USGS

Sound Waves Coastal Science and Research News from Across the USGS

http://soundwaves.usgs.gov/

Fieldwork

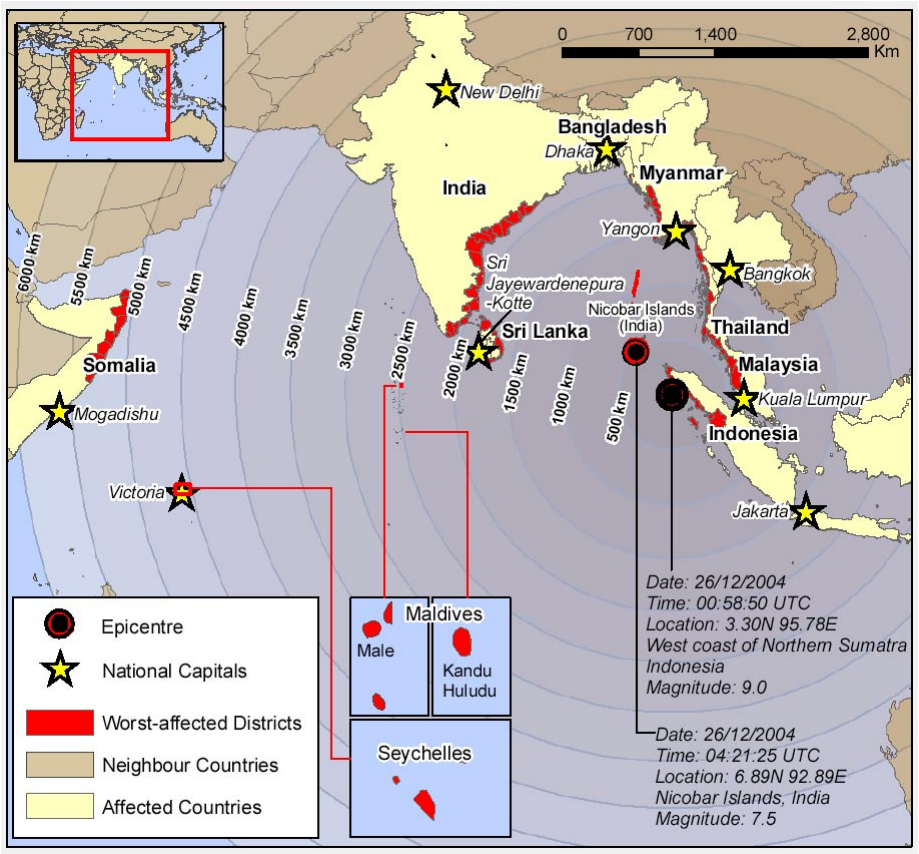
Indian Ocean Earthquake Triggers Deadly Tsunami

By Bruce Jaffe, Eric Geist, and Helen Gibbons

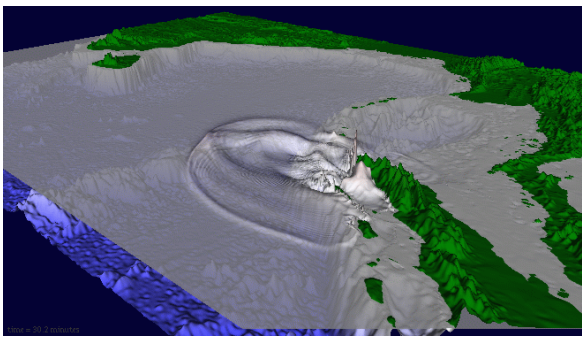
U.S. Geological Survey (USGS) scientists are assessing preliminary data and beginning more detailed studies of the devastating tsunami that lashed coasts around the Indian Ocean on December 26, 2004. The large tsunami waves were generated by a magnitude 9.0 earthquake off the northwest coast of Indonesia's island of Sumatra. The earthquake occurred on the interface between the India and Burma tectonic plates where the India plate subducts beneath the overriding Burma plate. USGS scientists estimate that the sea floor in the vicinity of the earthquake was uplifted by several meters. Displacement of water above the sea floor triggered the tsunami, which caused catastrophic levels of destruction in countries around the Indian Ocean basin—even as far as the east coast of Africa—with Indonesia, Sri Lanka, India, Thailand, Somalia, Maldives, Malaysia, Myanmar, Tanzania, Bangladesh, and Kenya among the countries hardest hit. The death toll reported by the Associated Press on January 10, 2005, was more than 150,000 and expected to rise.

The tsunami arrived in northern Sumatra approximately 1/2 hour after the earthquake, in Thailand approximately 1 1/2 to 2 hours after the earthquake, and in Sri Lanka approximately 2 to 3 hours after the earthquake. According to initial modeling and eyewitness accounts, areas east of the earthquake rupture, or "generation area," were first affected by a negative wave (drawdown of water and retreat from shore before a rise in water), whereas areas west of the generation area were first affected by a positive wave (no drawdown or retreat of water before the first tsunami wave hit). Maximum wave heights estimated from media reports

(Tsunami continued on page 2)



*Areas affected by the 2004 Indian Ocean tsunami (excerpt from map produced by the Relief Web Map Centre [URL **http://www.reliefweb.int/w/map.nsf/home?OpenForm**], Office for the Coordination of Humanitarian Affairs, United Nations, Jan. 5, 2005).*



*Waves heights are greatly exaggerated relative to water depth in this computer model of the December 26, 2004, Indian Ocean tsunami (frame from an animation that will soon be posted at URL **http://walrus.wr.usgs.gov/tsunami/**). Image shows the tsunami 30 minutes after it was triggered by the earthquake. Land areas are green, with Sumatra to the right of the tsunami and India and Sri Lanka at the top of the image. The ocean floor is gray (blue in the cutaway at bottom left), with light shading to show its bathymetry. Heights of waves and sea-floor features have been vertically exaggerated to make details easier to see.*

Sound Waves

Editor
Helen Gibbons
Menlo Park, California
Telephone: (650) 329-5042
E-mail: hgibbons@usgs.gov
Fax: (650) 329-5190

Print Layout Editors
Susan Mayfield, Sara Boore
Menlo Park, California
Telephone: (650) 329-5066
E-mail: smayfiel@usgs.gov; sboore@usgs.gov
Fax: (650) 329-5051

Web Layout Editor
Jolene Shirley
St. Petersburg, Florida
Telephone: (727) 803-8747 Ext. 3038
E-mail: jshirley@usgs.gov
Fax: (727) 803-2032

SOUND WAVES (WITH ADDITIONAL LINKS) IS AVAILABLE ONLINE AT URL
http://soundwaves.usgs.gov/

Contents

Submission Guidelines

Deadline: The deadline for news items and publication lists for the March 2005 issue of *Sound Waves* is Friday, February 11.
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).

Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

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**

Fieldwork, continued

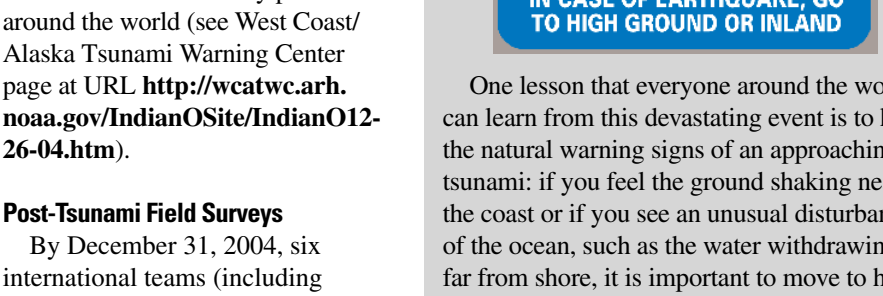
(Tsunami continued from page 1)

are Sumatra, 10 to 15 m; Sri Lanka, 5 to 10 m; India, 5 to 6 m; Andaman Islands, 5 m; Thailand, 3 to 5 m; and Kenya, 2 to 3 m. Some energy from the tsunami "leaked" into adjoining oceans, producing sea-level fluctuations at many places around the world (see West Coast/Alaska Tsunami Warning Center page at URL **http://wcatwc.arh.noaa.gov/IndianOSite/IndianO12-26-04.htm**).

Post-Tsunami Field Surveys

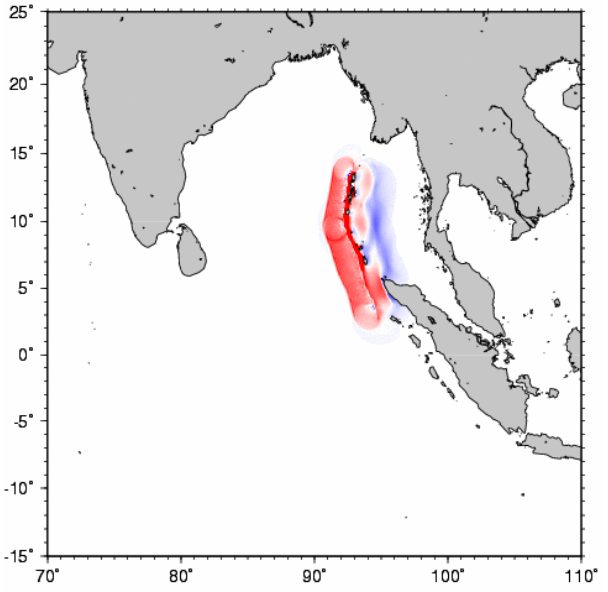
By December 31, 2004, six international teams (including Japanese and American teams) had been formed to document the magnitude and effects of the tsunami before the evidence is destroyed. Typically, such teams arrive in the affected areas about one to three weeks after the tsunami occurs. Because this was the largest tsunami in more than 40 years and the area affected is very large, there could be as many as a dozen international teams investigating the tsunami. USGS oceanographer **Bruce Jaffe** and USGS geologist **Bob Morton** traveled to Sri Lanka from January 7 to 16 with an international team funded by the National Science Foundation

(Tsunami continued on page 3)



One lesson that everyone around the world can learn from this devastating event is to heed the natural warning signs of an approaching tsunami: if you feel the ground shaking near the coast or if you see an unusual disturbance of the ocean, such as the water withdrawing far from shore, it is important to move to high ground. Because of the complex behavior of tsunami waves near the coast, the first wave of a tsunami is generally not the largest, emphasizing the importance of staying away from the coast until wave activity has subsided (commonly several hours or even days).

For a discussion of tsunamis that have hit the United States, plus links to Web sites with general information about tsunamis and what to do during a tsunami warning, please see the article "Could It Happen Here?" in this issue. For lessons learned from the stories of people who have survived tsunamis, please see USGS Circular 1187, "Surviving a Tsunami—Lessons from Chile, Hawaii, and Japan," available at URL **http://pubs.usgs.gov/circ/c1187/** (PDF files in English and Spanish can be accessed from this site).



*Frame from a computer animation of the December 26, 2004, Indian Ocean tsunami (animation can be viewed at URL **http://staff.aist.go.jp/kenji.satake/animation.gif**). Frame shows the tsunami 10 minutes after it was triggered by the earthquake. Red represents a positive wave (crest arrives first), and blue represents a negative wave (trough arrives first—drawdown warns of approaching crest of tsunami wave). Deeper colors represent larger wave heights. (Note: This model shows a longer wave front than the oblique-perspective model, because the modeler assumed a longer fault rupture as the tsunami trigger. Seismologists are still sifting through the evidence to determine the length of the deep rupture that caused the earthquake and subsequent tsunami.)*

(Tsunami continued from page 2)

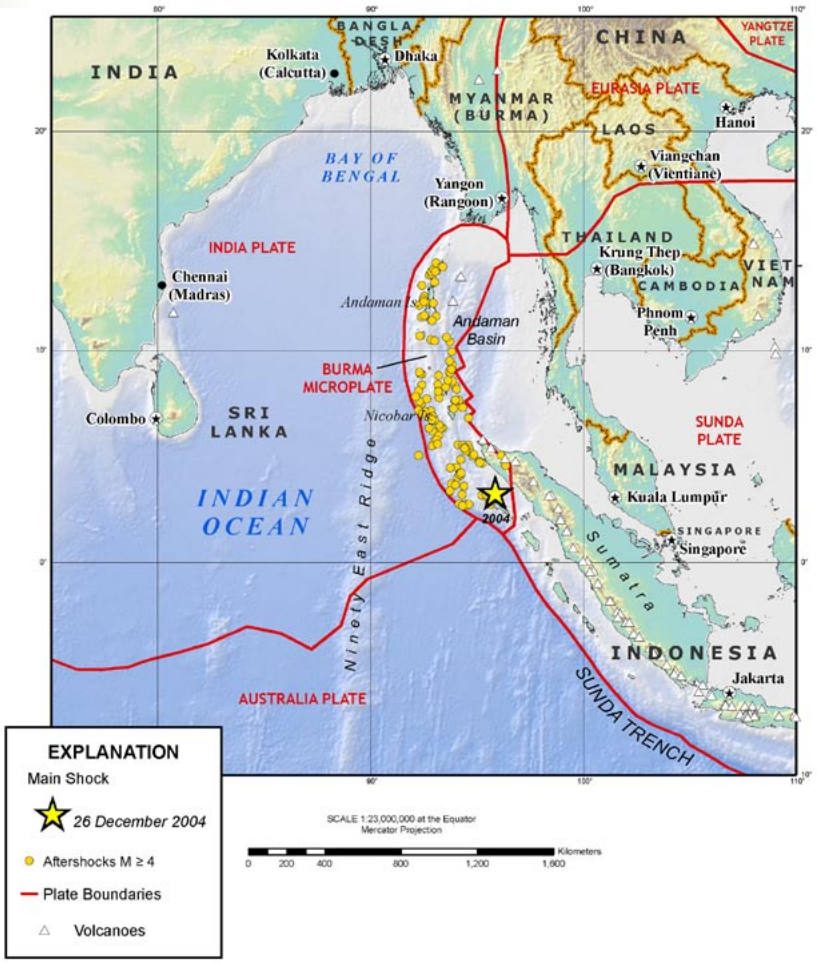
and the USGS to examine inundation areas, estimate wave heights, determine the tsunami's precise arrival time, scour the area for geologic evidence and sedimentary deposits, and examine structural damage. As of this writing, the USGS had also been invited to have scientists participate in post-tsunami surveys in India, Thailand, and Sumatra.

Ideally, post-tsunami surveys will include both a quick response focusing on ephemeral evidence and a later response (possibly in February or March) focusing on tsunami sedimentation and erosion. The quick response will include measurements of water levels, inundation distances (horizontal distance from the shoreline to the farthest inland reach of the tsunami), and indicators of the tsunami's flow direction and flow velocity. The later response will focus on the sediment deposited by the tsunami: whether it has characteristics that reflect those of the tsunami itself, such as its height, power, and extent; how much of the sediment is likely to be preserved in the geologic record; and how much is likely to be eroded away. The more we learn about sedimentary deposits from modern tsunamis, the more accurately we can identify and decipher sedimentary deposits from ancient tsunamis. Because scientists cannot yet predict when a tsunami will occur, learning to read a geologic record of past tsunamis may be one of the only ways to assess future risk.

USGS scientists have conducted such studies of sediment deposited by recent tsunamis in Papua New Guinea (tsunami of 1998, see URL **http://walrus.wr.usgs.gov/tsunami/itst.html**) and Peru (tsunami of 2001, see URL **http://walrus.wr.usgs.gov/peru2/**). They are working to determine how sediment layers deposited by tsunamis differ from those deposited by large storms, such as hurricanes, to aid identification of tsunami deposits in the geologic record (see article in *Sound Waves*, October 2002, at URL **http://soundwaves.usgs.gov/2002/10/**.

Tsunami Information on the Web

Many Web sites have information about the Indian Ocean tsunami and tsunamis in general. Here are a few particularly useful ones:



*Tectonic setting of the magnitude 9.0 earthquake that generated the tsunami (from link at URL **http://earthquake.usgs.gov/eqinthenews/2004/usslav/**). The earthquake occurred at the interface between the India and Burma tectonic plates and was caused by the release of stresses that develop as the India plate subducts beneath the overriding Burma plate. USGS scientists estimate that during the deep thrust faulting that generated the earthquake, in which rock on one side of the fault moved up and over rock on the other side, the sea floor above the fault was uplifted by several meters. Displacement of overlying seawater triggered the tsunami. The world's largest recorded earthquakes have all been megathrust events, occurring where one tectonic plate subducts beneath another. For a list of examples and more information about the characteristics of the Indian Ocean earthquake, please visit URL **http://neic.usgs.gov/neis/bulletin/neic_slav_ts.html.***

- USGS Northern Sumatra Earthquake event page: **http://earthquake.usgs.gov/eqinthenews/2004/usslav/**
- USGS site, with basic tsunami information: **http://walrus.wr.usgs.gov/tsunami/basics.html**
- Pacific Marine Environmental Lab (PMEL): **http://www.pmel.noaa.gov/tsunami/home.html**
- Russian Tsunami Laboratory: **http://tsun.sscc.ru/tsulab/20041226.htm**
- UNESCO site, with animation and links to additional news stories: **http://ioc.unesco.org/itsu/**
- International Research Institute for Climate Prediction site, with scientific background on the Indian Ocean earthquake and tsunami: **http://iri.columbia.edu/~lareef/tsunami/**
- USGS Circular 1187, "Surviving a Tsunami—Lessons from Chile, Hawaii, and Japan" (also available in Spanish): **http://pubs.usgs.gov/circ/c1187/**
- USGS site addressing the question "Can it happen here in the United States?": **http://earthquake.usgs.gov/eqinthenews/2004/usslav/canit.html** (summarized in article "Could It Happen Here?," this issue)❁

Could It Happen Here? Tsunamis That Have Struck U.S. Coastlines

By Eric Geist, Paul Earle, and Jill McCarthy

Soon after the destructive tsunami in the Indian Ocean on December 26, 2004, many people asked, could such a tsunami happen in the United States? Information about tsunamis that have struck U.S. coasts in the past, summarized briefly here and in more detail at URL **http://earthquake.usgs.gov/eqinthenews/2004/usslav/canit.html**, provide a foundation for estimating tsunami likelihood in the future.

*Damage in Hawai'i from a tsunami generated by a 1946 earthquake in the Aleutian Islands, AK, included wreckage of a political-party clubhouse, pictured here, on Kamehameha Avenue, Hilo, HI. Every house on the main street facing Hilo Bay was washed across the street and smashed against the buildings on the other side. Houses were overturned, railroads ripped from their roadbeds, coastal highways buried, and beaches washed away. The waters off the island were dotted with floating houses, debris, and people. Property damage in Hawaii was $255 million in today's dollars. Photograph by U.S. Army Corps of Engineers (from URL **http://www.ngdc.noaa.gov/seg/hazard/slideset/25/25_slides.shtml**).*

What Is a Tsunami?

A tsunami is a set of powerful ocean waves most commonly caused by a large earthquake or landslide that occurs near or under the ocean. Scientists do not use the term "tidal wave" because these waves are not caused by tides. Tsunami waves are unlike typical ocean waves generated by wind and storms. When tsunami waves approach shore, they behave like a very fast-moving tide that extends far inland. A rule of thumb is that if you see the tsunami, it is already too late to outrun it. Most tsunamis do not "break" like the curling, wind-generated waves popular with surfers. Even "small" tsunamis (for example, 6 ft high) are associated with extremely strong currents, capable of knocking people off their feet. As with many natural phenomena, tsunamis can range in size from micro-tsunamis detectable only by sensitive instruments on the ocean floor to mega-tsunamis that can affect the coastlines of entire oceans, such as the Indian Ocean tsunami of 2004.

Because of complex interactions with the coast, tsunami waves can persist for many hours. If you hear a tsunami warning or if you feel strong shaking at the coast or observe highly unusual wave activity (for example, the sea withdrawing far from shore), it is important to move to high ground and stay away from the coast until wave activity has subsided (generally several hours to days).

For more general information on tsunamis and what to do during a tsunami warning, please visit the Web sites sponsored by the Federal Emergency Management Agency (FEMA, URL **http://www.fema.gov/areyouready/tsunamis.shtm**), the National Weather Service (URL **http://www.nws.noaa.gov/om/brochures/tsunami.htm**), State agencies (links at URL **http://www.wsspc.org/tsunami/tsunamilinks.html**), the National Oceanic and Atmospheric Administration (NOAA, URL **http://www.pmel.noaa.gov/tsunami/**), and the U.S. Geological Survey (USGS, URL **http://walrus.wr.usgs.gov/tsunami/**). For tips from the stories of people who have survived tsunamis, please see USGS Circular 1187, "Surviving a Tsunami—Lessons from Chile, Hawaii, and Japan," at URL **http://pubs.usgs.gov/circ/c1187/** (PDF files in English and Spanish can be downloaded from this site).

Data We Can Use to Answer the Question "Could It Happen Here?"

Three primary sources of information can be used to answer the question "Could it happen here?": (1) tsunami catalogs of historical events, (2) the age of geologic deposits left by great earthquakes and tsunamis (see related article in *Sound Waves*, October 2002, at URL **http://soundwaves.usgs.gov/2002/10/index.html**), and (3) computer simulations of tsunamis from potential great earthquakes and landslides around the world. This article focuses on the first source, historical information, taken mainly from the worldwide catalog of historical tsunamis maintained by NOAA's National Geophysical Data Center (NGDC). This catalog includes two types of measurements: runup observations from eyewitness accounts, and wave-height readings from tide-gauge stations, most often located in harbors. The term "runup" refers to the vertical height a wave reaches above sea level as it washes ashore, "wave height" to the vertical measurement of the wave before it reaches shore, and "inundation distance" to the horizontal distance a tsunami reaches landward from the shoreline. More information on tsunami measurements can be found on the NGDC Tsunami Introduction Page at URL **http://www.ngdc.noaa.gov/seg/hazard/tsuintro.shtml**.

Hawai'i

Hawai'i has a long recorded history of tsunamis—both "teletsunamis" (also called "far-field tsunamis") from earthquakes around the Pacific rim, and "local tsunamis" from earthquakes and landslides near Hawai'i. The Pacific Disaster Center (URL **http://www.pdc.org**) reports that tsunamis have accounted for more lost lives in Hawai'i than the total of all other local

(U.S. Tsunamis continued on page 5)

(U.S. Tsunamis continued from page 4)

disasters. In the 20th century, an estimated 221 people were killed by tsunamis on the islands of Hawai'i. One of the largest and most devastating tsunamis that Hawai'i has experienced was a teletsunami in 1946 from an earthquake along the Aleutian subduction zone. Runup heights reached a maximum of 33 to 55 ft and 159 people were killed. Damage was more than $26 million ($255 million in today's dollars). Other important teletsunamis include one from the 1960 magnitude 9.5 earthquake in southern Chile and one from the 1964 magnitude 9.2 earthquake in the Gulf of Alaska. The May 22, 1960, Chile earthquake generated a 35-ft-high wave, causing 61 deaths and $23 million damage (about $150 million in today's dollars). Hawai'i has also been hit by local tsunamis, primarily from earthquakes and large-scale subsidence along the south flank of Kilauea.

Alaska

Because Alaska, including the Aleutian Islands, is bordered on the south by a major subduction zone capable of generating large earthquakes, Alaska has sustained many damaging tsunamis. By far, the one that stands out is the tsunami generated by the 1964 magnitude 9.2 earthquake in the Gulf of Alaska. Not only was a Pacific-wide tsunami generated by this great earthquake, but landslides in coastal fiords, such as Port Valdez, also generated localized, extremely damaging waves. The 1964 tsunami caused damage and loss of life across the Pacific. The West Coast & Alaska Tsunami Warning Center in Palmer, AK (URL **http://www.wcatwc.gov/64quake.htm**), indicates that the 1964 tsunami was the most disastrous tsunami to hit the U.S. west coast, causing many fatalities and financial losses.

U.S. West Coast

The historical record of tsunamis along the U.S. west coast consists mainly of teletsunamis generated by large earthquakes around the Pacific Rim. Of the teletsunamis that have struck the West Coast, the 1964 Gulf of Alaska tsunami caused the most extensive damage, particularly in Crescent City, CA, where at least 10 deaths occurred. Potentially tsunamigenic fault structures exist locally offshore the U.S. west coast, most notably the Cascadia subduction zone—an offshore fault system about 1,200 km (750 mi) long that extends from northern California to southern Canada and accommodates motion between the Pacific and North American tectonic plates at a rate of about 40 mm/yr (1.6 in./yr). This subduction zone is believed to have most recently ruptured in a magnitude 9.0 earthquake in 1700; the resulting tsunami was recorded in historical accounts in northern Japan. Geologic evidence of submerged vegetation indicates that large or great earthquakes (magnitude 8 to 9) have occurred on average every 500 years along this zone. Great ruptures

(U.S. Tsunamis continued on page 6)

*Damage from a tsunami generated by the magnitude 9.2 earthquake of March 27, 1964, in Prince William Sound, Alaska. In this view of the north end of Resurrection Bay at Seward, AK, about 75 km from the epicenter, a beached ship, a demolished Texaco chemical truck, and a torn-up dock strewn with logs and scrap metal are visible. At Seward, a community of about 2,300, a section of the waterfront slid into Resurrection Bay. Waves spread in all directions, destroying the Alaska railroad docks, washing out railroad and highway bridges, and piling railroad rolling stock into giant windrows of wreckage. The waves spread flaming petroleum over the waterfront, igniting the rolling stock, the electrical-generation plant, and some residences. Resurrection Bay sustained $14.6 million in damage, and 11 fatalities occurred in the Seward area. Photograph by U.S. Department of the Interior (from URL **http://www.ngdc.noaa.gov/seg/hazard/slideset/25/25_slides.shtml**).*

*Lisbon, Portugal, during the great earthquake of November 1, 1755. This copper engraving, made that year, shows a local tsunami destroying wharves on the shore and disturbing water in the harbor, where many ships sank. Teletsunamis were reported in Newfoundland (Canada) and islands in the Caribbean. (Image from URL **http://en.wikipedia.org/wiki/Image:1755_Lisbon_earthquake.jpg**.)*

(U.S. Tsunamis continued from page 5)

along this subduction zone would most likely cause local and possibly oceanwide tsunamis that could affect the Western United States.

U.S. Gulf Coast

In historical times, tsunami waves recorded along the Gulf Coast have all been less than 1 m high. Those reported from the 1964 Gulf of Alaska earthquake as felt in Louisiana and Texas are technically termed seiches—oscillations of a body of water typically caused by atmospheric disturbances but in this case caused by ground motion from the earthquake. Seiches can also occur in lakes from earthquake movements.

U.S. East Coast

Because the only major subduction zones in the Atlantic Ocean are along the Caribbean Sea, tsunamis have been relatively infrequent here in comparison with the Pacific Ocean. The most famous Atlantic tsunami was the 1755 Lisbon tsunami, generated by an earthquake on a fault offshore Portugal. Teletsunamis from that earthquake were reported in Newfoundland (Canada) and islands in the Caribbean Sea. The most noteworthy local tsunami in North America resulted from the 1929 magnitude 7.3 Grand Banks earthquake near Newfoundland. In this complex event, most, if not all, of the tsunami energy may have been triggered by a submarine landslide. The maximum tsunami runup was 2 to 7 m, which was concentrated on the coast of Newfoundland, although it was recorded as far south as South Carolina. A couple of tsunamis reported from Caribbean earthquakes had runups less than 1 m.

Puerto Rico and the U.S. Virgin Islands

Puerto Rico and the U.S. Virgin Islands are more susceptible than other places in the Eastern United States, because a subduction zone capable of generating large earthquakes lies beneath the Caribbean Sea. Tsunamis have struck Puerto Rico and the Virgin Islands more than six times in recorded history. The tsunami with the greatest amount of damage in Puerto Rico was generated in 1918 by an earthquake off the Mona Passage, east of the island. With a maximum runup of 6 m, the tsunami itself killed 40 people; an additional 76 people were killed by the earthquake. The Caribbean region as a whole has a history of earthquakes that have caused damaging tsunamis. (See article in *Sound Waves*, June 2004, at URL **http://soundwaves.usgs.gov/2004/06/meetings.html**.)

Other U.S. Territories

Other territories of the United States are adjacent to large subduction zones. Guam and the Marianas Islands are next to the Marianas Trench. American Samoa is affected by earthquakes about 100 mi away along the Tonga-Kermadec Trench.

Acknowledgments

These historical reports are based largely on the tsunami catalog maintained by the NGDC (URL **http://www.ngdc.noaa.gov/ngdc.html**). In addition we have used information from the Pacific Tsunami Warning Center (URL **http://www.prh.noaa.gov/ptwc/**) and the Pacific Disaster Center (URL **http://www.pdc.org/**).

Deltaic Habitats in Puget Sound—Natural Versus Human-Related Change

By Eric Grossman

River deltas provide essential habitat to many terrestrial, avian, estuarine, and marine species of ecological, cultural, and commercial importance. Sediment and large woody debris supplied by the many rivers in Puget Sound form a large proportion of the sound's nearshore geologic framework for important estuarine ecosystems—including wetlands, marsh channels, and eelgrass meadows. Such environments in Puget Sound have undergone rapid deterioration and loss of habitat because of alterations to streamflow, sediment delivery, and water quality through damming, land clearing and drainage, and shoreline hardening (construction of dikes, seawalls) for agricultural development.

Of all the rivers flowing into Puget Sound, the Skagit River contributes the greatest amount of freshwater. Despite sustaining an approximately 70-percent loss of salmon-rearing habitat since the 1880s, the Skagit River and Delta complex supports the largest salmon run in Puget Sound and is the only river system in the lower 48 States that is home to all five species of Pacific salmon.

In March and September 2004, U.S. Geological Survey (USGS) scientists partnered with Federal, State, academic, and nongovernmental-organization scientists and resource managers to conduct surveys in the Skagit Delta and the San Juan Islands. The goals of this research, which is part of the USGS Coastal Habitats in Puget Sound Project, are to characterize (1) the geologic framework for deltaic ecosystem structure and (2) the hydrodynamic, sedimen-

(Deltaic Habitats continued on page 7)

Puget Sound region, showing the Skagit River and Skagit Delta study area (right box) and the San Juan Island study area (left box).

(Deltaic Habitats continued from page 6)

tary, and biogeochemical processes that influence ecosystem functions in deltaic and coastal environments. The Skagit Delta and San Juan Island areas were selected for two reasons: (1) they lie along a gradient in sediment inputs and human land-use activities that are adversely affecting nearshore habitats, and (2) they have ongoing and planned restoration projects that require scientific understanding of the natural processes that shape estuarine habitat. This work supports many needs of the Puget Sound science community and specifically the goals of the Puget Sound Restoration Program, a cooperative effort among government organizations, Native American tribes, and industry and environmental organizations to preserve and restore the health of Puget Sound's nearshore habitat (see URL **http://www.pugetsoundnearshore.org/**).

USGS research in the Skagit Delta is focusing on Fir Island and the delta front, where historical changes to habitat structure are suspected to be limiting salmon survival. These settings continue to respond to landscape alterations, including restoration projects and the largest dike-removal project in North America, completed at Deepwater Slough in 2000. Research in the San Juan Islands is targeting sites on San Juan, Shaw, and Orcas Islands, where extensive eelgrass declines and die-offs that have been documented in recent years are poorly understood. Here, nearshore environments are fed sediment and nutrients from small, semiarid, and lightly developed watersheds.

USGS research vessel Karluk.

Ground-penetrating-radar system. Transceivers and receivers are towed on a cart behind a handpushed buggy carrying the data-acquisition equipment, including power supply, electronics, and laptop computer. This system is effective for imaging the subsurface over large distances in areas with little or no vegetation. The instruments can also be carried by hand over more rugged or highly vegetated terrain.

Field Activities and Methods

In March 2004, **Eric Grossman**, **Larry Kooker**, **Mike Boyle**, **Andy Stevenson**, and **Bill Danforth** collected approximately 40 km of high-resolution bathymetric and backscatter data along the North Fork Skagit River and delta front, using a 234-kHz Submetrix interferometer swath-sonar system in water depths of 2 to 20 m aboard the USGS research vessel *Karluk*. To ground-truth this data and map eelgrass coverage, ship-tow video was collected along the delta front from a 17-ft Boston Whaler with the assistance of **Greg Hood** of the Skagit River System Cooperative.

We collected samples of surface sediment and eelgrass along a gradient between high and low eelgrass coverage for sedimentologic and geochemical analyses to explore possible sediment controls on eelgrass distribution and to test for the presence of eelgrass biomarkers—chemical compounds whose abundance in the sediment may vary in proportion to eelgrass coverage. If such compounds are identified, they will be measured in older, deeper sedimentary layers to determine where and how abundantly eelgrass grew in the past. Vibracores ranging from 3 to 4 m in length were collected from the North Fork Skagit River marsh and tidal flats, and sediment and detrital wood were subsampled from three 10-m-deep auger holes in the South Fork Skagit River marsh. We imaged the morphology and distribution of old marsh and tidal channels buried below agricultural fields by using ground-penetrating radar. Surface-sediment grain-size measurements were made at 160 sites across the tidal flats to establish baseline data for examining sediment transport.

In September, **Renee Takesue** and **Eric Grossman** sampled water, surface sediment, eelgrass, and marsh and aquatic vegetation for geochemical analyses. They recovered more than 50 m of material in 26 vibracores in marsh and nearshore areas to develop histories of change in sedimentation, fauna, contaminants, and eelgrass biomarkers. With the help of **Rob Kayen**, **Guy Gelfenbaum**, **Jodi Eshleman**, and **Greg Hood**, they used a portable Riegl laser scanner to acquire baseline high-resolution topographic data in areas undergoing rapid erosion. They also mapped and sampled a recent flood deposit within the recently restored marsh of Deepwater Slough.

(Deltaic Habitats continued on page 8)

***Renee Takesue** extracting vibracore.*

(Deltaic Habitats continued from page 7)

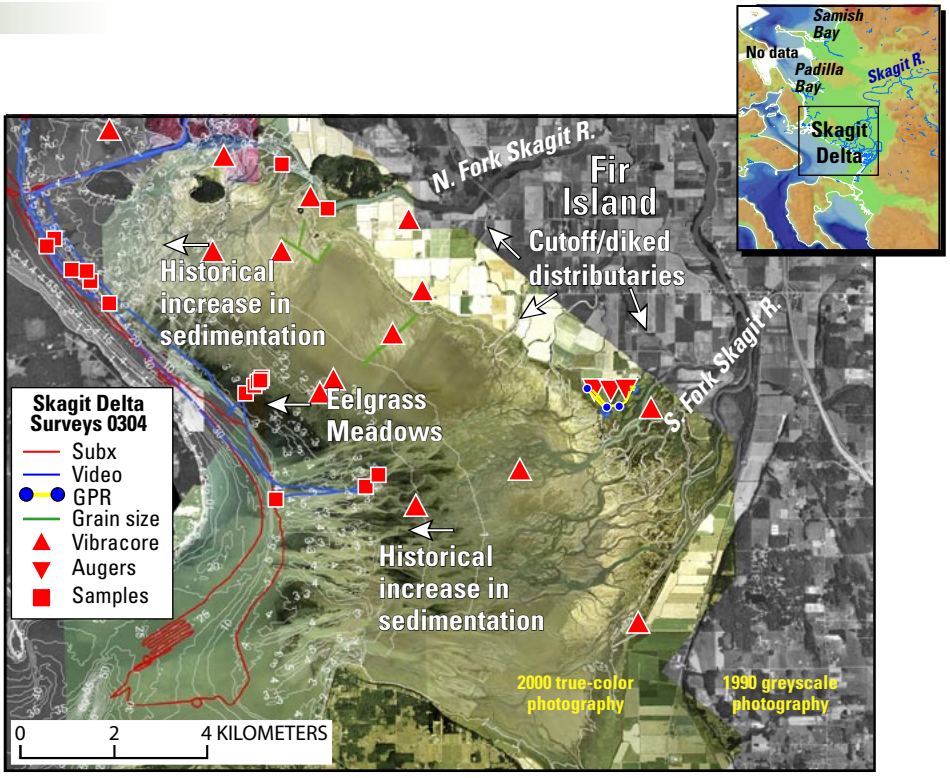
Preliminary Results

Aerial photography of the Skagit Delta illustrates the staggering change occurring to marsh-channel and eelgrass environments as a result of the shoreline hardening of Fir Island. Historically, many distributaries flowed across Fir Island and distributed flow and sediment evenly along its shore. Diking has focused flow into fewer channels, leading to an increase in sediment delivery to the delta front at the mouths of the North and South Forks of the Skagit River and a decrease along the central part of Fir Island. In aerial photographs and in ship-tow video, this focusing of sediment can be seen to be burying eelgrass and fragmenting it into patches.

Samples from vibracores obtained at the delta front also show significantly coarser sediment overlying much finer material below, consistent with a recent change in sediment source. These samples are being analyzed and radiometrically dated to determine whether this lithologic transition represents an abrupt change in depositional history and whether the timing and new sediment source are associated with human land-use activities (for example, increased sediment runoff, focusing of flow) or natural climatic or geologic processes.

Ground-penetrating-radar imagery collected in the marsh near the mouth of the South Fork Skagit River reveals evidence of marsh and tidal channels buried below modern agricultural fields and shows sedimentary facies internal to the delta. Analyses of sediment composition from cores of these sedimentary facies will help to determine their origin, the environment that they supported, and the flow conditions that deposited them.

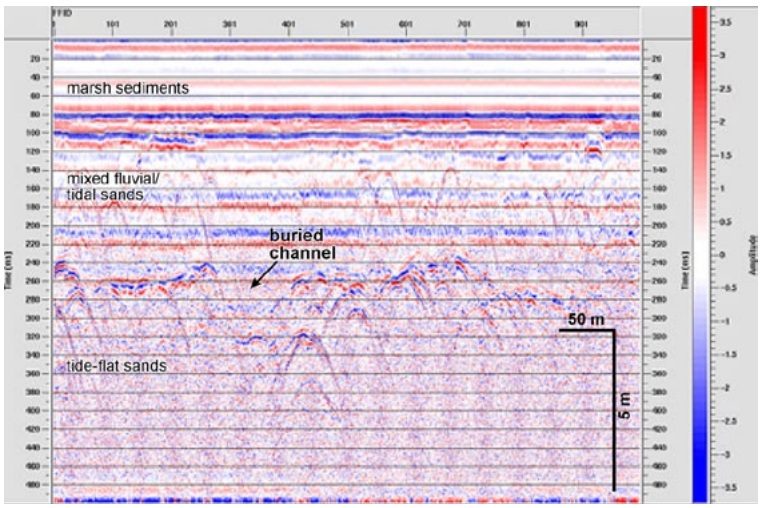
Radiometric ages of wood debris ranging from 150 to 400 calendar years before present (cal yr BP) from the base of three auger holes across the marsh reveal that, over several kilometers of southern Fir Island, more than 10 m of marsh sediment and vegetation has accumulated since logging and land clearing began around 1850. This thickness is equivalent to a vertical accretion rate of between 2 and 6 cm/yr, which is 10 to 100 times higher than long-term rates spanning the Holocene. The thickness of this historical deposit in the South Fork Skagit River region rivals that of lahar runout deposits (debris flows from the slopes of a volcano) that are known to radically alter the landscape, suggesting that human modifications of the Puget Sound lowlands may match catastrophic geologic agents of environmental change.



*Photographs in true color (taken in 2000) and black and white (1990) showing USGS surveys. We are testing the hypothesis that increased sediment delivery to the delta front associated with land-use activities has buried and fragmented eelgrass meadows. Ship-tow video shows healthy eelgrass today (for example, see 69-MB video clip at **http://soundwaves.usgs.gov/2005/01/fieldwork3.html**, shot near tip of arrow labeled "Eelgrass Meadows") and large expanses of rippled sand where eelgrass existed in 1990 (for example, see 172-MB video clip at **http://soundwaves.usgs.gov/2005/01/fieldwork3.html**, shot to left of word "increase" near upper left corner). Photographs courtesy of the Skagit River System Cooperative. GPR, ground-penetrating radar; Subx, Submetrix (bathymetric and backscatter survey lines).*

In contrast, sediment cores in the San Juan Islands reveal dry, stiff, basal green clay across three separate embayments; this clay is interpreted to be a glacial deposit lying only 1 to 2 m below the modern sea floor (approx 4 m below the marsh sur-

(Deltaic Habitats continued on page 9)



Ground-penetrating-radar imagery showing buried marsh and tidal channels and facies associated with recent marsh development.

(*Deltaic Habitats continued from page 8)*

faces). It suggests that sedimentation is significantly lower in the islands than on the mainland and likely not a major factor in the massive eelgrass die-offs observed since the year 2000. These sediment samples are currently being analyzed to determine their age and geochemical composition.

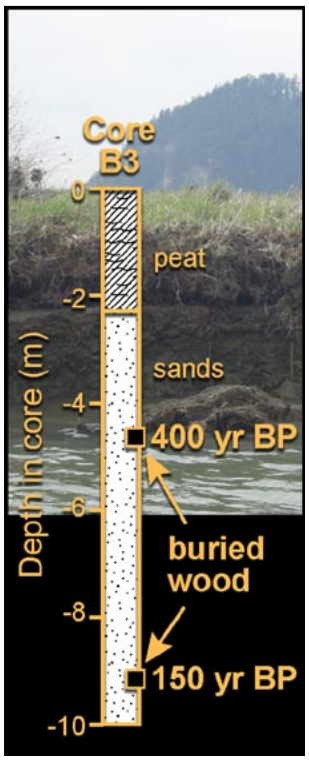
Ongoing Research

Geophysical mapping, using seismic reflection and ground-penetrating radar, is targeting the depth and expanse of lahar and basal glacial deposits and the internal structure of the delta to establish the stratigraphic framework of the Holocene deposits. Analyses of the sedimentary facies will be integrated with geophysical mapping to develop a model of recent marsh and delta development and to quantify the variation in accumulation history associated with climatic, geologic, and land-use change. Geochemical analyses are examining contaminant and nutrient loading, eelgrass biomarkers, compound-specific stable isotopes, and other proxies of eelgrass presence and abundance in sediment cores to reconstruct a history of change in eelgrass distribution over time. A sediment budget for specific subenvironments of the Skagit Delta is being constructed to analyze changes in accumulation rates, sources, and the ultimate fate of sediment reaching the sound as a result of natural climatic and geologic agents versus changes caused by human land-use activities.

Sandy Wyllie-Echeverria *(far left) and family crew with* ***Eric Grossman*** *(second from left) and* ***Renee Takesue*** *(far right).*

Acknowledgments

These field efforts benefited greatly from the wonderful support of **Sandy Wyllie-Echeverria** and his adventurous family crew, **Captain Martin Sampson** and **Todd Mitchell** of the Swinomish Indian Tribal Community's Office of Planning and Community Development, **Doug Bulthuis** and **Paula Margerum** of the Padilla Bay National Estuarine Research Reserve, and **Greg Hood** and **Steve Hinton** of the Skagit River System Cooperative. ❁



We used carbon-14 ages of buried tree branches to calculate historical sediment-accumulation rates. The deepest wood in the pictured core yielded a carbon-14 age of 150 yr BP, indicating an accumulation rate of about 6 cm/yr, which is 10 to 100 times higher than long-term Holocene rates. (The wood dated at 400 yr BP is believed to have been eroded from older strata and redeposited with younger sediment.)

Invasive Sea Squirt Alive and Well on Georges Bank

By Ellen Mecray (USGS) and Teri Frady (NOAA)

An invasive sea squirt that was discovered on Georges Bank by Federal and university researchers a year ago is flourishing in U.S. waters near the United States-Canadian border, a joint research team announced in November after a research cruise to the affected area.

Scientists from the U.S. Geological Survey (USGS), the National Oceanic and Atmospheric Administration (NOAA), and the University of Rhode Island estimate that mats made of thousands of individual squirts infest a 40-mi^2 area of seabed that is highly productive for fish and sea scallops. In large parts of the affected area, the sea squirts cover 50 percent or more of the seabed. The Georges Bank infestation is unique, the only known occurrence of this magnitude in a major offshore fishing ground.

Sea squirts are tunicates, a type of sea life with a primitive spinal cord and a firm, flexible outer covering called a "tunic," from which the name derives. A filter-feeding species of the genus *Didemnum,* they form dense mats, made of thousands of individuals, by attaching to firm substrates such as gravel, sea scallops, mussels, docks and other structures, and even seaweed. Tunicates can overgrow sea scallops and mussels, and they may affect other species of clams and worms that live in the seabed below the tunicate colony. An "invasive species" is one that is not native to an ecosystem and may harm that ecosystem if introduced.

In fall 2003, the same research team first spotted this infestation over an approximately 6-mi^2 area of ocean bottom during a scientific cruise to study habitats on Georges Bank. This year, a larger area with tunicate coverage was surveyed.

The mats were observed over at least 40 mi^2 of the gravel substrate on the

(Sea Squirt continued on page 10)

(Sea Squirt continued from page 9)

north edge of Georges Bank. Video and photo transects made using the USGS Seabed Observation and Sampling System (SEABOSS; see USGS Fact Sheet at URL **http://pubs.usgs.gov/fs/fs142-00/**) documented the distribution of the tunicate colonies in water depths of 42 to 65 m (138-213 ft). The cruise was conducted aboard the NOAA ship *Delaware II*.

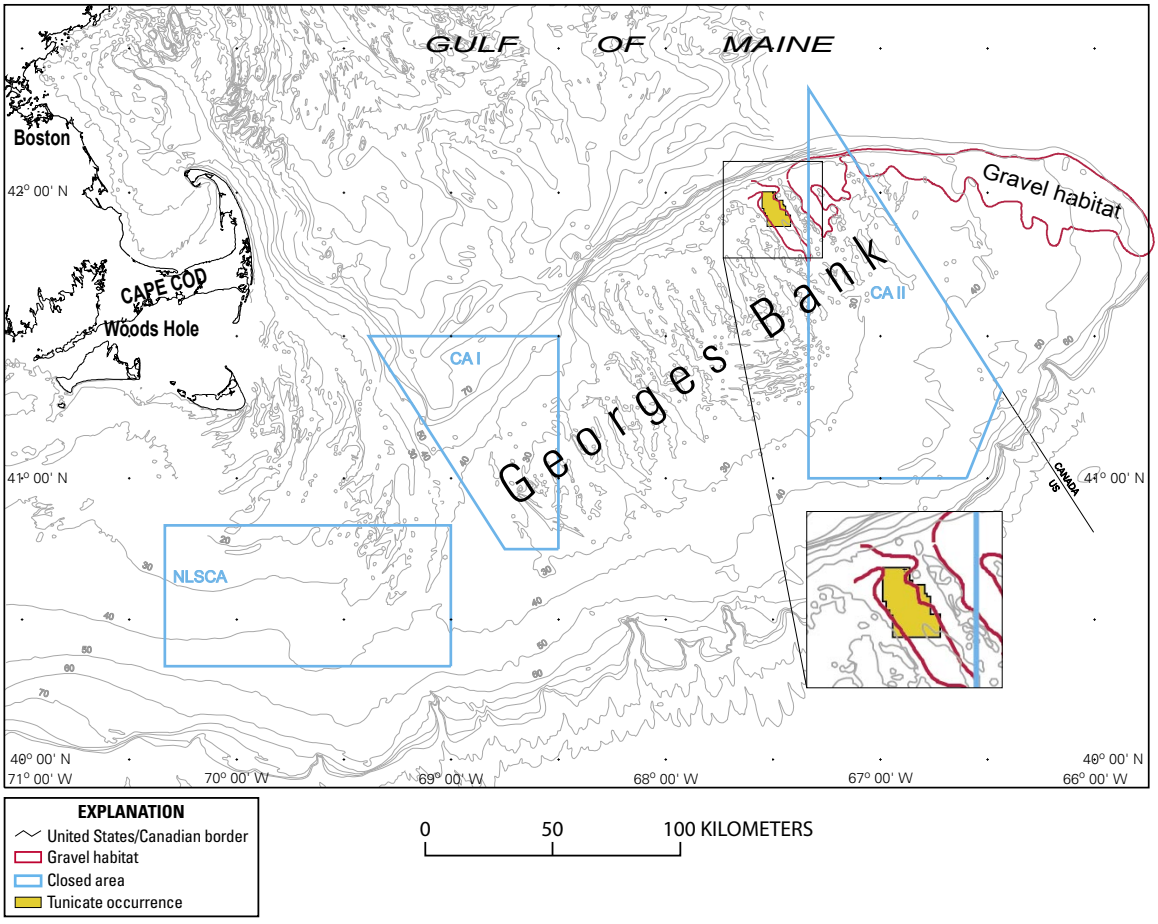
Scientists will analyze data collected on the cruise to determine whether the tunicate invasion has the potential to alter the seabed communities that sustain commercial fish species. Tunicate fragments were also found in the stomachs of haddock and winter flounder collected in the area, but they did not appear to be digested. Samples of the tunicate will be evaluated to determine its nutritional value to predators and to confirm the species through DNA analysis.

The tunicate can spread by reproducing either sexually or asexually by budding. The free-swimming tadpoles produced by sexual reproduction live only a few days, during which time they can be spread by tidal and storm currents to form new colonies. By contrast, fragments of colonies are long-lived. Controlled experiments in Cape Cod waters by USGS and Woods Hole Oceanographic Institution scientists have shown that small pieces removed from *Didemnum* colonies increase dra-

(Sea Squirt continued on page 11)

Tunicate colony of a species of the genus Didemnum *encrusting and cementing a pebble-gravel seabed and crowding a dark-orange anemone (lower part of photograph). Note the relatively few holes in the mat where the gray background is visible. Northern Georges Bank (lat 41°54.429′ N., long 67°27.146′ W.); water depth, 59 m (194 ft); November 2004. Specimen is 9 in. wide. Collectors:* ***Page Valentine*** *(USGS),* ***Jeremy Collie*** *(University of Rhode Island), and* ***Robert Reid*** *(NOAA). Photograph by* ***Dann Blackwood*** *(USGS).*

Underside of tunicate mat in image above, showing pebble gravel cemented by colonial tunicates (pale yellow). Note the relatively few holes in the mat where the gray background is visible. Northern Georges Bank (lat 41°54.429′ N., long 67°27.146. W′); water depth, 59 m (194 ft); November 2004. Specimen is 5.6 in. wide. Collectors: ***Page Valentine*** *(USGS),* ***Jeremy Collie*** *(University of Rhode Island), and* ***Robert Reid*** *(NOAA). Photograph by* ***Dann Blackwood*** *(USGS).*



Area of invasive tunicate (yellow-shaded polygon) surveyed in November 2004. Map based on NOAA National Ocean Service (NOS) Chart 13200, depths in fathoms.

(Sea Squirt continued from page 10)

matically by budding in a matter of weeks. Thus, fragmentation of tunicate mats could promote the spread of the species.

Didemnum sp. occurs along the coasts of the Netherlands and France. In the United States, it has been documented in coastal New England from Connecticut to northern Maine and along the California coast, and in October 2004 it was first reported in Puget Sound off Edmonds, WA. The same species (or a close relative) is present at several localities in New Zealand. Officials in Edmonds and in New Zealand have used chemical applications and physical removal in attempts to eradicate the relatively small infestations there.

The species thrives in marine environments that lie within its preferred temperature range (28-75°F) and that have firm substrates and plentiful food, conditions that are widespread off the coasts of New England and Atlantic Canada. It could change gravel habitats that lie along the north edge of Georges Bank, as well as immobile sand habitats characteristic of southern Georges Bank. *Didemnum* cannot survive on habitats of moving sand, and therefore much of the shallow Georges Bank crest is not threatened. The species is not yet known to occur on mud habitats that are typical of the deep basins of the Gulf of Maine.

For more information on *Didemnum* on Georges Bank, and the worldwide occurrence of this invasive species, see the USGS Web site "Marine Invasive Species" at URL **http://woodshole.er.usgs.gov/project-pages/stellwagen/didemnum/**.

Ripples for Everyone!—Investigating How Sediment Moves on the Sea Floor

By Dan Hanes

Researchers from the U.S. Geological Survey (USGS) Coastal and Marine Geology Program recently conducted two cruises aboard the research vessel *Pelican* in the Florida panhandle to investigate the morphology, orientation, and dynamics of ripples on the sea floor. Ripples are an important part of sediment movement on the sea floor, called bedload sediment transport, and they also contribute to flow resistance and turbulence generation in the layer of water just above the sea floor, or the bottom boundary layer. A better understanding of sediment movement on the seabed and in the bottom boundary layer can be used in many ways—to predict how sediment will bury sunken objects, for example, or how and where contaminated sediment will move on the seabed.

This research is collaborative with the University of Florida; the Monterey Bay Aquarium Research Institute (MBARI); and the Office of Naval Research, which is conducting a study called "Ripples DRI" to better understand the growth, evolution, and decay of ripples on sandy sea floors in shallow water. The research is also coordinated with work by scientists from Woods Hole Oceanographic Institution and with the Sediment-Acoustics Experiment (SAX04) led by the University of Washington's Applied Physics Laboratory. The overall objective of SAX04 is to better understand acoustic detection at low grazing angles of objects, such as mines, buried in sandy marine sediment (see URL **http://www.apl.washington.edu/projects/SAX04/summary.html**).

(Left to right) ***Jodi Harney***, ***Viktor Adams***, ***Sidney Schofield***, *and* ***Dan Hanes*** *with instrumentation on the deck of the research vessel* Pelican *off Fort Walton Beach, FL.*

During the cruises, conducted September 24-29 and November 6-11, we measured ripple morphology and bed-sediment size with a new instrumentation system, designed and built in collaboration with MBARI, that uses a combination of acoustical and optical techniques. Ripples were measured by using a multiple-transducer array, a sector-scanning fan-beam sonar, and a slide-projector/camera system. Bed-sediment size was measured by using a retractable bed-sediment camera known as the "poking eyeball" (see article in *Sound Waves*, April 2003, at URL **http://soundwaves.usgs.gov/2003/04/research.html).** All the instruments were powered and controlled through a single cable, using network communication protocols.

The passage of Hurricane Ivan just a week before the start of our field study provided an unusual opportunity to investigate the formation and endurance of ripples across the continental shelf. We observed wave-formed ripples across the continental shelf out to our deepest measurement station, at approximately 50-m depth.

Next, we will be conducting laboratory experiments under controlled wave and current conditions to investigate the orientation of ripples. These experiments will be conducted in a large flume at a unique laboratory facility at Tsukuba University in Japan.

Scientific personnel on the cruises were **Carissa Carter**, **Hank Chezar**, **Daniel Hanes**, **Jodi Harney**, **Gerry Hatcher**, **Jessie Lacy**, **Kevin O'Toole**, and **David Rubin** (USGS Coastal and Marine Geology); **Craig Okuda** (MBARI); **Viktor Adams**, **Allison Penko**, **Sidney Schofield**, and **Don Slinn** (University of Florida); and **Hiroshi Ikeda** (Tsukuba University).

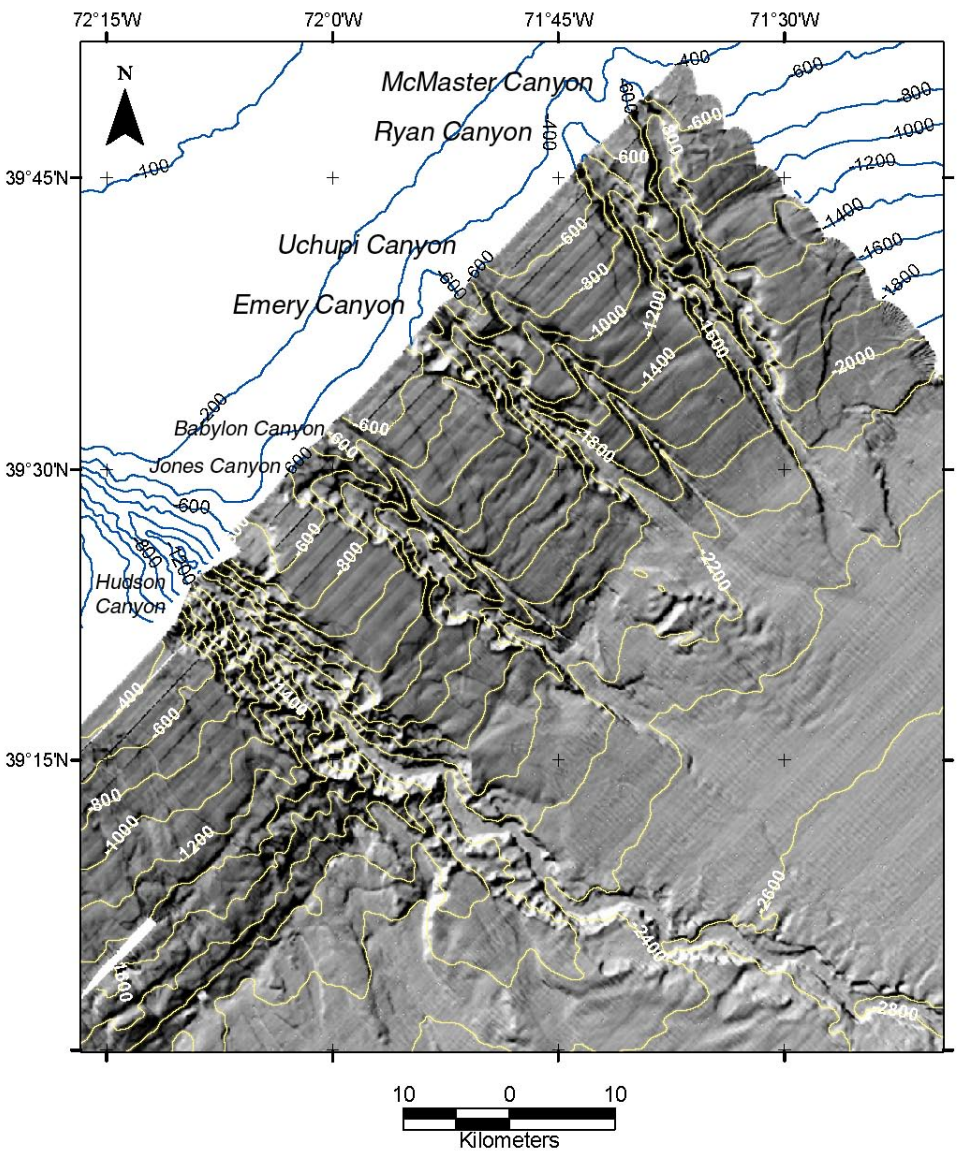
Four Submarine Canyons on U.S. East Coast Named for Marine Geologists

By Jim Robb and Dave Twichell

As part of a cooperative sea-floor-exploration project with the National Oceanic and Atmospheric Administration (NOAA), Rutgers University, the Woods Hole Oceanographic Institution (WHOI), and the U.S. Geological Survey (USGS), four submarine canyons that cut the U.S. east coast continental slope northeast of the Hudson Submarine Canyon have been named for eminent marine geologists who studied the area and its geologic history and processes: **Kenneth O. Emery** and **Elazar Uchupi** of WHOI, **William B.F. Ryan** of the Lamont-Doherty Earth Observatory of Columbia University, and **Robert L. McMaster** of the University of Rhode Island's Graduate School of Oceanography.

The four newly named canyons had been known to exist but had not been mapped in detail. In August 2002, USGS and Rutgers scientists aboard the NOAA ship *Ronald H. Brown* used the ship's multibeam echosounder to map a 110- by 205-km area about 200 km southeast of New York City, in water depths from about 500 to 4,000 m. The mapping applies to studies of the geologic history and the processes, both depositional and erosional, that have modified the sea floor, and to investigations of submarine gas hydrates.

The new map shows complex details of canyon development, a topic studied by **Emery**. Terraced and recut canyons are visible, as are sites where large submarine overbank flows have created additional channels down the continental slope. Areas of large sheet landslides are evident along the continental slope, and landslide deposits at the base of the slope. Early studies of these features were conducted by **Ryan** and his students. Lobate sedimentary deposits detected in high-resolution bathymetric data from the continental shelf off New York City were recently reported by **Uchupi** and colleagues as evidence that large, catastrophic discharges of water from glacial lakes poured down the Hudson River valley and swept across the continental shelf near the close of the Pleistocene Epoch. Large lobes of probable debris-flow deposits visible in the new map on the continental rise may have resulted from similar flows from lakes in Long Island Sound and Block Island Sound, a drainage pattern first mapped by **McMaster**. Interpretation of this new data set will reshape our understanding of continental slope and rise processes, and we are pleased to be able to honor some pioneers of modern marine geology.



Continental slope and upper continental rise northeast of Hudson Canyon, showing the four newly named submarine canyons along the continental slope: Emery, Uchupi, Ryan, and McMaster. Shaded-relief bathymetric imagery constructed by ***Tammie Middleton*** *from multibeam bathymetric data collected on the NOAA ship* Ronald H. Brown, *2002. Contour interval, 100 m; dark blue lines were derived from the NOAA Coastal Relief Model, and light yellow lines from multibeam bathymetric data collected in 2002.*

The project was led by **Peter Rona** of Rutgers University and **Brad Butman** of the USGS. Other participants included **Tammie Middleton** (USGS), **Tom Bolmer** (WHOI), **Laura Cottrell** (State University of New York [SUNY], Stony Brook), and **Kyle Kingman** and **Lisa Weiss** (Rutgers University).

(Biologists continued from page 12)

Appreciation Day for Congressman Young of Florida

By Jennifer Leigh Oates

The support of **U.S. Representative C.W. "Bill" Young** for the science community in downtown St. Petersburg, FL, was publicly recognized October 29 in Hangar No. 1 at the Albert Whitted Municipal Airport. The celebration included unveiling of the University of South Florida (USF) C.W. Bill Young Marine Science Complex. Speakers included **Peter Betzer**, dean of the USF College of Marine Science, **Rick Baker**, mayor of St. Petersburg, **Judy Genshaft**, president of USF, **Lisa Robbins**, director of the U.S. Geological Survey (USGS) Center for Coastal and Watershed Studies, and **Jim Sebesta**, State senator. **Lisa** presented **Congressman Young** with a plaque and limestone cutout in the shape of Florida. The three USGS Florida Integrated Science Centers were represented with symbolic drawings encircled by the center names.

USGS **Captain Richard Young** (not related to the congressman) welcomed **Congressman Young** aboard the USGS research vessel *G.K. Gilbert* on Tampa Bay, where scientists from the USF Center for Ocean Technology (COT) demonstrated equipment for underwater counter-terrorism surveillance.

The USGS Center for Coastal and Watershed Studies had several exhibits representing research on the National Assessment of Coastal Change Hazards (see URL **http://coastal.er.usgs.gov/national-assessment/**), Tampa Bay (see URL **http://gulfsci.er.usgs.gov/tampabay/**), and African dust and coral mortality (see URL **http://coastal.er.usgs.gov/african_dust/**). Additionally, the USGS Unmanned Aerial Vehicle (UAV) used in atmospheric sampling was granted permission to take off and land on the airport runway.

The C.W. Bill Young Marine Science Complex, formally dedicated in February 2002, includes the following organizations, all with offices in St. Petersburg: the USF College of Marine Science and its Center for Ocean Technology, the USGS Center for Coastal and Watershed Studies, the Fish and Wildlife Research Institute of the Florida Fish and Wildlife Conservation Commission, the Tampa Bay Estuary Program, the Southwest Regional Office of the National Marine Fisheries Service, Florida Sea Grant, Eckerd College, and the Florida Institute of Oceanography. The USF, USGS, and St. Petersburg Downtown Partnership sponsored the event.

*(Left to right) USGS personnel **Gene Shinn**, **Dale Griffin**, and **Forrest Waller** attended **Congressman Young's** appreciation day to answer questions about African dust and the USGS Unmanned Aerial Vehicle (UAV, foreground). **Forrest Waller** flew the UAV at **Mayor Rick Baker's** request.*

*USGS **Captain Richard Young** (far left; not related to the congressman) greets **Congressman Young** (fifth from left) and others aboard the USGS research vessel* G.K. Gilbert. *Mounted on the vessel is a counter-terrorism surveillance system that provides high-resolution three-dimensional color images of what it scans and a georeferencing system that allows analysts to pinpoint the locations of objects.*

***Hilary Stockdon** (pictured) worked with **Abby Sallenger** and **Bob Morton** to explain the work of the National Assessment of Coastal Change Hazards Project.*

*(Left to right) **Congressman Young**, **Lisa Robbins**, and **Jack Kindinger** beside the plaque presented to **Congressman Young** from the USGS Florida Integrated Science Center (FISC) (see URL **http://fisc.er.usgs.gov/**).*

High-School Students Learn About Coastal and Marine Science Research

By Jennifer Leigh Oates

*High-school students and teachers from Oak Park School were photographed with **Tara Miller** (standing at far left).*

Do you remember what it was like to be in high school? The pressures of trying to decide whether college was right for you and what you wanted to achieve? U.S. Geological Survey (USGS) scientists at the Center for Coastal and Watershed Studies in St. Petersburg, FL, were reminded on November 19 when 16 high-school students from Oak Park School visited the center. A teacher from the Sarasota school contacted **Jennifer Oates** (USGS) to schedule a field trip during which students could meet and interact with scientists.

Tara Miller presented research relating to the National Assessment of Coastal Change Hazards Project (see URL **http://coastal.er.usgs.gov/national-assessment/**), including the Coastal Classification Atlas, recent hurricane-impact studies, and research on historical shoreline change. She helped the students learn how to determine the hazard vulnerability of an area on the basis of geomorphic features and conditions presented in the Coastal Classification Maps. Devastation from the recent hurricane season, seen in aerial photographs and lidar (light detection and ranging) images, caught students by surprise.

After **Tara's** presentation, the students were led on a tour of the center, during which **Chad Stout** told the group what happens in the center's lab. They were interested to learn about the diversity of scientific research being conducted in the center. After the tour, students walked to a restaurant on the University of South Florida's campus. The number of students expressing an interest in attending college after the USGS trip was remarkable.

Special thanks to **Russ Peterson** and **Laurinda Travers** for printing posters for the group to take back to their classroom. The posters provided background information relating to the Coastal Classification Atlas, as well as an aerial map of Sarasota County. These posters gave the students a personal connection to the impact USGS science has on their community.❁

Extreme Storms Bring Pleasant Surprises—2004 Hurricane Season Gains Publicity for USGS Research

By Jennifer Leigh Oates

(Left to right) National Geographic *reporter **Alan Tomlinson** carefully maneuvers around USGS scientists **Kristy Guy**, **Abby Sallenger**, and **Dave Thompson** as they examine posthurricane images created with lidar (light detection and ranging).*

The work of U.S. Geological Survey (USGS) scientists during 2004's extremely busy hurricane season has drawn the attention of reporters, scientific colleagues, and public officials.

One storm after another (four strikes to Florida in 6 weeks) gave reporters a reason to program **Abby Sallenger's** number at the USGS Center for Coastal and Watershed Studies (St. Petersburg, FL) into their cell phones. **Abby** heads a team of researchers who went out after each hurricane to collect data as part of USGS Hurricane and Extreme Storm Impact Studies (see URL **http://coastal.er.usgs.gov/hurricanes/**). After Hurricane Ivan, a reporter from *National Geographic* worked alongside the USGS hurricane team, filming the damage caused by Ivan in the Florida Panhandle (see URL **http://coastal.er.usgs.gov/hurricanes/ivan/**). The *National Geographic* hurricane special will be broadcast in January 2005.

As USGS data on the recent hurricanes grew, **Neil Frank**, former director of the National Hurricane Center in Miami (**http://www.nhc.noaa.gov/**), came to St.

(Publicity continued on page 15)

(Publicity continued from page 14)

Petersburg to review images and share hurricane stories.

Abby has been asked to speak at the 2005 National Hurricane Conference to be held March 21-25 in New Orleans (see URL **http://www.hurricanemeeting.com/**). His presentation will be given on the last day of the conference, when the long-range forecasters give their predictions for the upcoming hurricane season. The conference is typically attended by media representatives and more than a thousand other attendees, primarily local, State, and Federal emergency managers.

Mayor Rick Baker of St. Petersburg, FL, was so impressed by the hurricane exhibit at the USGS open house held in October at the Center for Coastal and Watershed Studies (see related article, this issue) that he requested several images to post in St. Petersburg's City Hall and the city's Emergency Management Center. The series of images included preliminary projected storm paths through Tampa Bay, the actual paths of destruction, satellite images of the hurricanes in relation to St. Petersburg, and before-and-after storm-damage photos. The images will help St. Petersburg residents remember how close they came to feeling the wrath of Charley (Aug. 13), Frances (Sept. 5), Ivan (Sept. 16), and Jeanne (Sept. 25; see related article in *Sound Waves*, October 2004, at URL **http://soundwaves.usgs.gov/2004/10/**). Special thanks to **Karen Morgan** for designing the posters.

***Jennifer Oates** and **Mayor Rick Baker** discuss recent USGS hurricane research.*

College Students Visit USGS Center in St. Petersburg, FL

By Jennifer Leigh Oates

After searching the U.S. Geological Survey (USGS) Center for Coastal and Watershed Studies' Web site (URL **http://coastal.er.usgs.gov/**) for local geology research projects, a professor from St. Petersburg College in Clearwater, FL, contacted **Jennifer Oates** to arrange for his geology class to visit the center on December 1. He planned to conclude the semester by showing his students where geologists work and what types of research activity the local USGS office is conducting.

Dennis Krohn gave the students a brief overview of USGS history. The class was particularly impressed by the multidisciplinary nature of many projects. Research relating to the National Assessment of Coastal Change Hazards Project (see URL **http://coastal.er.usgs.gov/national-assessment/**), including the Coastal Classification Atlas, recent hurricane-impact studies, historical shoreline change, and deep-water coral reefs at Pulley Ridge off Florida's southwest coast (see URL **http://coastal.er.usgs.gov/pulley-ridge/**), was highlighted. The professor was especially interested in climate change, and so **Dennis** explained the history behind the discovery of evidence for freshwater Lake Edgar found in the middle of Tampa Bay. Lake Edgar began to fill about 21,000 years ago, at the end of the latest glacial period, and existed until at least 11,000 years ago, when Tampa Bay filled. "The variations in sediment types, trace elements in fossil shells, and pollen content of the sediment combine to describe a detailed climate history of the Florida peninsula," said **Terry Edgar**.

***Wayne Baldwin** explained how mapping the sea floor with geoacoustics could affect the lives of the students.*

Students were introduced to state-of-the-art technologies that USGS scientists use to map the sea floor and shallow-subsurface sediment in coastal areas, and they were shown examples of how coastal managers might use the information. **Wayne Baldwin** used examples from the South Carolina Coastal Erosion Study to illustrate how three-dimensional mapping of the inner shelf off northeastern South Carolina has provided an increased understanding of the long- and short-term evolution of the area.

As the students were leaving, one was overheard saying, "It almost makes you want to be a geologist, doesn't it?"

Special thanks go to **Russ Peterson** and **Laurinda Travers** for printing posters for the group to take back to their classroom.

Great-American Teach-In Brings Scientists to Schools

By Jennifer Leigh Oates

Scientists and staff from the U.S. Geological Survey (USGS) Center for Coastal and Watershed Studies (CCWS) in St. Petersburg, FL, participated in the Great American Teach-In on November 17. Pinellas County area teachers were eager to reserve a scientist to speak to their students after attending the sixth annual open house at CCWS (see Web page at URL **http://coastal.er.usgs.gov/openhouse2004.html** and related *Sound Waves* article, this issue). The Great American Teach-In is a special opportunity for USGS scientists to visit schools and share experiences with a younger generation.

John Lisle visited Sutherland Elementary School during the Great American Teach-in. In the kindergarten class, **John** explained how scientists are cool and travel to interesting places, like Antarctica. He showed lots of pictures of scientists doing research, and of glaciers, seals, penguins, killer whales, and many more unusual animals that live in Antarctica. Naming a few interesting places where scientists work, **John** told the second-grade class about research in Antarctica, Tampa Bay, Biscayne National Park, and the Florida Keys. He wanted students to know that scientists are not geeks and have great adventures! Another focus the students enjoyed were pictures of the different scientific "tools" used at work. **John** included photographs of female scientists who work with him to encourage more girls to study science.

The submersible Deep Worker *was used to shoot video of Pulley Ridge for National Geographic on a Sustainable Seas Expedition cruise in 2001. (See article in* Sound Waves*, August 2001, at URL* ***http://soundwaves.usgs.gov/2001/08/****.)*

At Rawlings Elementary School, **Marci Marot** visited two fifth-grade classes, where she discussed different areas of research conducted by the USGS, including energy resources, natural hazards, mapping, water resources, and biology. Students learned the differences between geologists, oceanographers, hydrologists, and microbiologists. **Marci** showed and explained several types of sediment-collection methods that she uses in her work. The students were particularly interested in the equipment she uses when coring and gathering samples.

Every kid wanted to be a scientist when ***Kate Ciembronowicz*** *showed them she had had the opportunity to ride in a submersible.*

Martha Loyd visited James Sanderlin Elementary School, where she gave a presentation to 20 students. She used the Sponge Bob Squarepants character to give students a tour of tidal wetlands. The students learned how marshes absorb and release water and air, and how tidal marshes help absorb wave energy. They also learned how tidal wetlands contribute to the estuary food web and what sorts of animals call the marsh their home. Singing the Sponge Bob song and naming the inhabitants of the wetlands made the presentation memorable for the students. **Kathy Krohn** (**Dennis Krohn's** wife) also used **Ellen Raabe's** Sponge Bob poster at McMullen-Booth Elementary School.

Photographs of a submersible made **Kate Ciembronowicz's** presentation at Campbell Park Elementary Marine Science Center a huge success. She gave her presentation to two classes of approximately 35 students. **Kate** described the tools of an oceanographer and used fieldwork at Pulley Ridge off Florida's southwest coast as an example. The students enjoyed learning that Pulley Ridge is a deep reef consisting of a remarkable ecosystem of live coral and diverse fish populations.

USGS Scientist Interviewed About Invasive Sea Squirt on Georges Bank

The status of an invasive sea squirt discovered in 2003 by U.S. Geological Survey (USGS) scientists and their collaborators caught the attention of the press in New England this fall. The original discovery came during a 2003 cruise to study benthic habitats on Georges Bank; a followup cruise in November 2004 revealed that the invader is flourishing, with mats made of thousands of individual sea squirts infesting a 40-mi^2 area of seabed. A press release coauthored by **Ellen Mecray** (USGS) and **Teri Frady** (National Oceanic and Atmospheric Administration's National Marine Fisheries Service) reported the findings of the second cruise (see article "Invasive Sea Squirt Alive and Well on Georges Bank," this issue) and was picked up by several major papers over the Thanksgiving week. **Page Valentine**, the chief of the project "USGS National Geologic Studies of Benthic Habitats, Northeastern United States," was interviewed by the *Boston Globe* and the *Cape Cod Times*, which featured him in an article on the front page of the *Cape Cod Times* on Saturday, November 20.

Geographic Information System (GIS) Day Celebrated by Scientists

By Jennifer Leigh Oates

The U.S. Geological Survey (USGS) Center for Coastal and Watershed Studies in St. Petersburg, FL, participated in a Geographic Information System (GIS) Day held November 16 at the University of South Florida (USF) in St. Petersburg. Countries all over the world hold annual GIS Day events (see URL **http://www.gisday.com/**), and one such event has been held for three consecutive years at USF. This year, 168 people attended. The purpose of GIS Day is to help teach the world about GIS technology and provide GIS users and vendors an opportunity to interact with the general public and demonstrate practical applications.

Michael Holmes *(left) and* ***Russ Peterson*** *staffed the booth at the University of South Florida's GIS Day, where they demonstrated how the USGS uses GIS technology.*

During the GIS Day celebration at USF, **Mike Holmes** (USGS) used two Internet connections to show GIS data sets available through the USGS *National Map* (URL **http://nationalmap.gov/**) and the USGS real-time water-data Web site for Florida (URL **http://waterdata.usgs.gov/fl/nwis/rt**).

Russ Peterson (USGS) explained how GIS technology is used to map windspeed, storm-tracking information, and bathymetric data in areas hit by hurricanes. He showed data sets used to determine shoreline changes and other impacts of Hurricane Ivan, which came ashore near Gulf Shores, AL, on September 16, 2004. Additionally, **Russ** described how **John Brock** (USGS) is working with the National Park Service, using GIS and lidar (light detection and ranging) technology to map coral reefs in the Biscayne Bay.

A GIS is a system of computer software, hardware, and data that allows a user to manipulate, analyze, and present information that is tied to a spatial location. GIS technology is used in scientific investigations, resource management, development planning, and many other applications that require analysis of spatial data.

Florida Center Celebrates Earth Science Week and 125 Years of USGS Science

By Jennifer Leigh Oates

The U.S. Geological Survey (USGS) Center for Coastal and Watershed Studies in St. Petersburg, FL, held its sixth annual Open House on October 26 and 27, in a delayed celebration of this year's Earth Science Week (Oct. 9-15; see URL **http://www.earthsciweek.org/**). This year's open house had two themes: (1) the traditional Earth Science Week theme, selected by the American Geological Institute (AGI), "Living on a Restless Earth"; and (2) a recognition of many years of USGS research, "125 Years of Science." After Floridians survived the busy 2004 hurricane season and Mount St. Helens became active, the 2004 Earth Science Week theme seemed a perfect fit; the theme focused on natural hazards and the ways Earth scientists study hazards to understand their causes and minimize their impact on society.

(Open House continued on page 18)

St. Petersburg's ***Mayor Rick Baker*** *(front row center, in light shirt) and Open House participants posed under the USGS blimp.*

(Open House continued from page 17)

The two-day event was a successful educational experience for the entire community. St. Petersburg's **Mayor Rick Baker** attended the first day, along with approximately 650 fourth-grade students and teachers, and returned in the afternoon to participate in the traditional group photo under the USGS blimp. During a day for the general public on October 27, the USGS welcomed a record crowd of approximately 450 people. High-school National Honor Society (NHS) students from Indian Rocks Christian School and Seminole High School volunteered for the second year in a row, helping to staff exhibits and lead tour groups. USGS scientists from Tampa, St. Petersburg, Gainesville, Miami, and Tallahassee prepared 37 exciting demonstrations and hands-on exhibits showcasing aspects of their research. The activities were planned to introduce the whole family to the wonders of natural science.

Visitors watched a volcano erupt unpredictably, tracked manatees from space, examined microfossils through a microscope, and donned the gear and tools of a geologist! Visitors had fun learning what minerals are present in everyday products and how the USGS tracks the effects of severe storms on coastal environments. Using the USGS *National Map*, visitors learned how to find a satellite image of their house. Scientists demonstrated the technique used to gain a bird's-eye view of coral reefs, and explained the suspected connections between African dust and the decline in coral-reef and human health. Two 3-ft-long Gulf sturgeons captivated the attention of adults and children alike with their prehistoric look and unusual features (whiskers and vacuum-like mouths). The popular touch tank gave kids the opportunity to interact with horseshoe crabs, large conchs, and squishy sea squirts. Visitors were excited to find sharks' teeth, fossils, and coral in sediment cores collected at various sites in Florida. How tornadoes form, how waves are made, how river and stream flows are monitored, and what different types of bacteria can be found at the beach were among other popular exhibits. Exhibits on topics ranging from water quality, Mississippi mud, and monitoring the sinking of coastal Louisiana to how marshes are like sponges left adults and children inspired!

More information about the USGS Open House, including a list of exhibits and descriptions, as well as teacher resources, is available online at URL **http://coastal.er.usgs.gov/openhouse2004.html**.

Gary Hill *demonstrated how a hovercraft operates and told visitors how scientists plan to use the hovercraft in the field.*

Geologists ***Chris Reich*** *(not pictured) and* ***Jason Greenwood*** *(beside barge) assembled the auger-drill barge to show how cores are drilled in sand and clay. The auger drill has a corkscrew-shaped drill.*

Brian Dery, a local videographer, volunteered to film the exhibits to create a virtual tour, which should be online and working by early 2005. We encourage educators and scientists to use this resource in their classrooms all year.

Outside-agency participants included the National Aeronautics and Space Administration (NASA), the Southwest Florida Water Management District (SWFWMD), the Clearwater Marine Aquarium, and the Pier Aquarium. Special thanks to our neighbor, the Fish and Wildlife Research Institute (FWRI), for loaning us a 300-gallon tank to display the Gulf sturgeon during the event, and to the U.S. Fish and Wildlife Service in Chiefland, FL, for loaning us a 1-ft-long stuffed Gulf sturgeon.

The Gulf sturgeon is a difficult fish to photograph, but well worth the effort. Sturgeons have been traced back 200 million years.

USGS Scientist Interviewed About Climate Change for Planned HBO Program

A representative of the cable television network Home Box Office (HBO) interviewed U.S. Geological Survey (USGS) scientist **Jeff Williams** (Woods Hole, MA) by telephone on December 3, 2004, in connection with research that the network is conducting for a TV program on climate change and its effects on sea-level rise, coastal change, wetland loss, and increased storminess in coastal areas. Although the initial discussion focused on the striking effects of sea-level rise (approx 1 m per 100 yr) in low-lying areas such as Louisiana, **Jeff** encouraged the researchers to broaden their scope to include other major population centers likely to be affected by predicted increases in sea-level rise. **Jeff** offered contacts for interviews, field trips, and related topics in Louisiana, as well as in the Chesapeake Bay and Cape Cod areas; he hopes for further contact during the filming process if the ideas are accepted by HBO management.

USGS Scientists Invited to International Symposium on Coastal Issues in Tianjin, China

By Lisa Robbins

Center director **Lisa Robbins** and coastal scientist **Bob Morton** of the U.S. Geological Survey (USGS) Florida Integrated Science Center (FISC)'s Center for Coastal and Watershed Studies were invited by the China Geological Survey (CGS) to speak at the International Symposium on Coastal Geo-Environment and Urban Development, held in Tianjin, China, on October 15-18. The symposium was organized by the CGS Department of Hydrogeology and Environmental Geology and cosponsored by the Tianjin Institute of Geology and Mineral Resources (TIGMR). **Lisa** and **Bob** each gave two talks at the symposium: a 30-minute talk and a followup 1-hour talk. **Lisa's** topics were "Challenges in Science" and "Challenges in Science: Organizational Structure to Facilitate Integrated Science." **Bob's** topics were "Coastal Geo-Environment and Urban Development" and "Examples of Hazard Prediction and Hazard Vulnerability Analysis." Not being fluent in Chinese, both scientists worked for three days before the talks with two very capable students who served as translators for the presentations. The four presentations stimulated a significant amount of discussion among the audience and the hosts from TIGMR and other departments and institutes within the CGS. Other speakers included scientists from the geological surveys of the Netherlands, Egypt, and Japan and a scientist from the Marine Sciences Research Center at Stony Brook University, Stony Brook, NY.

China Geological Survey hosts **Dr. Wang Hong**, Deputy Director of the Research Center of Coastal Geology, and **Dr. Yu Haifeng**, Deputy Director of the TIGMR, also organized a field trip to the Bohai Bay coastal zone for the international group. It was apparent within the first few minutes of driving to the field area that the traffic in Tianjin was horrifying, and it was much appreciated that a police escort accompanied the group, helping it to bypass the choked traffic on the streets and highways. Field-trip participants were able to see one of the most extensive land-reclamation projects on the coast of Bohai Bay, which was described for them by a Tianjin port manager. Bohai Bay is the site of active oil production, and the reclamation site in Tianjin will accommodate a Dow Chemical facility. Tianjin city, with 10 million people, faces all the issues of rapid urbanization, including air and water pollution, ground-water withdrawal that has caused major subsidence in parts of the city, siltation in the ports, overfishing, and coastal erosion. The field-trip participants saw one of the few remaining coastal cheniers (ancient beach ridges) in the area, as well as a hydrologic monitoring station that records ground-water levels and subsidence in the region.

***Bob Morton** on the Great Wall of China, one of the original superhighways of commerce; vendors hawking their wares all over the wall are a reminder that the commerce continues!*

The leaders and scientists at the China Geological Survey and hosting scientific institutions were receptive to new ideas presented by the USGS. As a result of **Lisa's** and **Bob's** visit, and a previous visit to Shanghai by **Dawn Lavoie** of the

(China Symposium continued on page 20)

*(Left to right) **Bob Morton**, **Wang Hong**, and **Lisa Robbins** at one of the many banquets held by the Chinese.*

*The Forbidden City in Beijing allowed **Lisa** to step back into a different time (not geologic time, this time!) and get a feel for the people and their customs. She quickly snapped out of it when she spotted a Starbucks "embedded" deep within the Forbidden City! Though longing for a decaf mocha, she protested this modern encroachment by not succumbing to the temptation.*

(China Symposium continued from page 19)

USGS Coastal and Marine Geology Program and **Virginia Burkett** of the USGS National Wetlands Research Center in Lafayette, LA, a delegation of five Chinese scientists and managers will be visiting USGS offices in St. Petersburg, FL, and Lafayette, LA, in the spring to discuss, among other things, common scientific issues of subsidence, shoreline change, lidar (light detection and ranging) technology, and mapping products.

Before the meeting in Tianjin, **Lisa** visited the U.S. Embassy in Beijing, where she met with **Daniel Jassem** and **Donald Steele**, Second Secretaries in Environment, Science, Technology, and Health, to discuss some of the major scientific issues on which the State Department and China are working. **Lisa** presented **Daniel** and **Donald** with an array of USGS Fact Sheets.❁

Technology being used to reclaim land in Tianjin by draining pore water from fill material in Bohai Bay.

***Daniel Jassem** outside the U.S. Embassy in Beijing*

Jeff Williams Presents DOI with a Review of Army Corps Storm-Surge Modeling

U.S. Geological Survey (USGS) scientist **Jeff Williams** (Woods Hole, MA) was invited to a Department of the Interior (DOI) meeting held December 14, 2004, to present the results of his review committee's work on a U.S. Army Corps of Engineers (USACE) storm-surge-modeling effort for the south shore of Long Island. The committee members were contracted by the USACE to assist in reviewing coastal-geology and coastal-engineering data relating to the USACE's renourishment project from Fire Island to Montauk Point, NY, a stretch of coast that includes the National Park Service (NPS) Fire Island National Seashore. Although the official results will be released by the USACE, **Jeff** agreed to present the results of the review process and the recommendations the committee set forth to the USACE. All of the participants are grateful for the collaborative work between the USGS, the USACE, and the NPS.❁

Gulf and Caribbean Fisheries Institutes Conference

By Jennifer Leigh Oates

The 57th annual Gulf and Caribbean Fisheries Institutes (GCFI) conference, cosponsored by the U.S. Geological Survey (USGS), took place in St. Petersburg, FL, the week of November 8-12. **Allen Brooks** (USGS, Gainesville, FL), **Rikki Dunsmore** (USGS, Gainesville), and **Randy Edwards** (College of Marine Science, University of South Florida) attended the conference. **Randy's** presentation was entitled, "New Paradigms for Yellowfin Tuna Movements and Distributions—Implications for the Gulf and Caribbean Region." **Kenneth Sulak** (USGS, Gainesville) is a coauthor.

Jennifer Oates (USGS, St. Petersburg, FL) staffed a booth and was available to answer questions. Exhibited were Hurricane Ivan images, articles, and USGS Open-File reports in English and Spanish. Poster topics included transcontinental African dust storms, the declining health of Florida corals, the effects of hurricane-induced conversion of mangroves to mudflats on fish and decapod crustacean assemblages in the Big Sable Creek complex of southwestern Florida, community structure and habitat use by fish assemblages in altered wetlands, Isla del Coco fishes (see URL **http://coastal.er.usgs.gov/cocos/**), and Virgin Islands fishes (see URL **http://coastal.er.usgs.gov/vi-fishes/**).

Besides the USGS, other conference sponsors included the Florida Fish and Wildlife Conservation Commission's Fish and Wildlife Research Institute, the Government of Bermuda, the Nature Conservancy, Environmental Defense, the Ocean Conservancy, the National Oceanic and Atmospheric Administration (NOAA), NOAA's National Ocean Service, the National Marine Fisheries Service (NOAA Fisheries), the United Nations Environment Programme (UNEP), the University of South Florida, the Pier Aquarium, and Sea Grant College Programs of Florida, the Gulf of Mexico, and Puerto Rico.❁

*"Virgin Islands Fishes" poster by USGS scientists **Ginger Garrison** and **William Smith-Vaniz** (see URL **http://coastal.er.usgs.gov/vi-fishes/**).*

Suwannee River Basin and Estuary Integrated Science Workshop

By Jennifer Leigh Oates

A Suwannee River Basin and Estuary Integrated Science Workshop was held September 22-24 in Cedar Key, FL. Scientists, resource managers, and representatives from State and regional agencies from Florida and Georgia met with Federal researchers to develop research and management objectives for the Suwannee River ecosystem. All parties agreed that the basin and estuary form an ecosystem deserving of special efforts to conserve its unusual natural resources—water, plants, and animals that are important to local economies and lifestyles in the region. Human and natural impacts in the Suwannee River basin are magnified in the estuary. Together, the basin and estuary include much of north-central Florida and south-central Georgia.

"The U.S. Geological Survey [USGS] is well suited to facilitate cooperative efforts of researchers and agencies across State and other jurisdictional boundaries in the Suwannee River basin and estuary," said **Thomas Armstrong**, Science Coordinator for the USGS Eastern Region. "It is our hope that our endeavor in the Suwannee River ecosystem can serve as a model for similar efforts in other river basins and estuaries in the Southeast and across the Nation."

Research questions identified during the workshop linked water supply, water quality, and ecosystem function across county and State boundaries. The mostly pristine Suwannee River system is a watershed that has grown increasingly vulnerable to competing demands on water supply and multiple environmental impacts. The workshop's 125 participants focused on addressing the challenges of basinwide information needs, science priorities, and management issues. The four main topics were (1) water quality and geochemistry, (2) hydrogeology, (3) ecosystem dynamics, and (4) information management.

In a breakout group, representatives from various agencies brainstormed about the top research priorities and information gaps for each of the four main topics. Clockwise around near table: ***Michael Hein*** *(Water and Air Research, Inc.),* ***Rodney DeHan*** *(Florida Geological Survey),* ***Barbara Poore*** *(USGS, FISC),* ***Jim Preacher*** *(USGS, Coordinator of Fisheries: Aquatic and Endangered Resources Program),* ***Jennifer Oates*** *and* ***Jeff Keay*** *(USGS, FISC),* ***Mike Crane*** *(USGS, EROS Data Center),* ***Paul Lee*** *(Florida Department of Environmental Protection), and* ***Sarah Kruse*** *(University of South Florida).*

Workshop participants gave 44 presentations on topics ranging from recreational fishing, nutrient contamination of spring discharge, and habitat mapping to protected species, including the Florida salt marsh vole, the Gulf sturgeon, and the Florida manatee. Porous limestone and numerous springs complicate the hydrology of the basin, which is economically dependent on agriculture, fishing, and a productive estuary. The springs, wildlife, and river recreation also support a burgeoning ecotourism industry.

"Heavy loading of nutrients, ecological and economic considerations, and rapidly growing demands for water are all concerns we have for the basin and estuary," said **Brian Katz**, USGS research hydrologist and one of this year's primary workshop coordinators. "The Suwannee River ecosystem can serve as an effective model for more impacted basins throughout the United States, in part due to the habitat-sensitive indicator species that call the river and estuary home."

"An area of gravel-covered bottom about 140 miles upstream from the river's mouth is an essential spawning habitat for the bottom-dwelling Gulf sturgeon," said **Randy Edwards**, a biologist at the University of South Florida's College of Marine Science. "The continued existence of a healthy Gulf sturgeon population in the Suwannee River will reflect the river's healthy condition. In turn, protection of the Gulf sturgeon will help conserve the river."

Brian Katz and **Ellen Raabe** (of the USGS Florida Integrated Science Center [FISC]) coordinated this year's workshop. The USGS, the Suwannee River Water Management District (SRWMD), and the Florida Marine Research Institute (FMRI) cosponsored the workshop, which was built on a successful basinwide conference organized through the Suwannee Basin Interagency Alliance (SBIA) three years ago in Live Oak, FL. Representatives from SBIA and other stakeholders, as well as **Janet Oehmig**, legislative aide for Florida State Senator **Nancy Argenziano**, attended the workshop. **Argenziano's** district includes most of the Suwannee River basin and estuary in Florida.

More information about the workshop, including an agenda and photographs, is available online at URL **http://gulfsci.usgs.gov/suwannee/index.html**.

(Left to right) ***Sonya Jones*** *(USGS, Norcross, GA),* ***Jess Weaver*** *(USGS Eastern Region, Deputy Regional Executive for Hydrology), and* ***Jack Kindinger*** *(USGS, FISC) discuss water-related issues.*

Kirk Webster *(left), Deputy Director for Water Resources at SRWMD, and* ***Al Hine****, professor at the University of South Florida, converse during the workshop.*

New Regional Executive Visits Florida Integrated Science Center Office in St. Petersburg, FL

By Jennifer Leigh Oates

Pam Malam, the new Regional Executive for Geospatial Information and the Florida Integrated Science Center (FISC) in the Eastern Region of the U.S. Geological Survey (USGS), visited the FISC Center for Coastal and Watershed Studies (CCWS) in St. Petersburg, FL, on November 18. This was the last stop in **Pam's** tour of FISC offices in Gainesville, Tallahassee, Altamonte Springs (Orlando), Tampa, Fort Myers, Miami, and St. Petersburg. During an all-hands meeting at the CCWS in St. Petersburg, **John Brock** and **Dick Poore** were presented awards by center director **Lisa Robbins**. **John** was acknowledged for 10 years of Federal service, 6 of which he has worked at the USGS. **Dick** received the Meritorious Service Award for his outstanding contributions in the field of paleoclimatology and for his leadership in the USGS component of the interagency U.S. Global Change Research Program.

Lisa Robbins *presents* ***Dick Poore*** *with the Meritorious Service Award. Pictured (left to right):* ***Jack Kindinger, Dick Poore, Lisa Robbins****, and* ***Pam Malam****.*

During the all-hands meeting, **Pam** introduced herself to the CCWS staff and hosted a question-and-answer session. **Abby Sallenger** gave a presentation on the 2004 hurricane season. **Gene Shinn** presented **Pam** with a FISC puzzle in the shape of Florida during lunch on the lawn. In the afternoon, **Pam** met with several investigators and heard presentations on several major projects, including the Tampa Bay Study (see URL **http://gulfsci.er.usgs.gov/tampabay/index.html**), whose project chief is **Kim Yates**; the National Assessment of Coastal Change Hazards (see URL **http://coastal.er.usgs.gov/national-assessment/**), represented by **Robert Morton**; and the Coral Mortality and African Dust project (see URL **http://coastal.er.usgs.gov/african_dust/**), whose project chief is **Gene Shinn**.

Pam Malam *holds the FISC puzzle. The Virgin Islands puzzle piece, designed to dangle from the rest of the puzzle, is on the table. Also pictured (left to right) are* ***Gene Shinn*** *and* ***Jack Kindinger.***

Jingping Xu Becomes a Permanent Member of the Western Coastal and Marine Geology Team

By Sam Johnson

Jingping Xu has become a permanent Research Oceanographer on the U.S. Geological Survey (USGS) Western Coastal and Marine Geology Team. **Jingping** brings to the team his significant and broad expertise in sediment transport, pollutant transport, coastal dynamics, and software development.

Jingping received B.S. and M.S. degrees in marine sciences from Shandong College of Oceanography, China, and a Ph.D. in geological oceanography from the Virginia Institute of Marine Science (VIMS). After his graduate work, **Jingping** held postdoctoral research appointments with VIMS and Louisiana State University (LSU) and was a Research Assistant Professor at LSU. His early work focused on sediment transport in Chesapeake Bay and along the Louisiana coast, with a special emphasis on barrier islands.

Jingping came to the USGS in 1996 as a postdoctoral researcher, working with Western Coastal and Marine Geology Team scientists **Steve Eittrem**, **Marlene Noble**, and **Dave Cacchione** in the Monterey Bay National Marine Sanctuary and along the central California coast. Subsequently, **Jinpging** has been a major player in the team's Southern California project, including high-profile work offshore Palos Verdes funded by the Environmental Protection Agency, pollution studies at Huntington Beach, and post-wildfire work in the Santa Clara River delta. Most recently, his work in Monterey Canyon led to the

Jingping Xu

(Jingping Xu continued on page 23)

(Jingping Xu continued from page 22)

important first in-place measurements of a large turbidity flow in a major submarine canyon (see article in *Sound Waves*, February 2004, at URL **http://soundwaves.usgs.gov/2004/02/index.html**).

Jingping has extensive experience in designing field experiments, as well as in the retrieval, transfer, and processing of field data. He has also developed numerous software programs to help in the acquisition, quality control, process, and display of oceanographic data. In my short time as chief scientist of the Western Coastal and Marine Geology Team, I have become very aware of **Jingping's** special expertise in recovering instruments that are lost, covered by sediment, or otherwise distressed (for example, see "Looking for a Needle in a Haystack…," *Sound Waves*, March 2004, at URL **http://soundwaves.usgs.gov/2004/03/**). This is one area where I would like him to do less work in the future! **Jingping** is a member of the American Geophysical Union and the Marine Technology Society.

Jingping will be moving from his present office in Menlo Park to Santa Cruz this winter. We look forward to **Jingping's** continued work with the team and the Coastal and Marine Geology Program.

Special Issue of *Oceanography* Includes Article on Sediment Dynamics in the Adriatic Sea

The December 2004 issue of *Oceanography*, published by the Oceanography Society, highlights research on the EuroSTRATAFORM project and contains an article entitled "Sediment Dynamics in the Adriatic Sea Investigated with Coupled Models," by U.S. Geological Survey (USGS) oceanographer **Chris Sherwood** and a host of coauthors, including USGS scientists **Rich Signell** and **John Warner**. The table of contents can be viewed and copies of the journal ordered at URL **http://www.tos.org/oceanography/.**

Recently Published Articles

Bratton, J.F., Böhlke, J.K., Manheim, F.T., and Krantz, D.E., 2004, Ground water beneath coastal bays of the Delaware Peninsula; ages and nutrients: Ground Water (special issue), v. 42, no. 7, p. 1021-1034.

Bratton, J.F., Crusius, J.F., Meunier, J.K., Spruill, T.B., and Wrege, B.M., 2004, Use of continuous resistivity profiling to detect low-salinity ground water beneath the Upper Neuse River Estuary, North Carolina [abs.]: Eos (American Geophysical Union Transactions), Fall Meeting Supplement, v. 85, no. 47, abstract H24A-04 [go to URL **http://www.agu.org/meetings/fm04/waisfm04.html** and search on "bratton"].

Butman, B., Alexander, P.S., and Bothner, M.H., 2004, Time-series photographs of the sea floor in western Massachusetts Bay; June 1998 to May 1999: U.S. Geological Survey Data Series 96 [DVD-ROM].

Butman, B., Alexander, P.S., and Bothner, M.H., 2004, Time-series photographs of the sea floor in western Massachusetts Bay; May to September 1999; May to September 2000; and October 2001 to February 2002: U.S. Geological Survey Data Series 97.

Cable, J.E., Martin, J.B., Swarzenski, P.W., Lindenberg, M.K., 2004, Advection within shallow pore waters of a coastal lagoon, Florida: Ground Water, v. 42, p. 1011-1020.

Chen, Z., Hu, C., Clayton, T., Muller-Karger, F., and Brock, J., 2004, Application of SeaWiFS imagery in monitoring Chesapeake Bay water quality; a preliminary examination: National Conference on Ecosystem Restoration, 1st, Lake Buena Vista, FL, December 6-10, 2004, Conference Abstracts, p. 71.

Chuanmin Hu, Z.C., Clayton, T.D., Swarzenski, P., Brock, J.C., and Muller-Karger, F.E., 2004, Assessment of estuarine water quality indicators using MODIS medium-resolution bands; initial results from Tampa Bay, Florida: Remote Sensing of Environment, v. 93, p. 423-441.

Crusius, J., Bothner, M.H., and Summerfield, C.K., 2004, Bioturbation depths, rates and processes in Massachusetts Bay sediments inferred from modeling of ^{210}Pb and $^{239+240}$Pu profiles: Estuarine Coastal and Shelf Science, v. 61, no. 4, p. 643-655.

Crusius, J., Koopmans, D.J., Ryckman, L., Charette, M., Halloran, K., Kroeger, K., Henderson, P., Bratton, J.F., Colman, J., and Masterson, J., 2004, Submarine groundwater discharge to Salt Pond (MA) estimated from continuous ^{222}Rn measurements [abs.]: Eos (American Geophysical Union Transactions), Fall Meeting Supplement, v. 85, no. 47, abstract H24A-06 [go to URL **http://www.agu.org/meetings/fm04/waisfm04.html** and search on "crusius"].

Garrison, V.H., Rogers, C.S., Beets, J., and Friedlander, A.M., 2004, The habitats exploited and the species trapped in a Caribbean island trap fishery: Environmental Biology of Fishes, v. 71, p. 247-260.

Gibbs, Ann, Grossman, Eric, Logan, Josh, Cochran-Marquez, Susan, Storlazzi, Curt, Field, Mike, Payton, Adina, and Street, Joseph, 2004, Seafloor habitat mapping and oceanographic studies in the Kona Coast national parks: Geological Society of America Annual Meeting, Denver, CO, November 7-10, 2004, Abstracts with Programs, v. 36, no. 5, p. 124, abstract 45-7 [CD-ROM; URL **http://gsa.confex.com/gsa/2004AM/finalprogram/abstract_79346.htm**].

Griffin, D.W., Donaldson, K.A., Paul, J.H., and Rose, J.B., 2004, Pathogenic human viruses in coastal waters: Clinical Microbiology Reviews, v. 16, no. 1, p. 129-143.

Griffin, D.W., and Kellogg, C.A., 2004, Dust storms and their impact on ocean and human health: EcoHealth, v. 1, no. 3, p. 284-295.

Harris, M.S., Brock, J.C., Duffy, M., Wright, C.W., and Nayegandhi, A., 2003, Lidar applications for vital signs monitoring at Assateague Island National Seashore: Restore America's Estuaries Inaugural National Conference on Coastal and Estuarine Habitat Restoration, Baltimore, MD, April 13-16, 2003, Proceedings [CD-ROM].

Holcomb, R.T., and Robinson, J.E., 2004, Maps of Hawaiian Islands Exclusive Economic Zone interpreted from GLORIA

(Recently Published continued on page 24)

(Recently Published continued from page 23)

sidescan-sonar imagery: U.S. Geological Survey Scientific Investigations Map 2824.

Lipp, E.K., and Griffin, D.W., 2004, Analysis of coral mucus as an improved medium for detection of enteric microbes and determining patterns of sewage contamination in reef environments: EcoHealth, v. 1, no. 3, p. 317-323.

Lisle, J.T., 2004, Significance of native microbial populations in ASR storage zones [PowerPoint presentation] *in* Proceedings, Aquifer Storage Recovery IV; Science, Technology, Management and Policy: Florida Geological Survey Special Publication 54 [CD-ROM].

Manheim, F.T., Krantz, D.E., and Bratton, J.F., 2004, Studying ground water under Delmarva coastal bays using electrical resistivity: Ground Water (special issue), v. 42, no. 7, p. 1052-1068.

Martin, J.B., Cable, J.E., Swarzenski, P.W., and Lindenberg, M.K., 2004, Enhanced submarine ground water discharge from mixing of pore water and estuarine water: Ground Water, v. 42, p. 1000-1010.

McCrory, P.A., Danforth, W.W., O'Brien, T.F., and Foster, D.S., 2004, Archive of sidescan-sonar data and DGPS navigation data collected during cruise 97013, Washington Shelf, 6 July-14 July 1997: U.S. Geological Survey Open-File Report 01-508 [DVD-ROM].

Moore, L.J., Jol, H.M., Kruse, S., Vandenburg, S., and Kaminsky, G.M., 2004, Annual layers revealed by GPR in the subsurface of a prograding coastal barrier, southwest Washington, U.S.A.: Journal of Sedimentary Research, v. 74, no. 5, p. 690-696.

Normark, W.R., and McGann, Mary, 2004, Late Quaternary deposition in the inner basins of the California continental borderland—part A. Santa Monica Basin: U.S. Geological Survey Scientific Investigations Report 2004-5183 [URL **http://pubs.usgs.gov/sir/2004/5183/**].

Pendleton, E.A., Thieler, E.R., Williams, S.J., and Beavers, R.L., Coastal vulnerability assessment of Padre Island National Seashore (PAIS) to sea-level rise: U.S. Geological Survey Open-File Report 2004-1090 [URL **http://pubs.usgs.gov/of/2004/1090/**].

Poppe, L.J., Smith, S.M., Lewis, R.S., and DiGiacomo-Cohen, M.L., 2004, Glacial features and sediment transport processes in eastern Long Island and western Block Island Sounds [abs.]: Geological Society of America Annual Meeting, Denver, CO, November 7-10, 2004, Abstracts with Programs, v. 36, no. 5, p. 290, abstract 120-17 [CD-ROM; URL **http://gsa.confex.com/gsa/2004AM/finalprogram/abstract_73899.htm**].

Scanlon, K.M., Coleman, F.C., Koenig, C.C., Twichell, D.C., and Halley, R.B., 2004, Landscape modification and sediment mixing by red grouper and other fish on the West Florida Shelf [abs.]: Geological Society of America Annual Meeting, Denver, CO, November 7-10, 2004, Abstracts with Programs, v. 36, no. 5, p. 302, abstract 124-13 [CD-ROM; URL **http://gsa.confex.com/gsa/2004AM/finalprogram/abstract_77931.htm**].

Sherwood, C.R., Carniel, S., Cavaleri, L., Chiggiato, J., Das, H., Doyle, J.D., Harris, C.K., Niedoroda, A.W., Pullen, J., Reed, C.W., Russo, A., Sclavo, M., Signell, R.P., Traykovski, P., and Warner, J.C., 2004, Sediment dynamics in the Adriatic Sea investigated with coupled models: Oceanography, v. 17, no. 4, p. 58-69.

Shinn, E.A., 2004, The mixed value of environmental regulations; do acroporid corals deserve endangered species status?: Marine Pollution Bulletin, v. 49, p. 531-533 [requested editorial].

Shinn, E.A., Griffin, D.W., Kellogg, C.A., Garrison, V.H., and Holmes, C.W., 2004, Atmospheric deposition of African dust in the Everglades and Florida Bay ecosystem: National Conference on Ecosystem Restoration, 1st, Lake Buena Vista, FL, December 6-10, 2004, Conference Abstracts, p. 389.

Snyder, N.P., Rubin, D.M., Alpers, C.N., Childs, J.R., Curtis, J.A., Flint, L.E., and Wright, S.A., 2004, Estimating accumulation rates and physical properties of sediment behind a dam; Englebright Lake, Yuba River, northern California: Water Resources Research, v. 40, W11301, doi:10.1029/2004WR003279, 2004 [URL **http://www.agu.org/journals/wr/wr0411/2004WR003279/**].

Swarzenski, P.W., 2004, Submarine groundwater discharge—its role in coastal processes and as a potential new proxy for ecosystem restoration: National Conference on Ecosystem Restoration, 1st, Lake Buena Vista, FL, December 6-10, 2004, Conference Abstracts, p. 422.

Swithinbank, C., Williams, R.S., Jr., Ferrigno, J.G., Foley, K.M., Rosanova, C.E., and Dalide, L.M., 2004, Coastal-change and glaciological map of the Eights Coast area, Antarctica, 1972-2001: U.S. Geological Survey Scientific Investigations Series Map I-2600-E, 11 p., scale 1:1,000,000 [URL **http://pubs.usgs.gov/imap/2600/**].

Twichell, D.C., Hanson, A.D., Cross, V.A., and Rudin, M.J., 2004, Sediment accumulations on the bottom of Lake Mead; a 70-year record of depositional processes [abs.]: Geological Society of America Annual Meeting, Denver, CO, November 7-10, 2004, Abstracts with Programs, v. 36, no. 5, p. 551, abstract 238-11 [CD-ROM; URL **http://gsa.confex.com/gsa/2004AM/finalprogram/abstract_75688.htm**].

Twichell, D.C., Schwab, W.C., and Kenyon, N.H., 2004, Review of recent depositional processes on the Mississippi Fan, Gulf of Mexico [abs.]: Geological Society of America Annual Meeting, Denver, CO, November 7-10, 2004, Abstracts with Programs, v. 36, no. 5, p. 303, abstract 124-17 [CD-ROM; URL **http://gsa.confex.com/gsa/2004AM/finalprogram/abstract_75716.htm**].

Publications Submitted for Director's Approval

Baskaran, M., and Swarzenski, P.W., Is the extraction of thorium onto MnO_2-coated filter cartridges uniform?: Marine Chemistry.

Buster, N.A., and Holmes, C.W., Skeletal architecture and magnesium content within the coral *Montastraea faveolata*: Coral Reefs.

Cable, J.E., Martin, J.B., Swarzenski, P.W., Lindenberg, M.K., Advection within shallow pore waters of a coastal lagoon, Florida: Ground Water.

Condie, S.A., and Sherwood, C.R., Sediment distribution and transport across the continental shelf and slope under idealized wind forcing: Progress in Oceanography.

Cross, V.A., Foster, D.S., and Bratton, J.F., Integration of continuous resistivity profiling and seismic-reflection data in the near-shore environment [abs.]: Coastal GeoTools '05, Myrtle Beach, SC, March 7-10, 2005.

Draut, A.E., Rubin, D.M., Dierker, J.L., Fairley, H.C., Griffiths, R.E., Hazel, J.E., Jr., Hunter, R.E., Kohl, Keith, Leap, L.M., Nials, F.L., Topping, D.J., and Yeatts, Michael, Sedimentology and stratigraphy of the Palisades, Lower Comanche, and Arroyo Grande areas of the Colorado River corridor, Grand Canyon, Arizona: U.S. Geological Survey Scientific Investigations Report.

Flocks, J.G., Ferina, N.F., Dreher, C., Kindinger, J.L., FitzGerald, D.M., and Kulp, M.A., High-resolution stratigraphy of a recent delta lobe progradation; north-central Gulf of Mexico: Journal of Coastal Research.

Geist, E.L., and Parsons, Tom, Triggering of tsunamigenic aftershocks from large strike-slip earthquakes; analysis of the November

(Publications Submitted continued on page 25)

(Publications Submitted continued from page 24)

16-17, 2000, New Ireland earthquake sequence: Geochemistry, Geophysics, Geosystems.

Gelfenbaum, Guy, Lesser, Giles, Kaminsky, George, Landerman, Laura, and Ruggiero, Peter, Modeling shoreline erosion and channel migration in a highly dynamic bay entrance; Willapa Bay, WA [abs.]: International Conference on Coastal Dynamics, 5th, Barcelona, Spain, April 4-8, 2005.

Griffin, D.W., Kubilay, N., Kocak, M., Gray, M.A., Borden, T.C., Kellogg, C.A., and Shinn, E.A., A correlation between airborne desert dust and microorganisms over the Turkish Mediterranean coastline [abs.]: International Symposium on Remote Sensing of Environment, 31st, St. Petersburg, Russia, June 20-24, 2005.

Griffin, D.W., Kubilay, N., Kocak, M., Gray, M.A., Borden, T.C., Kellogg, C.A., and Shinn, E.A., Dust storms and aeromicrobiology over the Turkish Mediterranean coastline [abs.]: American Society for Microbiology General Meeting, Atlanta, GA, June 5-9, 2005.

Kellogg, C.A, McLaughlin, M.R., and Stone, R.P., Microbial ecology of deep-sea corals [abs.]: American Society for Microbiology General Meeting, Atlanta, GA, June 5-9, 2005.

Kvenvolden, K.A., Organic geochemistry—its recognition as a geoscience [abs.]: American Chemical Society National Meeting, 229th, San Diego, CA, March 13-17, 2005.

Logan, J.B., Field, M.E., and Chavez, P.S., Views of a fringing coral reef, Moloka'i, Hawai'i: U.S. Geological Survey Scientific Investigations Map.

Molnia, B.F., Krimmel, R.M., Manley, W.E., March, R.S., Molnia, B.F., and Trabant, D.C., Glaciers of Alaska (Glaciers of the United States, Glaciers of North America), *in* Williams, R.S., Jr., and Ferrigno, J.G., eds., Satellite image atlas of glaciers of the world: U.S. Geological Survey Professional Paper 1386-K.

Moore, Laura, Ruggiero, Peter, and List, Jeff, Comparing mean-high water and high water line shorelines; should proxy-datum offsets be incorporated in shoreline change analysis?: Journal of Coastal Research.

Normark, W.R., Gutmacher, C.E., and Sliter, Ray, Natural hydrocarbon seeps on the inner shelf off Point Conception and western Santa Barbara Channel, California [abs.]: Joint AAPG/SEPM Pacific Section and GSA Cordilleran Section Meeting, San Jose, CA, April 29-May 1, 2005.

Poag, C.W., A Chesapeake chronicle; discovering a buried impact crater [abs.]: American Association for the Advancement of Science Annual Meeting, Washington, DC, February 17-21, 2005.

Poore, R.Z., and Quinn, T.M., Holocene variability in the Atlantic Intertropical Convergence Zone and the southwest monsoon [abs.]: Geological Society of America, Southeastern Section Annual Meeting, Biloxi, MS, March 17-18, 2005.

Poppe, L.J., Foster, D.S., Danforth, W.W., Butman, B., Blackwood, D.S., and Masterson, J.P., Character and distribution of exposed glaciolacustrine sediments off outer Cape Cod, Massachusetts [abs.]: Geological Society of America, Northeastern Section Annual Meeting, 40th, Saratoga, NY, March 14-16, 2005.

Rashid, H., Quinn, T.M., and Poore, R.Z., Do the Bay of Bengal *Globigerinoides ruber* ^{18}O data represent the diminishing trend of the Indian Ocean monsoon during the late Holocene? [abs.]: Chapman Conference on Tropical-Extratropical Climatic Teleconnections, a Long-Term Perspective, Honolulu, Hawaii, February 8-11, 2005.

Scanlon, K.M., Ackerman, S.D., and Rozycki, J.E., Sedimentary environments of east and west Flower Garden Banks area: Gulf of Mexico Science.

Shinn, E.A., Lidz, B.H., and Hickey, T.D., 250 Miles of reef history; Ft. Lauderdale to Dry Tortugas [abs.]: AAPG/SEPM Annual Meeting, Calgary, Canada, June 19-22, 2005.

Storlazzi, C.D., and Wingfield, D.K., The spatial and temporal variability in oceanographic and meteorologic forcing along central California; 1980-2002: U.S. Geological Survey Scientific Investigations Report.

Sweeney, E.M., Ackerman, S.D., Cross, V.A., Andrews, B., and Blackwood, D., Managing ground-truth survey data with ARCGIS [abs.]: Coastal GeoTools '05, Myrtle Beach, SC, March 7-10, 2005.

Sweeney, E.M., Danforth, W.W., Karl, H.A., O'Brien, T.F., and Schwab, W.C., The Gulf of the Farallones; sidescan-sonar imagery: U.S. Geological Survey Open-File Report 2004-1082.

Todd, B.J., Noji, T.T., Snow-Cotter, S.A., Tyrell, M.C., Valentine, P.C., and Killerlain, K., The Gulf of Maine mapping initiative; a framework for ocean management [abs.]: Gulf of Maine Council on the Marine Environment Gulf of Maine Summit, St. Andrews, New Brunswick, Canada, October 26-29, 2004.

Winters, W.J., Waite, W.F., Mason, D.H., and Gilbert, L.Y., Physical properties of sediment containing methane gas hydrate [abs.]: Symposium on Gas Hydrate and Clathrates, American Chemical Society, Petroleum Chemistry Division, San Diego, CA, March 13-17, 2005.

Winters, W.J., Waite, W.F., Mason, D.H., and Gilbert, L.Y., Physical properties of sediment containing methane gas hydrate [paper]: Symposium on Gas Hydrates and Clathrates, American Chemical Society, Petroleum Chemistry Division, San Diego, CA, March 13-17, 2005.

Winters, W.J., Waite, W.F., Mason, D.H., Gilbert, L.Y., and Hutchinson, D.R., Determination of *in situ* methane gas hydrate stability and properties [abs.]: National Gas Hydrate Program of India Workshop, New Delhi, India, January 15, 2005.