USGS

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Fieldwork

Measuring Hurricane Impacts— USGS Coastal Hazards Team Is Up to the Challenge

By Ann B. Tihansky and Laura Fauver

The hurricane seasons of 2004 and 2005 continue to challenge and hone the skills of the U.S. Geological Survey (USGS)'s Coastal Hazards team in Florida, a part of the USGS National Assessment of Coastal Change Hazards project. The team's work is featured in an educational exhibit called "Into the Eye: Hurricanes" that opened October 13, 2005, at the Pier Aquarium in St. Petersburg, FL. The exhibit describes the team's ongoing studies of long-term coastal changes and the effects of extreme storms, with a focus on the destructive 2004 hurricane season, during which three hurricanes crossed Florida and one battered the Gulf Coast. While this exhibit was being finalized, along came the even more destructive storms of 2005.

The 2005 hurricane season arrived earlier than expected on June 9, when Tropical Storm Arlene became the first named storm. By July 5, Dennis became the fourth named storm of the season, eventually growing to a category 4 hurricane and slamming the Florida panhandle with 120-mph winds. As Dennis headed north through the Gulf of Mexico, a massive red-tide bloom coinciding with storm surge stranded dead fish in the streets of downtown St. Petersburg, where the Coastal Hazards team is headquartered in the USGS Center for Coastal and Watershed Studies. Perhaps these events were a hint of the intensity of storms still to come in the 2005 hurricane season.

By the end of September 2005, 17 storms had been named in the Atlantic Ocean and Gulf of Mexico, including five major hurricanes rated category 3 or higher on the Saffir-Simpson scale (see URL **http://**

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***Abby Sallenger**, chief of the National Assessment of Coastal Change Hazards project, headquartered at the USGS Center for Coastal and Watershed Studies in St. Petersburg, FL.*

▲ *Hurricane Rita approaching the Gulf Coast on September 23, 2005. Image by MODIS Rapid Response Team, NASA Goddard Space Flight Center (see URL **http://rapidfire.sci.gsfc.nasa.gov/gallery/**).*

◄ *This pair of photographs assembled by the Coastal Hazards team shows the effects of Hurricane Rita at Holly Beach, LA. For more information, visit URL **http://coastal.er.usgs.gov/hurricanes/rita/photo-comparisons/cameron.html**.*

Sound Waves

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Deadline: The deadline for news items and publication lists for the December 2005/January 2006 issue of *Sound Waves* is Thursday, December 1.
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 Earth Science Information Sources

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**

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www.nhc.noaa.gov/aboutsshs.shtml). The research team has responded to three major storms that made landfall in the United States—Hurricanes Dennis, Katrina, and Rita—forecasting likely coastal impacts as each storm approached, and documenting coastal changes as soon as possible after landfall. (As of this writing, on October 19, 2005, they are preparing for the possible impacts of Hurricane Wilma.)

In this rapid-response mode, the team operates at a fast pace, with daily meetings to assure that their efforts are organized and on track. The team's numerous goals begin with a forecast of coastal inundation (flooding) based on tropical-weather advisories from the National Hurricane Center (NHC; see URL **http://www.nhc.noaa.gov/**). After a storm makes landfall, crews book small aircraft to fly low-elevation missions over the affected areas, recording coastal impacts with digital video and photography. Partner organizations are contracted to fly lidar (light detection and ranging) surveys over the same areas in order to create high-resolution topographic maps, which allow researchers to quantify shoreline retreat, overwash, and other important indicators of coastal change.

Dave Thompson *sorts through historical archived slide images to compare with modern images of the same area that depict conditions after Hurricane Katrina.*

The 2004 and 2005 storm seasons have been remarkably similar, both producing multiple major hurricanes hitting Florida and the Gulf Coast. During both seasons, as soon as team members outlined a plan of action for addressing one storm, another appeared on the horizon. The 2005 season has been different, however, in the overwhelming amount of media and intergovernmental interest in the effects of Hurricane Katrina on the Louisiana and Mississippi coastlines. Certainly, Katrina has set a new standard for examining the natural and societal impacts of hurricanes; Rita, too, generated some drastic changes in coastal areas of Louisiana and Texas (for examples, visit URL **http://coastal.er.usgs.gov/hurricanes/rita/**).

Ideally, the research team would like to spend more time analyzing data and addressing indepth scientific questions about coastal change, but the rapid-fire hurricane season has kept them busy. Under the guidance of **Abby Sallenger**, chief of the National Assessment of Coastal Change Hazards project, the team maintains a steady routine with respect to each storm that makes landfall in the United States as a major hurricane. The scientific team, composed of **Hilary Stockdon**, **Peter Howd**, **Dave Thompson**, **Laura Fauver**, and **Mark Hansen**, first analyzes previous topographic surveys and NHC advisories to predict inundation along vulnerable coastlines. After a storm makes landfall, video and photography teams consisting of **Karen Morgan**, **Dennis Krohn**, and **Russell Peterson** fly over the affected area 1 to 2 days after the storm's passage. Before-and-after photographic pairs provide a first look at coastal change and the impacts of the storm on beaches. Photographs are posted online for public viewing, serving as a resource not only for scientists but also for evacuees hoping to locate their damaged homes in the wake of the storm.

The USGS researchers coordinate with members of partner organizations, including **Wayne Wright** of the National Aeronautics and Space Administration (NASA) and **Jeff Lillycrop** of the U.S. Army Corps

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of Engineers, who fly lidar surveys of the affected coastlines. USGS team members **Billy Reynolds** and **Nancy DeWitt** set up Global Positioning System (GPS) base stations to provide navigational guidance for these surveys, often living out of government vehicles for lack of alternate housing. Within a few days, data from the lidar surveys are transmitted to the USGS office, where geographic-information-system (GIS) specialist **Kristy Guy** processes the data and creates GIS images of sediment erosion and accretion that are used to quantify coastal changes seen in the quick-response photography. These GIS images are posted online for public viewing (for example, visit URLs **http://coastal.er.usgs.gov/hurricanes/rita/** and **http://coastal.er.usgs.gov/hurricanes/katrina/**). The scientific team then analyzes the lidar data for such indicators of coastal change as shoreline retreat, volume change, and change in island elevation. Longer-term goals include analyzing spatial variations in erosion patterns and improving the group's ability to predict which coastal regions are especially vulnerable to storm impacts.

Abby Sallenger *(left) and* ***Karen Morgan*** *(right) compare before-and-after-Hurricane-Katrina video footage from the Chandeleur Islands, LA, with news reporter* ***Steve Nicholson*** *(center) of the local Fox television affiliate.*

Many challenges confront this group, including maintaining an ever-increasing library of video, photographic, and lidar data. **Morgan**, who is often tasked with the organization of data files, notes that "the volume of data we have collected in the past 2 years is beginning to overwhelm our storage space and processing limits, and we are starting to reassess these needs for upcoming seasons." Another challenge that faces the group is maintaining up-to-date surveys of coastlines that may potentially be affected by hurricanes. Baseline, or prestorm, lidar surveys are necessary to quantify the volume of erosion and accretion, and project chief **Sallenger** must keep informed of when each coastline was last surveyed so that he can determine when to fly new baseline surveys before the arrival of a major storm.

Despite these challenges, the Coastal Hazards team has stayed on top of the details, providing valuable data for scientists, decisionmakers, and the general public. The project's hurricane and extreme storm Web site (URL **http://coastal.er.usgs.gov/hurricanes/**) features inundation forecasts, pairs of before-and-after photographs, quick-response photographs of entire coastal towns, and lidar images detailing the magnitude of coastal change.

An important part of the team's work is to disseminate information within the scientific community. **Stockdon** presented the group's initial findings at the Geological Society of America meeting in Salt Lake City, UT, in October and will also cochair a special session on Hurricane Katrina at the American Geophysical Union Ocean Sciences meeting in Honolulu, HI, in February 2006.

The USGS has provided information and imagery to many media outlets, including the Web, television, and print. Many local and national news agencies have featured USGS images, and several have asked **Sallenger** to comment on the vulnerability of coastlines after the impacts of Katrina and Rita. *National Geographic* assembled three photomosaics with the descriptive title "Going, Going, Gone—Dauphin Island," showing the progressive erosion of the west end of the island after both Ivan (2004) and Katrina (2005) shifted the island landward (see USGS images at URL **http://coastal.er.usgs.gov/hurricanes/katrina/photo-comparisons/dauphin.html**). USGS images also have featured prominently in national newspapers, including the *New York Times* and *USA Today*. Asked to comment on rebuilding the Gulf Coast in one *New York Times* article, **Sallenger** responded "there are some places where you should think twice about putting up a pup tent."

The CBS Evening News picked up a video news release that showed post-Katrina aerial video footage from the Chandeleur Islands in eastern Louisiana. During the flight, USGS scientists onboard the plane were studying GPS data that told them they were above the Chandeleur Islands while seeing nothing below but open water. Lidar images later confirmed that the northern 3 mi of the island chain had been completely eradicated by the storm. The dialogue between **Morgan** and **Krohn** recorded on the video captures their confusion:

Morgan: "I don't think that's it."

Krohn: "According to the GPS, we're over the islands."

[As the flight proceeds south, remnants of marshy outcrops appear where sandy beaches once lay.]

Morgan: "Can you see some islands out there?"

Krohn: "Something like islands."

Morgan: "Okay, we've got pieces and parts here."

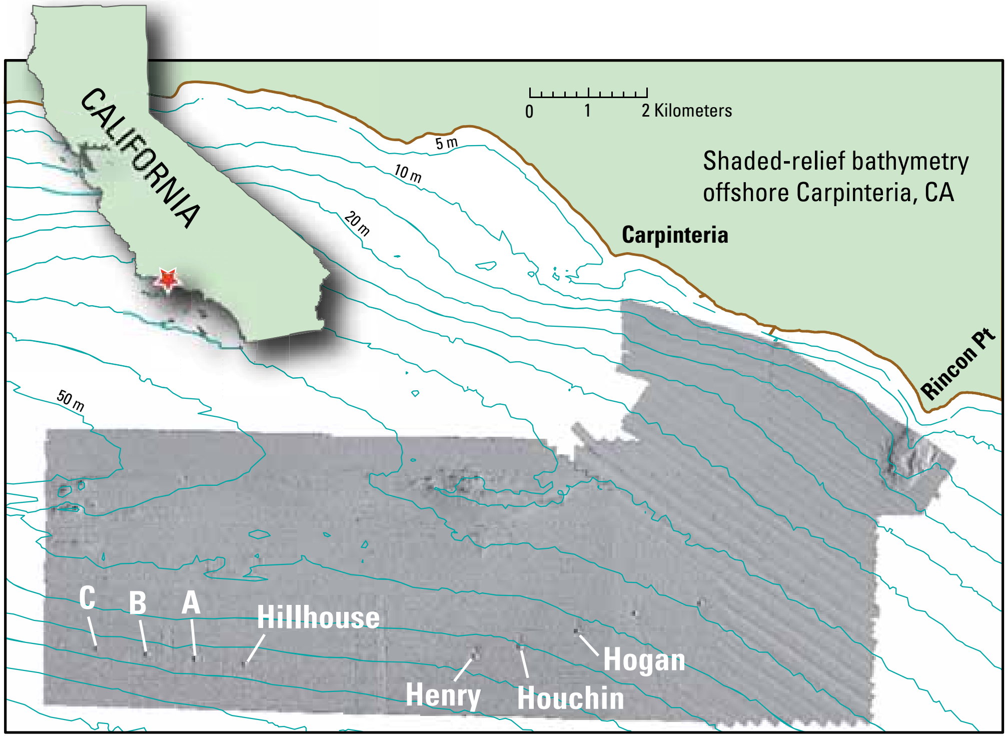
Krohn: "Definitely run the tape, because that might be all of the islands."

Pilot: "According to GPS we're over the Chandeleur Islands. They're right here."

While data collection and processing move forward, the team will continue to analyze their findings, hoping to uncover long-term implications of coastal change produced during the past two hurricane seasons. It's a tall order, but this team is up to the challenge.

Sonar Survey of Sea-Floor Habitats Southeast of Santa Barbara, California

By Guy Cochrane



Gray shading shows area mapped with interferometric sonar in 2005 (Santa Barbara is off map to left, about 18 km west of Carpinteria). Oil platforms are labeled in white. Bathymetric contours are at 5-m-depth intervals.

From August 7 to 27, U.S. Geological Survey (USGS) personnel surveyed approximately 75 km^2 of the continental shelf southeast of Santa Barbara, using interferometric sonar, which collects both bathymetric and acoustic-backscatter data. Similar to sidescan-sonar data, acoustic backscatter yields information about the sea-floor surface, allowing researchers to distinguish, for example, between areas of soft mud and hard rock and to image manmade structures, such as pipelines. The survey was funded by the Minerals Management Service (MMS), which will use the data for various purposes, including monitoring oil and gas activity, assessing biological resources, locating natural tar seeps, and monitoring archeological resources. A similar survey, also funded by MMS, was conducted in deeper water to the southeast in August 2004 (see "Mapping Benthic Habitat Around Oil Platforms in the Santa Barbara Channel, California" in *Sound Waves*, November 2004, at URL **http://soundwaves.usgs.gov/2004/11/fieldwork3.html**).

The recent survey was conducted in two legs. **Pete Dartnell**, **Jamie Conrad**, **Mike Boyle**, and **Gerry Hatcher** participated in the first week-and-a-half-long leg, and **Guy Cochrane**, **Nadine Golden**, and **Mike Boyle** crewed the second leg, along with USGS volunteer **Margie Boyle**. Before the cruise, **Kevin O'Toole** manufactured hardware for mounting the interferometric sonar on the Channel Islands

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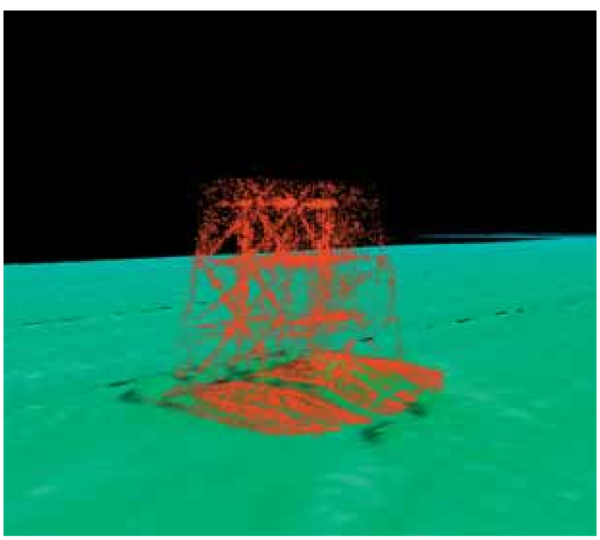

*◄ Oblique image of the sea floor around Platform Henry, produced from the recently collected sonar data by Pete Dartnell. Processing the data one way reveals sea-floor bathymetry, shown here in shades of green. Processing another way reveals features in the water column, such as the rough outlines of the submerged part of Platform Henry (red) and the top of material that has accumulated beneath the platform (possibly shells of animals, such as mussels, that live attached to the platform). View southwestward. To watch a "fly-by" showing 360° views of the sea floor around the base of this platform, visit URL **http://soundwaves.usgs.gov/2005/10/fieldwork2.html**.*

Interferometric sonar (arrow) mounted to the stern of the research vessel Shearwater.

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National Marine Sanctuary's research vessel *Shearwater*. For the first few days of each leg, **Andy Stevenson** provided onboard training in processing the interferometric-sonar data, a task which the scientists conducted daily during the survey.

The final 3 days of the cruise were spent collecting video footage in selected areas to groundtruth each type of pattern observed in the sonar data—smooth, featureless images that might indicate a muddy bottom, for example, or sharp contrasts that might indicate rocky habitat. University of California, Santa Barbara (UCSB) biologist **Donna Schroeder** participated in video surveying of bottom habitat and benthic species. Rocky sea floor was mapped north of the platforms along an east-west-trending bathymetric ridge. This type of sea floor particularly interests MMS because it supports diverse communities of marine organisms, including rockfish, an important resource for commercial and recreational fisheries.

Donna Schroeder *(UCSB, left) and* ***Nadine Golden*** *(USGS) log video observations during the final days of the survey.*

The original goal for the cruise was to survey the area around shallow-water oil platforms southeast of Santa Barbara, and that goal was readily accomplished. Good weather and reliable equipment gave us the opportunity to collect additional data southeast of Carpinteria for a USGS coastal-erosion study being conducted in cooperation with the city of Carpinteria and the U.S. Army Corps of Engineers. Headed by **Patrick Barnard**, that study will eventually include bathymetric surveys in nearshore waters and the surf zone, high-resolution mapping of the beach, and deployment of offshore instruments to measure waves and sediment transport.

Drilling for Submarine Ground Water at Cape Cod National Seashore

By John Bratton

An interdisciplinary U.S. Geological Survey (USGS) and National Park Service (NPS) science team conducted submarine drilling operations at Cape Cod National Seashore from August 22 to 26. The team sought to test some hypotheses about ground-water flow under and into the Nauset Marsh estuary system and to constrain the results of previous modeling efforts. NPS managers are concerned about nutrients that are entering the system via submarine ground-water discharge, leading to eutrophication and harmful algal blooms. The team used a USGS all-terrain-vehicle (ATV)-mounted drilling rig secured to a barge to drive an electrical-resistivity probe into sediment and (or) to collect submarine ground-water samples at seven sites in Salt Pond, Salt Pond Channel, and Salt Pond Bay, which are part of the estuary system.

Andy Massey *(USGS) operates a drilling barge that is temporarily stranded during low tide on a mudflat at Cape Cod National Seashore.*

Results are consistent with surface electrical-resistivity data collected in 2004. Sampling and geophysical measurements indicate that Salt Pond, a kettle pond that has been breached by rising sea level, is underlain by brackish ground water in sediment to a depth of about 45 ft below the sediment surface. Salt Pond Channel, which connects the pond to Salt Pond Bay, has nearly fresh water at shallow depths (10 ft or less below the sediment surface). Most surprisingly, Salt Pond Bay is underlain by a layer of fresh ground water more than 50 ft thick as far offshore as measured (about 1,300 ft).

Ground-water sampling was conducted by **John Bratton**, **John Crusius**, and **Dirk Koopmans** (USGS, Woods Hole Science Center, Woods Hole, MA). **Andy Massey** (USGS Massachusetts-Rhode Island Water Science Center, Northborough, MA) operated the drill rig, and **Tim McCobb**

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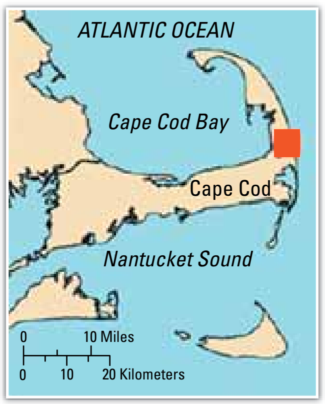
(also USGS, Northborough) operated the resistivity probe, a Geoprobe Systems Direct Image tool modified for marine work. Contractors **Mark Avakian** and **Len Perry** (TG&B, Inc.) operated the barge and secured anchors and spuds. Divers **Michael Casso** and **Sandy Baldwin** (USGS, Woods Hole) helped remove drill pipe left in the pond after drilling was complete. **Evan Gwilliam** and **Kelly Chapman** (NPS, Cape Cod National Seashore) provided a continuous tide-stage record. **John Colman** and **Denis LeBlanc** (USGS, Northborough) provided helpful input during the design and implementation stages of the field effort. The work was supported by the USGS Coastal and Marine Geology Program, the USGS Massachusetts-Rhode Island Water Science Center, and Cape Cod National Seashore. ❁

*USGS divers **Michael Casso** (left) and **Sandy Baldwin** prepare to remove submerged drill pipe near the center of Salt Pond.*



*Map at right shows location of the study area. Photograph at far right (by **Barbara Dougan**, NPS) shows approximate drilling locations in Salt Pond, Salt Pond Channel, and Salt Pond Bay. View southeastward.*

Outreach

USGS Science and Graphics Raise Awareness at Educational Geopark in Florida

By Ann B. Tihansky

The U.S. Geological Survey (USGS) was a key player in an educational partnership that raises awareness about Florida's hydrogeologic resources. The effort, led by University of South Florida (USF) geology professor **Len Vacher**, teamed students from USF's Geology Department and Environmental Science and Policy Department with local environmental professionals to create an outdoor educational park known as the "Geopark" on the USF Tampa campus.

Three large limestone boulders placed in the Geopark serve as the focus for furthering public awareness about the geology and environmental issues affecting the State of Florida. Although the rocks draw considerable interest, the area serves an as outdoor

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***Ann Tihansky** stands next to the Geopark sign describing sinkholes, which was created using graphics from her USGS publication.*

(Geopark continued from page 6)

learning laboratory for hydrology students. Students use monitoring wells installed in the park for class activities focused on understanding hydrogeologic principles. The area contains a sinkhole, which has been studied by previous students. Not only has the hydrogeology of the Geopark area been well described, it also generally represents the geologic framework throughout the State of Florida.

The Geology and Environmental Science and Policy Departments wanted to share this information with the rest of the campus community, whether geology students, political science students, or people simply interested in knowing what's beneath their feet. Faculty members **Vacher**, **Mark Stewart**, and **Mark Rains** requested educational-grant money from the Southwest Florida Water Management District to create five educational signs. They formed a committee consisting of themselves, students, and representatives of the USGS, the Florida Department of Environmental Protection, and the Southwest Florida Water Management District. The committee shared ideas, developed concepts, and designed the final graphics that were selected for the five signs. The major topics include:

- the geologic units and hydrology of Florida,
- the Floridan Aquifer,
- ground-water contamination,
- sinkhole formation, and
- land use within the entire Hillsborough River basin.

The sinkhole sign includes information and graphics from a publication about sinkholes by USGS hydrologist **Ann Tihansky** (available online at URL **http://fl.water.usgs.gov/Abstracts/c1182_tihansky.html**). **Beth Fratesi**, a USF graduate student and accomplished graphic artist, worked with **Vacher** and **Tihansky** to finalize the graphics before they were converted to the highly durable signs. The team hopes that these signs are the beginning of a long-term effort to increase awareness about the importance of geosciences to our society.☸

A boulder-size geologic sample of the Ocala Limestone (upper left) is referenced in the Geopark sign that describes the rock and aquifer units in Florida. The rock was donated by a quarry in Ocala, FL.

The Geopark is designed to educate geoscience majors as well as the general public about various aspects of Florida's hydrogeology.

USGS and Local Florida Elementary School Receive Mayor's Top Apple Award

By Ann B. Tihansky

A partnership between the U.S. Geological Survey (USGS) Center for Coastal and Watershed Studies (CCWS) and Bay Point Elementary School in St. Petersburg, FL, received the Top Apple Award from St. Petersburg **Mayor Rick Baker** on August 12. **Mayor Baker** initiated the corporate sponsor program to enhance school environments and increase community involvement with local schools (see article in *Sound Waves*, September 2004, at URL **http://soundwaves.usgs.gov/2004/09/outreach2.html**). The USGS and Echelon Real Estate Services are corporate sponsors of Bay Point Elementary. As part of this program, the sponsors coordinate with school administrators and teachers to identify ways in which the sponsors can help to enhance learning experiences. The sponsors provide items and services that include participating in mentoring programs, science fairs, and guest lectures and offering technical expertise, educational materials, and opportunities for school outings. Schools that maintain a State rating of "A," or raise their rating, are recognized as the Mayor's Top Apple schools. Top Apple recipients were recognized in a public ceremony in the city of St. Petersburg's Council Chambers. **Lisa Robbins**, CCWS director, and **Ann**

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Tihansky, hydrologist and head of the center's science communications, attended the ceremony and shared the recognition with Bay Point Principal **Gaye Lively** and Echelon representative **Ryan Lynch**.

*Administrators with the city of St. Petersburg celebrate with recipients of the Top Apple Award. From left to right: **Clayton Wilcox**, Superintendent of Pinellas County Schools; **Gaye Lively**, Principal of Bay Point Elementary; **Willie Gore**, Assistant Principal of Bay Point Elementary; **Ryan Lynch**, Echelon Real Estate Services; **Lisa Robbins**, USGS; **Mayor Rick Baker**; **Ann Tihansky**, USGS; and **Rick Kriseman**, City Council Chairman.*

Meetings

Chinese Delegation Visits USGS to Discuss Gas-Hydrate Studies

By Debbie Hutchinson

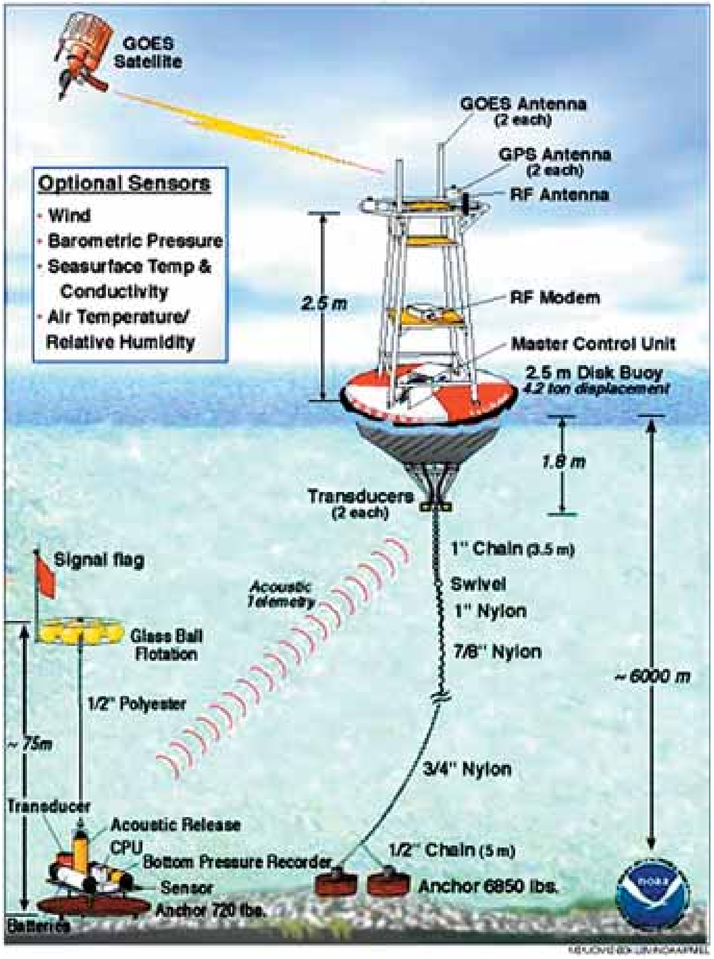
A delegation of eight scientists from the People's Republic of China, representing five Chinese government organizations, visited the U.S. Geological Survey (USGS) Woods Hole Science Center in Woods Hole, MA, on September 13, 2005, to discuss collaboration in gas-hydrate research. **Huang Yong Yang**, chief geologist of the Guangzhou Marine Geological Survey, was the leader of the delegation. The other institutions represented were the China Geological Survey, the Guangzhou Institute of Energy Conversion, the Qingdao Institute of Marine Geology, and China Geological University. Activities during the day included a welcome by acting USGS Woods Hole Coastal and Marine Geology Team chief scientist **Jeff Williams**, presentations by **Debbie Hutchinson** and **Jean Whelan** about USGS and Woods Hole Oceanographic Institution (WHOI) gas-hydrate studies, tours of the GHASTLI (Gas Hydrate and Sediment Testing Laboratory Instrument) laboratory with **Bill Winters** and **Bill Waite**, an overview of the Chinese gas-hydrate research program by **Dr. Huang**, and a tour of the WHOI Deep Submergence Facility in Woods Hole. The Chinese delegation's visit in Woods Hole followed a visit with **Tim Collett** in Denver, also to discuss gas-hydrate collaboration, particularly in regard to drilling needs.

Much of the Chinese research program for gas hydrates is focused on three areas of the South China Sea where bottom-simulating reflections (BSRs) and surficial mounds indicate active fluid venting. A discussion period at the end of the day provided a mechanism to discuss mutual interests, needs, and timelines for undertaking collaborative gas-hydrate studies. The meeting ended with a commitment to continue discussions, with **Debbie Hutchinson** and **Zhang Haiqi** acting as the primary points of contact.

*Participants in a 1-day meeting between USGS gas-hydrate researchers and visiting Chinese scientists. Left to right: **Jianli Song** (USGS), **Bill Winters** (USGS), **Li Chun** (Qingdao Institute of Marine Geology), **Zhang Guangxue** (Guangzhou Marine Geological Survey), **Xiao Guiyi** (China Geological Survey), **Zhang Haiqi** (China Geological Survey), **Fan Shuanshi** (Guangzhou Institute of Energy Conversion), **Huang Yong Yang** (Guangzhou Marine Geological Survey), **Dave Mason** (USGS), **Debbie Hutchinson** (USGS), **Michelle Edwards** (USGS), **Su Xin** (China Geological University), **Bill Waite** (USGS), and **Zhou Changfan** (Guangzhou Marine Geological Survey). Photograph courtesy of **Bill Winters**, taken by **Brian Buczkowski** (USGS).*

Workshop on Optimizing the DART Network for Tsunami Forecasting

By Eric Geist, Frank González, and Uri ten Brink



*First-generation DART mooring. A bottom-pressure recorder (BPR) on the sea floor (lower left) relays tsunami information to a surface buoy that sends it to a satellite for transmission to Tsunami Warning Centers. For more information about first- and second-generation (DART II) moorings, visit URL **http://www.pmel.noaa.gov/tsunami/Dart/**.*

After the devastating Indian Ocean tsunami of December 2004, there has been an increased emphasis on providing timely and accurate tsunami warnings to all U.S. coasts and U.S. interests around the world. In response to this need, the National Oceanic and Atmospheric Administration (NOAA) plans to increase the number of its deep-ocean tsunameters (tsunami detectors, also known as Deep-ocean Assessment and Reporting of Tsunamis, or DART, systems) to a total of 39. There are currently six "first generation" tsunameters: two off the Pacific Northwest, three off the Aleutian Islands, and one near the Equator. The new tsunameters will be distributed throughout the Pacific Ocean, the Caribbean Sea, the Atlantic Ocean, and the Gulf of Mexico. (For the latest map of NOAA tsunameter locations, visit URL **http://www.ndbc.noaa.gov/dart.shtml**.) A joint workshop attended by representatives of NOAA and the U.S. Geological Survey (USGS) was convened on July 6-7, 2005, in Seattle, WA, to develop a deployment plan for the new tsunameters. **Frank González**, Tsunami Research Program Leader of NOAA's Pacific Marine Environmental Laboratory (PMEL), set out the central goal of the deployment plan: to determine an optimal network configuration that meets multiple operational, logistical, and mitigation objectives.

NOAA's tsunameters consist of a bottom-pressure recorder (BPR) that measures the tsunami and a surface buoy that communicates the information to Tsunami Warning Centers. At the heart of the BPR is a quartz-crystal pressure transducer that can detect sea-level changes of less than 1 mm for waves with periods greater than 1 minute. Tsunami waves generally have periods ranging from 5 to 60 minutes, whereas surface waves and swells produced by wind generally have periods ranging from 1 to 30 seconds. The BPR is positioned in water several thousands of meters deep to eliminate pressure changes induced by wind-generated, short-period waves that rapidly attenuate with water depth. The surface buoy receives data from the BPR through acoustic telemetry and sends the information to ground stations by way of a Geostationary Operational Environmental Satellite (GOES) link. The next-generation DART II systems developed by PMEL engineers include a two-way communications capability that allows ground stations to remotely trigger DART transmission of the BPR data. For more information about sampling rates, detection algorithms, and other specifications, visit the DART Web site at URL **http://www.pmel.noaa.gov/tsunami/Dart/**.

Following introductory comments by **Eddie Bernard**, PMEL director, and **Sam Johnson**, chief scientist of the USGS Western Coastal and Marine Geology Team, workshop participants set out to define the set of criteria and objectives for the new DART network. First and foremost, these objectives include the operational objectives of the Tsunami Warning Centers, which were described by **Paul Whitmore**, director of the National Weather Service's West Coast & Alaska Tsunami Warning Center. Logistical constraints, such as ship availability and long-term maintenance of the almost-global DART network, were described by **Shannon MacArthur** of NOAA's National Data Buoy Center. Tools to aid in optimizing the DART deployment plan were presented by **Hal Mofjeld** (PMEL). These tools include the Nonlinear Optimization for Mixed vAriables and Derivatives (NOMAD) software developed, in part, by **John Dennis**, an optimization expert from Rice University. Graphical tools that display normalized tsunami energy, traveltimes, and other information, developed by **Mick Spillane** (PMEL), also proved to be extremely useful during the course of the workshop deliberations.

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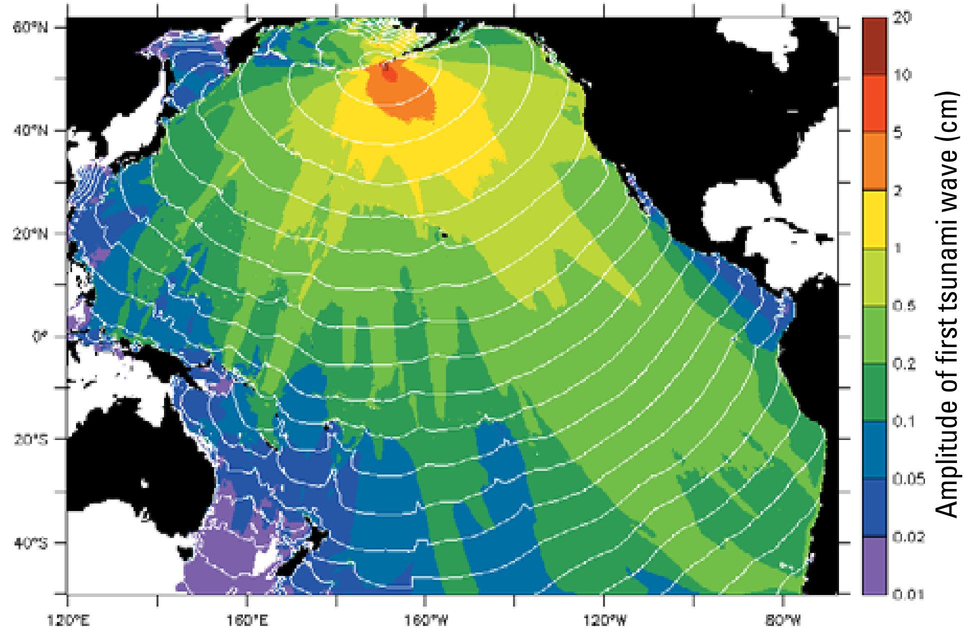
The primary role of the USGS participants was to specify tsunami sources—geologic phenomena likely to trigger tsunamis—for optimal positioning of DART stations. Tsunami triggers that were considered included earthquakes, landslides, and volcanoes. The primary source parameters used in the optimization process are location, potential size of the tsunami (in terms of both wave amplitude and aerial distribution of tsunami energy), and relative likelihood of occurrence. For subduction-zone earthquakes, which are the main source of far-field tsunamis, a necessary constraint is to place the DART station at a sufficient distance from the earthquake source to avoid interference between the tsunami signal and apparent changes in bottom pressure induced by Rayleigh waves (a type of seismic surface wave). On the other hand, the DART station needs to be placed close enough to the source to minimize the time to acquire the first direct evidence of a tsunami from the DART buoy. The goal is to allow sufficient time for evacuation should a damaging tsunami be forecast, and for cancellation of a tsunami warning should a tsunami be assessed as nondestructive.

Background on subduction-zone earthquakes and a generalized probability model were presented by **Eric Geist** (USGS). The long-term rate at which a given subduction zone produces tsunamis of all sizes is linked to the rate of convergence. Efforts to compile convergence rates at subduction zones on a worldwide basis were described by **Ken Hudnut**, Southern California Project Chief of the USGS Earthquake Hazards Program. Workshop participants then discussed tsunami sources in specific regions, including the North Pacific subduction zones—off southern Alaska, the Aleutian Islands, Kamchatka, the Kuril Islands, and Japan—which have a long history of generating destructive tsunamis. In contrast, the Cascadia subduction zone, off the Pacific Northwest, has only recently been recognized as having the potential to generate oceanwide tsunamis, as elegantly described by **Brian Atwater** (USGS).

A particularly difficult region to assess is the Caribbean, as described by **Uri ten Brink** (USGS) and **Aurelio Mercado** (University of Puerto Rico). All the likely types of tsunami sources occur in the Caribbean, including subduction-zone and backarc earthquakes, landslides from the tilted carbonate platform offshore northern Puerto Rico, and active volcanoes, such as Kick'em Jenny in the Lesser Antilles. Although fewer tsunamis have occurred in the Caribbean than in the Pacific, more fatalities due to tsunamis have occurred in the more densely populated Caribbean than in the U.S. West Coast and Alaska combined.



The geometry of a tsunami source, plus refraction and scattering caused by sea-floor bathymetry, tends to focus tsunami energy in beams—an effect illustrated in this figure showing the amplitude of the first wave emanating from a hypothetical magnitude 7.5 subduction-zone earthquake in the Aleutian Islands. This model predicts the wave's amplitude in deep water, data that can be used as input to coastal models for predicting how the wave's amplitude will increase as it enters shallow water and runs up on the shore. White lines show the positions of the tsunami wave at hourly intervals. The splitting of tsunami energy into lobes can place some remote sites at greater risk than others. Close to the source, the beamlike structure of the wave is a factor to be considered in tsunameter placement.

The discussion of tsunami sources concluded with an enlightening presentation by **Chris Newhall** of the USGS Volcano Hazards Program. He presented an overview of historical volcanogenic tsunamis with references to such processes as pyroclastic flows, submarine caldera collapses and explosions, and even catastrophic flank failures that are the specific triggers for tsunami generation. This information, in combination with (1) monitoring and further research into these physical mechanisms and (2) hydrodynamic modeling, will be important for evaluating the tsunamigenic potential of volcanoes such as Cumbre Vieja on La Palma in the Canary Islands.

One way to see how all this information fits together is to look at specific tsunami events from the perspective of a watchstander in a tsunami-warning center. Several cases described by **Vasily Titov** (PMEL) were particularly illuminating. For example, when an earthquake occurs in the Aleutians, someone on watch can use the initial earthquake information (epicenter and magnitude) to "forward-model" the tsunami using a precomputed database of tsunami-propagation scenarios that are built on source characterizations such as those described at the workshop. Then, once the data from DART stations are received, the occurrence of a tsunami can be verified, and the source can be updated to produce the best fit to the observed tsunami waveform. The propagation calculations are then carried forward

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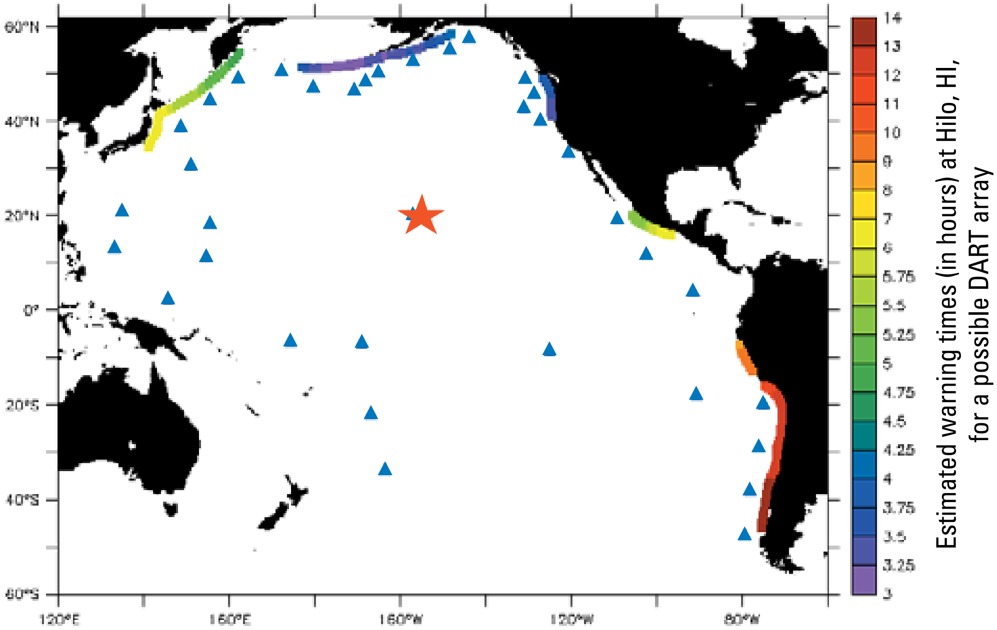

The major consideration in the design of a DART buoy (tsunameter) array is how soon a reliable forecast of tsunami runup can be provided to impact sites. An actual tsunami wave, detected at one or more tsunameters, is the first step in an intensive computational procedure needed to characterize the tsunami's source, predict tsunami-wave propagation throughout the ocean basin, and provide input to fine-scale, real-time models which forecast wave runup for locations at risk. Graphical aids, such as this example drawn for an impact site at Hilo, HI (red star), help assess the adequacy of a possible tsunameter-array design (blue triangles). A precomputed database of tsunami-propagation scenarios is queried to determine, for each source, the earliest arrival of a detectable tsunami wave at one of the tsunameters. A "computation time" of 1 hour is added to the earliest detection time to represent the time needed to sample the waveform and produce wave-runup forecasts. The difference between this "forecast time" and the tsunami wave's arrival at Hilo should exceed 3 hours—the estimated time needed by emergency managers to act on the warning—for the array to be deemed adequate. Estimated warning times (arrival times minus "forecast times") are color-coded in bands for simulated tsunami sources in the northwestern, northern, and eastern Pacific; they show that this array is adequate for Hilo, though marginally so for some Aleutian and Cascadia sources.

to interface with a high-resolution inundation model for vulnerable coastal communities. This entire process can be carried out by the operational Tsunami Forecast System currently under development by PMEL.

Doug Luther (University of Hawai'i) discussed the importance of developing multiuse strategies to garner the support needed from other scientific communities to ensure the future sustainability of the DART network. Not only will there be manifold oceanographic applications of the DART data, but collaborations with the broader oceanographic community are also needed to fully utilize and share the platform and ship-time resources of DART with other large oceanographic projects. Participants recognized that this workshop might provide a good first step in connecting the tsunami and broader oceanographic communities, as well as in determining how DART networks might be established as part of emerging tsunami-warning systems around the world. Results from the workshop will soon be published as a joint NOAA/USGS Special Report.

For more information on tsunami warnings and preparedness, visit URL **http://www.tsunami.noaa.gov/**.

Staff and Center News

New Hires for the Western Coastal and Marine Geology Team

By Sam Johnson

The U.S. Geological Survey (USGS) Western Coastal and Marine Geology Team (WCMG) is pleased to announce the hiring of three talented young scientists.

Amy Draut has accepted a position as a Research Geologist with WCMG, bringing to the team her significant and broad expertise in applied sedimentology, stratigraphy, geomorphology, and coastal processes and mapping. **Amy** received a B.S. in geological sciences and environmental studies from Tufts University and a Ph.D. in marine geology and geophysics from the Massachusetts Institute of Technology/Woods Hole Oceanographic Institution Joint Program. Her dissertation was titled "Fine-Grained Sedimentation on the Chenier Plain Coast and Inner Continental Shelf, Northern Gulf of Mexico." After her graduate work, **Amy** moved West to work as a postdoctoral researcher with WCMG geologist **Dave Rubin** on sediment-transport investigations in the Grand Canyon, specifically the relationship between aeolian sedimentation and preservation of archeological sites, with applications for Glen Canyon Dam management. In addition to her thesis and postdoctoral work, **Amy's** impressive publication list includes papers on volcanic-arc stratigraphy and geochemistry, and Pliocene climate change. **Amy** is a member of the American Geophysical Union, the Geological Society of America, and the Geological Society of London. **Amy** will be finishing her postdoctoral work in the next few months and begin her new WCMG appointment in February 2006.

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Eric Grossman has also accepted a position as a Research Geologist in WCMG, a conversion from his current term appointment to a permanent appointment. **Eric's** expertise includes coral reefs, sea-floor and coastal geology and geomorphology, shallow stratigraphy of shelf and estuarine settings, and benthic habitats. **Eric** received a B.A. in geography from the University of California, Berkeley (Go Bears!), followed by an M.S. and Ph.D. from the University of Hawai‘i. As a graduate student, **Eric** worked on his thesis, "Holocene Sea-Level History and Reef Development in Hawaii and the Central Pacific Ocean," as well as coauthoring the impressive USGS publication *Atlas of Natural Hazards in the Hawaiian Coastal Zone* (USGS Geologic Investigations Map I-2761; see URL **http://pubs.usgs.gov/imap/i2761/**). After graduate school, **Eric** came to WCMG as a postdoctoral researcher, continuing his work on Hawaiian coral reefs with **Mike Field** and beginning a new effort on central California continental-shelf deposits. **Eric** currently serves as the leader of the "Geological Reconstruction and Habitat Change of Major River Deltas" task in WCMG's Puget Sound project and as co-leader of the new bureauwide USGS integrated science program "Multi-Disciplinary Coastal Habitats in Puget Sound." **Eric** also spearheads research on submarine ground-water discharge and its impact on coral reefs in Hawai‘i and leads the "Rapid Sea-Level Rise and Reef Response" task of WCMG's Coral Reefs project. **Eric** is a member of the American Geophysical Union, the Geological Society of America, the International Society for Reef Studies, the Ecological Society of America, the Estuarine Research Foundation, the Association of American Geographers, and the International Quaternary Association, and he is currently serving on the King County (WA) scientific steering committee on Climate Change Impacts to the Puget Sound Coastal Sector.

Amy Draut *examines sedimentary structures exposed in a sandbar along the Colorado River in Grand Canyon.*

Eric Grossman *operates a vibracorer in northern Puget Sound as a flood tide races in.*

Patrick Barnard *stands beside a Webcam that he and WCMG oceanographer* ***Dan Hanes*** *installed on the roof of the Cliff House Restaurant overlooking San Francisco's Ocean Beach. The camera records images of the beach, which* ***Patrick*** *and* ***Dan*** *use in their research (see URL* ***http://walrus.wr.usgs.gov/coastal_processes/****).*

Patrick Barnard has accepted our offer to stay with WCMG as a term Research Geologist after completing his current position as a USGS Mendenhall Postdoctoral Fellow. WCMG will continue to count on **Patrick's** considerable expertise in shoreline and shallow-marine erosion and deposition, processes, and mapping. **Patrick** received a B.S. degree in geology from Williams College; an M.S. from the University of South Florida, where he worked on the evolution of tidal inlets on Florida's west coast; and a Ph.D. from the University of California, Riverside. His dissertation was titled "The Timing and Nature of Glaciofluvial Erosion and Resedimentation in the Himalaya: The Role of Glacial and Paraglacial Processes in the Evolution of High Mountain Landscapes." After his graduate work, **Patrick** came to WCMG as a USGS Mendenhall Postdoctoral Fellow, conducting work focused on Ocean Beach, CA, and the fascinating ebb-tidal delta at the mouth of San Francisco Bay. This study is designed to advance understanding of physically based models of sediment transport, morphologic change, and formation of sedimentary deposits along the coast. Significant partnerships with local and State agencies have resulted from these investigations, relationships that have since led to outside funding agreements for studies of coastal processes in Santa Barbara and Ventura Counties. **Patrick** is a member of the American Geophysical Union and the Geological Society of America. ☸

Recently Published Articles

Atwater, B.F., Satoko, Musumi-Rokkaku, Kenji, Satake, Yoshinobu, Tsuji, Kazue, Ueda, and Yamaguchi, D.K., 2005, The orphan tsunami of 1700—Japanese clues to a parent earthquake in North America: U.S. Geological Survey Professional Paper 1707, 144 p. [**URL http://pubs.usgs.gov/pp/pp1707/**].

Adams, Peter, and Ruggiero, Peter, 2005, Wave energy dissipation by intertidal sand waves on a mixed-sediment beach, *in* International Conference on Coastal Dynamics, 5th, Barcelona, Spain, April 4-8, 2005, Proceedings: Reston, VA, American Society of Civil Engineers Publications [CD].

Barnes, P.W., and Thomas, J.P., 2005, Benthic habitats and the effects of fishing; American Fisheries Society Symposium 41: Bethesda, MD, American Fisheries Society, 890 p.

Bothner, M.H., 2005, Summary of important findings, *in* Bothner, M.H., and Butman, Bradford, eds., Processes influencing the fate and transport of contaminated sediments in the coastal ocean—Boston Harbor and Massachusetts Bay: U.S. Geological Survey Open-File Report 2005-1250 [URL **http://pubs.usgs.gov/of/2005/1250/**].

Bothner, M.H., Casso, M.A., Lamothe, P.J., Milbert, S.M., and Rendigs, R.R., 2005, Contaminated sediments used to monitor environmental change in Massachusetts Bay and Boston Harbor, *in* Bothner, M.H., and Butman, Bradford, eds., Processes influencing the fate and transport of contaminated sediments in the coastal ocean—Boston Harbor and Massachusetts Bay: U.S. Geological Survey Open-File Report 2005-1250 [URL **http://pubs.usgs.gov/of/2005/1250/**].

Buster, N.A., and Holmes, C.W., 2005, Recent discoveries of elevated Mg within coral skeletons and other applications of laser ablation and the scanning electron microscope [abs.], *in* USGS science in Florida; proceedings of Florida Integrated Science Center Meeting, Orlando, Florida, May 3-5, 2005: U.S. Geological Survey Open-File Report 2005-1213, p. 60 [URL **http://pubs.usgs.gov/of/2005/1213/**].

Butman, B., Bothner, M.H., Martini, M., Borden, J., Rendigs, R.R., and Blackwood, D., 2005, Long-term oceanographic observations, *in* Bothner, M.H., and Butman, Bradford, eds., Processes influencing the fate and transport of contaminated sediments in the coastal ocean—Boston Harbor and Massachusetts Bay: U.S. Geological Survey Open-File Report 2005-1250 [URL **http://pubs.usgs.gov/of/2005/1250/**].

Butman, B., and Valentine, P.C., 2005, High-resolution geologic maps of the sea floor, *in* Bothner, M.H., and Butman, Bradford, eds., Processes influencing the fate and transport of contaminated sediments in the coastal ocean—Boston Harbor and Massachusetts Bay: U.S. Geological Survey Open-File Report 2005-1250 [URL **http://pubs.usgs.gov/of/2005/1250/**].

Butman, B., Warner, J.C., and Bothner, M.H., 2005, Predicting the transport and fate of sediments, *in* Bothner, M.H., and Butman, Bradford, eds., Processes influencing the fate and transport of contaminated sediments in the coastal ocean—Boston Harbor and Massachusetts Bay: U.S. Geological Survey Open-File Report 2005-1250 [URL **http://pubs.usgs.gov/of/2005/1250/**].

Draut, A.E., and Rubin, D.M., 2005, Measurements of wind, aeolian sand transport, and precipitation in the Colorado River corridor, Grand Canyon, Arizona—November 2003 to December 2004: U.S. Geological Survey Open-File Report 2005-1309 [URL **http://pubs.usgs.gov/of/2005/1309/**].

Evans, J.G., Fornari, D., Gilbert, L.Y., Boyle, M., Dougherty, J.A., and Hutchinson, D.R., 2005, Archive of raw bottom photographs collected during Cruise P1-04-GM, Northern Gulf of Mexico, 21-24 June 2004: U.S. Geological Survey Open-File Report 2004-1285, 2 DVD-ROMs [URL **http://woodshole.er.usgs.gov/openfile/of2004-1285/**].

Ferrigno, J.G., Foley, K.M., Swithinbank, C., Williams, R.S., Jr., and Dalide, L.M., 2005, Coastal-change and glaciological map of the Ronne Ice Shelf area, Antarctica; 1974-2002: U.S. Geological Survey Geologic Investigations Series Map I-2600-D, 10 p., scale 1:1,000,000.

Ferrigno, J.G., Williams, R.S., Jr., and Foley, K.M., 2004, Coastal-change and glaciological map of the Saunders Coast area, Antarctica, 1972-1997: Annals of Glaciology, v. 39, p. 245-250.

Gayes, P.T., Schwab, W.C., and Eiser, W.C., 2005, An integrated approach to assessing natural and constructed beach systems; the South Carolina coast, U.S.A., *in* Braun, P., ed., appendix to chap. 7 *of* Port engineering (5th ed.): Boston, Elsevier Butterworth-Heinemann.

Gray, S.C., and Hein, J.R., 2005, Lagoonal reef accretion and Holocene sea-level history from three atolls in the Cook Islands, central South Pacific: Journal of Coastal Research, special issue 42, p. 253-264.

Hickey, T.D., 2005, Geologic evolution of south Florida Pleistocene accumulations with an interpretation of the enigmatic rock-ridge development [abs.], *in* USGS science in Florida; proceedings of Florida Integrated Science Center Meeting, Orlando, Florida, May 3-5, 2005: U.S. Geological Survey Open-File Report 2005-1213, p. 25 [URL **http://pubs.usgs.gov/of/2005/1213/**].

Krebs, J.M., Brame, A.B., and McIvor, C.C., 2005, Habitat use by estuarine fish assemblages; assessing community structure in natural and altered wetlands in Tampa Bay, Florida [abs.], *in* USGS science in Florida; proceedings of Florida Integrated Science Center Meeting, Orlando, Florida, May 3-5, 2005: U.S. Geological Survey Open-File Report 2005-1213, p. 54 [URL **http://pubs.usgs.gov/of/2005/1213/**].

Martini, M., Lightsom, F.S., Sherwood, C.R., Xu, J., Lacy, J.R., Ramsey, A., and Horwitz, R., 2005, Hydratools, a MATLAB® based data processing package for Sontek Hydra data: IEEE/OES/CMTC Current Measurement Technology Conference, 8th, Southampton, UK, June 28-29, 2005, Proceedings, p. 147-151 [abstract online at URL **http://cis.whoi.edu/science/**

(Recently Published continued on page 14)

(Recently Published continued from page 13)

AOPE/cmtc2005/showAbstract.cfm?id=216].

Miller, T.L., Morton, R.A., Sallenger, A.H., and Moore, L.J., 2005, Recent shoreline comparisons, analyses, and preliminary products of the National Assessment of Shoreline Change Project [abs.], *in* USGS science in Florida; proceedings of Florida Integrated Science Center Meeting, Orlando, Florida, May 3-5, 2005: U.S. Geological Survey Open-File Report 2005-1213, p. 45 [URL **http://pubs.usgs.gov/of/2005/1213/**].

Normark, W.R., and Piper, D.J.W., 1998, Preliminary evaluation of recent movement on structures within the Santa Monica Basin, offshore southern California: U.S. Geological Survey Open-File Report 98-518 [URL **http://pubs.usgs.gov/of/1998/of98-518/**].

Pendleton, E.A., Thieler, E.R., and Williams, S.J., 2005, Coastal vulnerability assessment of Dry Tortugas National Park (DRTO) to sea-level rise: U.S. Geological Survey Open-File Report 2004-1416, [URL **http://pubs.usgs.gov/of/2004/1416/**].

Pendleton, E.A., Thieler, E.R., and Williams, S.J., 2005, Coastal vulnerability assessment of Gateway National Recreation Area (GATE) to sea-level rise: U.S. Geological Survey Open-File Report 2004-1257 [URL **http://pubs.usgs.gov/of/2004/1257/**].

Reich, Christopher, Halley, Robert, and Swarzenski, Peter, 2005, Marine groundwater studies in Biscayne National Park, south Florida [abs.], *in* USGS science in Florida; proceedings of Florida Integrated Science Center Meeting, Orlando, Florida, May 3-5, 2005: U.S. Geological Survey Open-File Report 2005-1213, p. 32 [URL **http://pubs.usgs.gov/of/2005/1213/**].

Stockdon, Hilary, and Sallenger, Abby, 2005, Forecasting coastal vulnerability to hurricanes; application to the 2004 hurricane season [abs.], *in* USGS science in Florida; proceedings of Florida Integrated Science Center Meeting, Orlando, Florida, May 3-5, 2005: U.S. Geological Survey Open-File Report 2005-1213, p. 35 [URL **http://pubs.usgs.gov/of/2005/1213/**].

Weber, K., List, J.H., and Morgan, K.L.M., 2005, An operational mean high water datum for determination of shoreline position from topographic lidar data: U.S. Geological Survey Open-File Report 2005-1027 [URL **http://pubs.usgs.gov/of/2005/1027/**].

Williams, R.S., Jr., 2004, Book review of *Bard of Iceland; Jonas Hallgrímsson, Poet and Scientist* by Dick Ringler: Isis, v. 95, no. 4, p. 734.

Williams, R.S., Jr., Ferrigno, J.G., and Foley, K.M., 2005, Coastal-change and glaciological maps of Antarctica: U.S. Geological Survey Fact Sheet 2005-3055 (supersedes USGS Fact Sheet 50-98), 2 p. [URL **http://pubs.usgs.gov/fs/2005/3055/**].

Publications Submitted for Director's Approval

Barnard, P.L., and Hanes, D.M., Bedform morphology under significant wave-tidal current interaction at the mouth of a major tidal inlet, San Francisco, California [abs.]: American Geophysical Union Fall Meeting, San Francisco, CA, December 5-9, 2005.

Brunner, C.A., Planktonic foraminiferal biostratigraphy of a latest Quaternary core, MD02-2570, from the northern Gulf of Mexico, *in* Winters, W.J., Lorenson, T.D., Paull, C.K., eds., Initial report of the IMAGES VIII/PAGE 127 gas hydrate and paleoclimate cruise on the R/V *Marion Dufresne* in the Gulf of Mexico, 2-18 July 2002: U.S. Geological Survey Open-File Report 2004-1358.

Cross, V.A., Twichell, D.C., Halley, R.B., Ciembronowicz, K.T., Jarrett, B.D., Hammar-Klose, E.S., Hine, A.C., Locker, S.D., and Naar, D.F., GIS compilation of data collected from the Pulley Ridge deep coral reef region: U.S. Geological Survey Open-File Report 2005-1089, DVD-ROM.

Dartnell, Peter, Foxgrover, Amy, and Jaffe, Bruce, Visualizing south San Francisco Bay tidal flats, marshes, wetlands, and channels using airborne lidar data [abs.]: Biennial State of the San Francisco Estuary Conference, 7th, Oakland, CA, October 4-6, 2005.

Geist, E.L., Titov, V.V., Arcas, Diego, Pollitz, Fred, and Bilek, S.L., What can we learn from the December 26, 2004, Sumatra earthquake to improve tsunami hazard assessment models? [abs.]: American Geophysical Union Fall Meeting, San Francisco, CA, December 5-9, 2005.

Guy, K.K., Automated extraction of coastal dune high and dune low from high-resolution lidar digital elevation models: U.S. Geological Survey Open-File Report.

Hastings, M.E., Poppe, L.J., Hathaway, J.C., and Reid, J.M., USGS east coast sediment texture database, *in* Poppe, L.J., Williams, S.J., and Paskevich, V.F., eds., USGS east-coast sediment analysis; procedures, database, and GIS data: U.S. Geological Survey Open-File Report 2005-1001.

Helgerud, M.B., Waite, W.F., Stern, L.A., and Kirby, S.H., Effects of fracture and crack healing in sI methane and sII methane-ethane gas hydrate [abs.]: American Geophysical Union Fall Meeting, San Francisco, CA, December 5-9, 2005.

Hutchinson, D.R., Childs, J.R., Edgar, T., Barth, G., Hammar-Klose, E.S., Dadisman, S.V., and Rowland, R., Geological and sediment thickness data sources from the U.S. continental margins [abs.]: American Geophysical Union Fall Meeting, San Francisco, CA, December 5-9, 2005.

Hutchinson, D.R., Snyder, F., Hart, P.E., Ruppel, C.D., Pohlman, J., Wood, W., Coffin, R.B., and Edwards, K.M., Geologic and site survey setting for JIP Gulf of Mexico gas hydrate drilling [abs.]: American Geophysical Union Fall Meeting, San Francisco, CA, December 5-9, 2005.

(Publications Submitted continued on page 15)

(Publications Submitted continued from page 14)

Jaffe, B.E.; Borrero, J.C.; Prasetya, G.S.; Dengler, Lori; Gelfenbaum, Guy; Hidayat, Rahman; Higman, Bretwood; Kingsley, Etienne; Lukiyanto; McAdoo, Brian; Moore, Andrew; Morton, Robert; Peters, Robert; Ruggiero, Peter; Titov, Vasily; Kongko, Widjo; and Yulianto, Eko, Field surveys of the effects of the 26 December 2004 and 28 March 2005 tsunamis and earthquakes in Indonesia [abs.]: American Geophysical Union Fall Meeting, San Francisco, CA, December 5-9, 2005.

Kayen, Robert, Carkin, Brad, Minasian, Diane, and Tinsley, John, Shear wave velocity of the ground underlying southern California TRINET sites using the spectral analysis of surface waves method (SASW) and parallel-arrayed harmonic-wave sources: U.S. Geological Survey Open-File Report.

Kayen, Robert, Pack, R.T., Bay, James, Sugimoto, Shigetoshi, and Tanaka, Hajime, Ground-LIDAR reconnaissance of the Niigata Ken Chuetsu, 23 October 2004, earthquake: Earthquake Spectra.

Kayen, Robert, Pack, R.T., Bay, James, Sugimoto, Shigetoshi, and Tanaka, Hajime, LIDAR investigation of the 2004 Niigata Ken Chuetsu earthquake [abs.]: American Geophysical Union Fall Meeting, San Francisco, CA, December 5-9, 2005.

Kayen, Robert, Thompson, Eric, Minasian, Diane, and Carkin, Brad, Shear wave velocity of the ground near sixty California strong motion recording sites using the spectral analysis of surface waves (SASW) method and harmonic wave sources: U.S. Geological Survey Open-File Report.

Meckel, T.A., ten Brink, U.S., and Williams, S.J., Estimates of current rates of surface elevation change due to compaction of shallow sediments in the Louisiana delta plain: Geology.

Paskevich, V.F., and Poppe, L.J., Data catalog of surficial sediments, *in* Poppe, L.J., Williams, S.J., and Paskevich, V.F., eds., USGS east-coast sediment analysis; procedures, database, and GIS data: U.S. Geological Survey Open-File Report 2005-1001.

Poppe, L.J., Eliason, A.H., Fredericks, J.J., Rendigs, R.R., and Blackwood, D.S., Grain-size analysis of marine sediments; methodology and data processing, *in* Poppe, L.J., Williams, S.J., and Paskevich, V.F., eds., USGS east-coast sediment analysis; procedures, database, and GIS data: U.S. Geological Survey Open-File Report 2005-1001.

Poppe, L.J., Williams, S.J., and Paskevich, V.F., Textural analysis of marine sediments from off the U.S. East Coast; methodology and data on DVD: Joint Eighth Federal Interagency Sedimentation Conference and Third Federal Interagency Hydrologic Modeling Conference, Reno, NV, April 2-6, 2006, Proceedings.

Reid, J.M., Reid, J.A., Jenkins, C.J., Hastings, M.E., Williams, S.J., and Poppe, L.J., usSEABED; Atlantic coast offshore surficial sediment data release: U.S. Geological Survey Data Series 118 (ver. 1), CD-ROM.

Rodgers, K.S., Jokiel, P.L., Smith, W.R., Farrell, F., and Uchino, K., Biological survey in support of the USGS turbidity and sediment baseline survey on the South Molokai reef flat: U.S. Geological Survey Open-File Report 2005-1361.

Sallenger, A.H., Wright, C.W., and Lillycrop, J., Coastal impacts of the 2004 hurricanes measured with airborne lidar; initial results: Shore and Beach, special issue.

ten Brink, U.S., and Geist, E.L., Size distribution of submarine landslides and its implication to tsunami probability [abs.]: American Geophysical Union Fall Meeting, San Francisco, CA, December 5-9, 2005.

ten Brink, U.S., Song, J., and Bucknam, R.C., Rupture parameters for the pre-historic Seattle fault earthquake from modeling shoreline change: Geology.

Warrick, J.A., Gelfenbaum, Guy, Johannessen, Jim, Beirne, Matt, and Winter, Brian, Dam removal as nearshore restoration—patterns and processes of the Elwha River delta [abs.]: American Geophysical Union Fall Meeting, San Francisco, CA, December 5-9, 2005.

Winters, W.J., Waite, W.F., and Mason, D.H., Effect of methane gas hydrate formation on pore pressure response, shear strength, and acoustic properties of sediment [abs.]: American Geophysical Union Fall Meeting, San Francisco, CA, December 5-9, 2005.