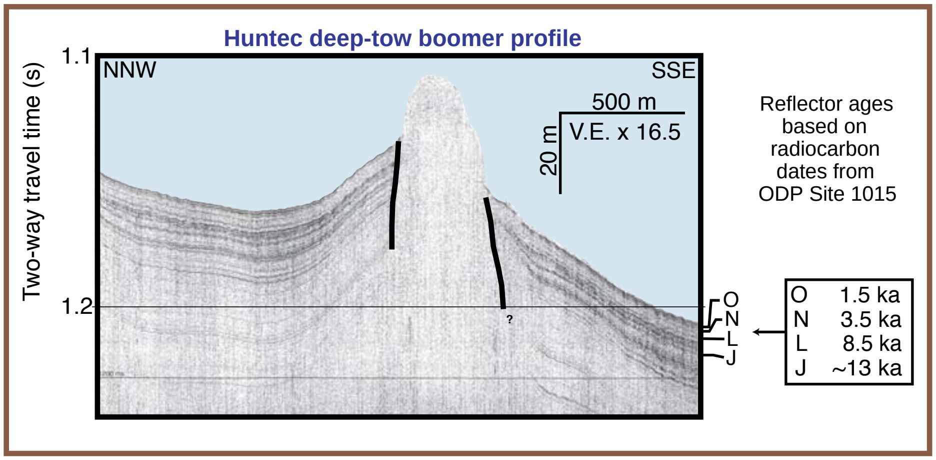
The gas and associated fluids venting through the sea floor at the mud volcano site are at approximately the same temperature as the surrounding seawater (approx 5°C) and so are termed a "cold seep." Like other cold seeps, the Santa Monica Basin site supports dense populations of bivalves. The site is unique, however, in that the composition of the bivalve shells indicates an unusually large amount of methane gas moving upward through the sediment. The shells are severely depleted in the carbon isotope ^{13}C—in fact, they are the most ^{13}C depleted shells of marine macrofauna yet reported. The scientists interpret this extreme ^{13}C depletion as evidence for the extreme flux of methane. Methane sources include breakdown of organic matter in the basin sediment and possible contributions from older hydrocarbon source rocks. Abundant heavy metals (such as mercury, cadmium, thallium, and silver) indicate leaching of basement rocks by fluid circulating along an underlying fault, which also allows for a high flux of fossil methane.

The paper reporting these findings, entitled "Methanogenic calcite, ^{13}C-depleted bivalve shells, and gas hydrate from a mud volcano offshore southern California," was authored by five USGS scientists—**Jim Hein**, **Bill Normark**,

(Methane Hydrate continued on page 9)

(Methane Hydrate continued from page 8)

Brandie McIntyre, **Tom Lorenson**, and **Chuck Powell**—and published by the Geological Society of America (GSA) in its journal *Geology*. GSA routinely asks authors to write a short paragraph about their paper, which is then incorporated into a press release sent to more than 300 science writers worldwide. The paragraph written by first author **Hein** caught the attention of **Alicia Chang** of the Associated Press (AP), who called **Hein** for an interview and then wrote an article based on the interview, the press release, and the *Geology* paper. **Chang's** article was picked up by hundreds of newspapers worldwide, including newspapers from every State in the United States, both major and local. The story appeared on many news Web sites (for example, see URL **http://abcnews.go.com/Technology/wireStory?id=1552545**) and aired on CBS affiliate radio stations around the country after CBS News, N.Y., conducted a phone interview with **Hein**. Importantly, the USGS' Web site (**http://www.usgs.gov/**) was cited in most of the stories. **Ann Cairns** (GSA media relations) said that the media response to this paper was among the largest they have seen for papers published by GSA.



Closeup of the mud volcano in a high-resolution seismic-reflection profile created from Huntec deep-tow boomer data collected by the Geological Survey of Canada in 1992. The boomer source and receiver were towed about 200 m below the sea surface; resolution is about 40 cm. V.E., vertical exaggeration.

Outreach

Fourth-Graders Explore the USGS Center in St. Petersburg, Florida

By Ann B. Tihansky

On November 30 and December 1, 2005, more than 800 fourth-grade students explored the U.S. Geological Survey (USGS) Center for Coastal and Watershed Studies in St. Petersburg, Fla. The carefully choreographed event, which was the 7th annual USGS Open House hosted at the St. Petersburg center, led groups of 10 students and their teachers through 25 exhibits focused on the theme "Geoscientists Explore Our Earth." This was the theme selected for Earth Science Week, an annual event sponsored by the American Geological Institute (see URL **http://www.earthsciweek.org/**).

In keeping with the USGS' mission, the Open House highlighted the science behind understanding hazards, such as hurricanes, earthquakes, volcanoes, and floods; assessing the quantity and quality of our water supplies; and using multidisciplinary methods to understand complex natural-science phenomena. During their visit, the students learned about many ways USGS geoscientists explore our Earth.

***Tracy Enright** leads a group through the USGS SOFIA (South Florida Information Access) online resources at URL **http://sofia.usgs.gov/**. This Web site has pages designed specifically for kids (see URL **http://sofia.usgs.gov/virtual_tour/kids/**).*

The issues of scale and how time and distance affect observations were demonstrated by displays about how scientists look at the world from both far away and closeup. Mapping large areas by plane was highlighted in the exhibit "Bird's Eye View: Using Laser Lidar to Map Coral Reefs," while microscopic inspection was the hands-on activity at the exhibits "Sands of the World" and "Microfossils and Ocean Temperatures." Mapping and remote-sensing technologies were highlighted in several exhibits, including "GIS—What in the World?," "3-D Visualization: GEOWALL," and "Deep Dive Exploration: Pulley Ridge—the Deep Reef."

The exhibit "Tsunami—Making Waves" made a big splash with students.

(St. Pete Open House continued on page 10)

(St. Pete Open House continued from page 9)

A specially designed wave tank created a scale model of a tsunami coming ashore along a typical coastline on the Pacific Ocean. This model demonstrated the powerful effect these waves can have and how scientists can learn from these events. "Watching Hurricanes" and "Volcanoes—Mount St. Helens" were other hazard exhibits that highlighted the strength of Earth processes and how scientists measure and learn from them.

Measuring both the quantity and quality of water resources was clearly illustrated with several hands-on demonstrations. "Where Does Your Water Come From and What Kind of Water Is It?" gave students an opportunity to measure the properties of several water samples that appeared to be the same. Through their examinations, the students found out that how water looks doesn't tell you all you need to know about what's in it. "Water Under Our Feet, Florida's Ground Water" used a visual ground-water display model to simulate ground-water movement and contamination. Students learned how ground water can be affected by land-surface activities. Another visually interactive display, "USGS Water Data: Real-Time, On-Line," gave students a chance to practice using the USGS National Water Information System. Access to online data gave them the tools to keep track of water resources in locations of personal interest.

The living resources that interact with the nonliving world were highlighted both on an individual scale and within the context of larger ecosystems. Representative fish populations associated with mangrove communities were living examples in the "In-Seine Fish" exhibit. "Turtle Mysteries" unraveled some myths about the elusive diamondback terrapin, while "The Difference Between Alligators and Crocodiles" showcased a live specimen of each reptile so that students could see firsthand how to tell them apart. How scientists study living resources was a hands-on activity entitled "Measuring Muddy Mangroves," in which students readily learned how measurements are made and incorporated into scientific investigations.

As students explored the USGS office, they learned how USGS geoscientists explore the world all around us. They learned that scientists are beginning to integrate all kinds of information to develop a better understanding of how large ecosystems (such as the Everglades) function. With a better understanding of these large Earth systems, humans can implement ways to restore damaged areas, conquer invasions of unwanted and threatening species, unravel the implications of climate change, and assess the vulnerability of large metropolitan areas to natural hazards. Most importantly, students learned that gaining a better understanding of the Earth not only takes scientific expertise but can be interesting and fun too. ❁

Students get a new perspective on microfossils.

***John Wiebe** shows visitors the differences between alligators and crocodiles. He's holding an American alligator (*Alligator mississippiensis*).*

***Mike Holmes** shows students how real-time data are easily accessed on the USGS Web page.*

***Chris Reich** shares his knowledge and lots of samples with students as they learn more about coral reefs.*

***Greg Ward** demonstrates one of many field-measurement methods.*

Buses full of fourth-graders line up outside the USGS Center for Coastal and Watershed Studies.

Inservice Day for Falmouth Science Teachers at USGS in Woods Hole

By Christopher Polloni (USGS), Christine Brothers (Falmouth High School), and Thomas Stone (WHRC)

A collaboration between the U.S. Geological Survey (USGS)'s Woods Hole Science Center in Woods Hole, Mass.; the Woods Hole Research Center (WHRC); and teacher **Chris Brothers** produced an inservice activity for science-department faculty from Falmouth High School and Lawrence Middle School, two public schools in Falmouth, Mass. The program featured speakers discussing geographic information systems (GIS), global positioning systems (GPS), and remote sensing. During a morning session at WHRC and an afternoon session at the USGS, the teachers received an overview of how these technologies work and how scientists are currently using them in research.

*Falmouth High School Earth-science teacher **Claudio Palhais** finds a geocache with his GPS unit. Photograph by **Chris Brothers**, Falmouth High School.*

The morning activities began with two overview talks by WHRC geographer **Greg Fiske,** on GIS, and WHRC environmental geologist **Tom Stone,** on remote sensing. **Greg** began with GIS definitions and fundamentals and gave an overview of a typical GIS methodology; then he described what goes into a GIS and what results or products might come from the research. **Tom Stone** gave a broad overview of remote sensing, describing the different types of satellites and their orbital paths. He then went into the fundamentals of remote sensing, with discussions of the electromagnetic spectrum, black-body radiation, passive versus active (for example, radar) satellite systems, and plant and soil spectral-reflectivity curves. An explanation of the tradeoffs between different temporal, spatial, and spectral resolutions was followed by examples of imagery and classification techniques. Finally, **Tom** described the links between GIS and remote sensing and told attendees where they could get free remote-sensing software.

The overview talks were followed by specific research examples presented by WHRC scientists **Paul Lefebvre**, who described his work in Brazilian Amazonia, and **Dan Steinberg**, who described his work in a forested part of Maryland. **Paul's** work in Mato Grosso, Brazil, is at an enormous soybean farm on once-forested land that was cleared by fire. About the size of the State of Rhode Island, the farm can easily be seen from space. As part of a large, multi-institutional team, **Paul** is (1) managing spatial aspects of data collection for a study of fire behavior and its cumulative impacts on forests; (2) plotting GPS coordinates of locations where riparian-zone restoration is underway; and (3) creating a huge GIS that will integrate topography, vegetative cover, land-use practices, property boundaries, and other characteristics of the headwaters area of the Xingu River, a tributary of the Amazon. One aim of this third project is to help landowners adopt best practices for protecting riparian zones and water quality in the Xingu River, upon which many indigenous people rely. The later talk by **Dan Steinberg** described his use of lidar (light detection and ranging) data to examine relationships between forest structure and bird-species diversity in Patuxent Research Refuge, Md. Lidar data collected in 2003 by the National Aeronautics and Space Administration (NASA)'s Laser Vegetation Imaging Sensor (LVIS) (see URL **https://lvis.gsfc.nasa.gov/**) was used to quantify habitat structure; these measurements of habitat structure and heterogeneity were subsequently compared with data on bird-species abundance and richness collected by collaborators in the same area in 1997. **Dan's** project seeks to determine how well models of forest structure derived from remote sensing can be used to predict how many and what species of birds are living in the forest.

The afternoon session at the USGS began with a presentation by USGS research geologist **John Bratton** on the use of GPS and GIS in studies of ground-water discharge into Cape Cod estuaries. **Bratton** showed maps of measurements of radon, a natural tracer of ground-water discharge, in two Falmouth estuaries. The data were collected from a small research vessel and a Sunfish (small sailboat) towed by a kayak and equipped with a GPS navigation system. Results, which could be plotted immediately after returning to shore, showed areas of the estuaries that were receiving more ground-water discharge and probably more nutrient inputs, which can cause environmental decline.

The teachers had a particular interest in learning more about GPS systems because the high school had acquired four handheld Garmin units. USGS scientist **VeeAnn Cross** gave a brief overview of GPS technology, focusing on accuracy and resolution issues that the teachers might face. Unseasonably warm temperatures

(Inservice Day continued on page 12)

(Inservice Day continued from page 11)

in Woods Hole enabled **VeeAnn** to keep the lecture short, put the GPS units in the hands of the teachers, and send them outside for some practical experience.

The participants were divided into two groups. One group took part in a mini-geocache GPS course that **VeeAnn** had set up. (Geocaching is a treasure-hunting game in which participants use GPS units to search for containers hidden by other participants; for more information, see URL **http://www.geocaching.com/**.) This activity gave the teachers some hands-on practice on using their GPS units, with assistance from **Dave Foster**, **Brian Andrews**, and **Dirk Koopmans** (all from the USGS Woods Hole Science Center). What the teachers learned during this exercise was the most immediately transferable to their classrooms.

The second group visited the Geowall display, where the teachers were given a virtual tour of Waquoit Bay estuary, using GIS software, and a flight over Falmouth High School, using the application Google Earth (URL **http://earth.google.com/**). Waquoit Bay was one of the estuaries that **John Bratton** had described earlier in the day; the Geowall tour provided a three-dimensional visualization of the estuary and showed sampling sites where **Bratton** had collected data to identify areas of groundwater discharge. The imagery included remotely sensed color orthophotos that had been rectified by Massachusetts GIS (MassGIS, the state's Office of Geographic and Environmental Information; see URL **http://www.mass.gov/mgis/**) and draped over an elevation model of Cape Cod.

Evaluations submitted by teachers after the event showed that none of the 22 teachers who attended had previous experience with GIS or remote sensing, although a few had used a GPS unit. In addition, virtually every teacher expressed an interest in learning more about these technologies, especially lessons that they could share with students in the classroom.

Teachers felt that the pace of the day was good and that there was good coordination of the presentations by WHRC and the USGS. **Tom Stone** and **Chris Polloni** had coordinated the activities, with suggestions from **Chris Brothers**. WHRC participants included **Greg Fiske**, **Tom Stone**, **Paul Lefebvre**, **Dan Steinberg**, and **Kathleen Savage**; USGS participants included **John Bratton**, **VeeAnn Cross**, **Dave Foster**, **Brian Andrews**, **Dirk Koopmans**, **Nancy Soderberg**, and **Chris Polloni**.

Chris Brothers stated that "the in-service days when we visit scientists in Woods Hole are always among teachers' favorites because they really enjoy interacting with the scientists and learning about recent developments in science. We are indeed fortunate to have organizations like the U.S. Geological Survey and the Woods Hole Research Center in our district and to have such opportunities available to our teachers."

Western Coastal and Marine Geology Team's Sea-Floor-Mapping Systems Described on New Web Pages

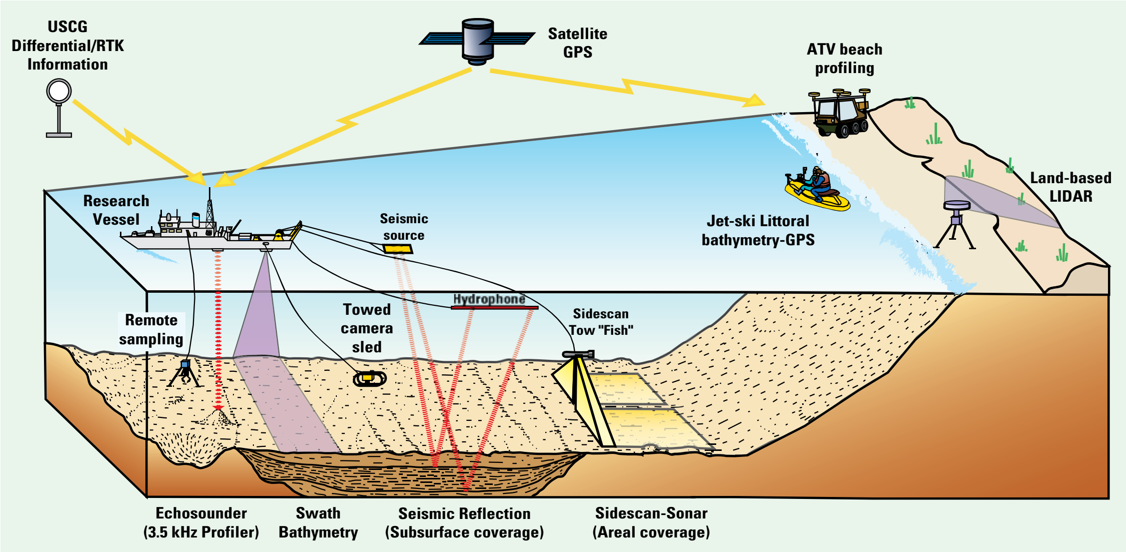
By Laura Zink Torresan

The U.S. Geological Survey (USGS)'s Western Coastal and Marine Geology (WCMG) team has posted a set of Web pages that describe the coastal- and sea-floor-mapping systems used by the team. These Web pages were created by WCMG Webmistress **Laura Zink Torresan**, from a PowerPoint presentation designed and created by WCMG scientist **Peter Dartnell**.

The new Web pages provide a quick overview about how we map the deep ocean floor, coastal areas, and beaches and how we combine this information with video footage, photographs, and sediment-sample data to make interpretations and create databases that many scientists can use.

We invite you to visit these pages at URL **http://walrus.wr.usgs.gov/mapping/**.

Schematic diagram showing the various types of sea-floor-mapping systems used by the Western Coastal and Marine Geology team. Drawing by ***Bruce Rogers****, modified from image on a Web page posted by the USGS Woods Hole Sea-Floor Mapping Group (URL* ***http://woodshole.er.usgs.gov/operations/sfmapping/dataacq.htm****).*



Awards

USGS Wetland Ecologist Named Fulbright Senior Specialist

By Susan Horton

U.S. Geological Survey (USGS) scientist **Beth Middleton** was recently named a Fulbright Senior Specialist, part of the Fulbright Scholar Program administered by the Council for International Exchange of Scholars (see URL **http://www.cies.org/**). **Middleton**, a specialist in wetland ecology at the USGS National Wetlands Research Center in Lafayette, La., was a Fulbright Scholar in the 1990s. As a Fulbright Senior Specialist, she will be available to serve (for the next 5 years) as an advisor on wetland ecology to the international academic community. Fulbright Senior Specialist projects are designed to provide U.S. faculty and professionals with opportunities to collaborate with professional counterparts at non-U.S. postsecondary academic institutions on curriculum and faculty development, institutional planning, and other research activities. ☸

*Recently named Fulbright Senior Specialist **Beth Middleton** measures tree-canopy cover in Cat Island National Wildlife Refuge , La., as part of her study of the impacts of the 2005 hurricane season on forested wetlands.*

Multiple Award Winner in USGS Photography Contest

By Susan Horton

Ann Gaygan, IAP World Services contractor at the U.S. Geological Survey (USGS)'s Publishing Service Center 9, uses her photographic talents to capture USGS staff at work. **Gaygan** recently won four awards in the 2005 "USGS Employees at Work" photography contest. **Gaygan** received a first place in the Biology category, both a second place and an honorable mention in the Science Support category, and a third place in the Geography category (see the winning photographs at URL **http://www.usgs.gov/artshow/photo_contest/2005_winners.html**). **Greg Smith**, director of the USGS National Wetlands Research Center in Lafayette, La., where Publishing Service Center 9 is housed, presented **Gaygan** with her award certificates at a centerwide meeting on January 23, 2006. **Gaygan** is a graduate of the School of Visual Arts in New York. ☸

***Ann Gaygan** (left) receives award certificates for her winning photographs from **Greg Smith**, director of the USGS National Wetlands Research Center.*

Staff and Center News

USGS Scientist on Nanjing University's Advisory Committee

U.S. Geological Survey (USGS) oceanographer **Jingping Xu** was recently selected as a 2005-09 member of the Academic Committee of the Ministry of Education's Key Laboratory for Coast and Island Development, Nanjing University, China. Committee members provide advice for the future development of the laboratory and associated research priorities. **Jingping** has also been appointed as a joint supervisor in the laboratory's graduate program.

Jingping's professional interests include sediment transport, boundary-layer dynamics, and submarine-canyon processes. He is currently involved in studies of sediment transport on the Palos Verdes shelf, turbidity currents in Monterey Canyon, and circulation in the San Gabriel River estuary (all on the California coast). ☸

***Jingping Xu** deploys moored current profilers from the stern of National Oceanic and Atmospheric Administration (NOAA) ship* MacArthur II*, for a study of turbidity currents in the Monterey and Soquel submarine canyons off central California.*

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