USGS

Sound Waves Coastal Science and Research News from Across the USGS

http://soundwaves.usgs.gov/

Fieldwork

Astonishing Wave Heights Among the Findings of an International Tsunami Survey Team on Sumatra

By Helen Gibbons and Guy Gelfenbaum

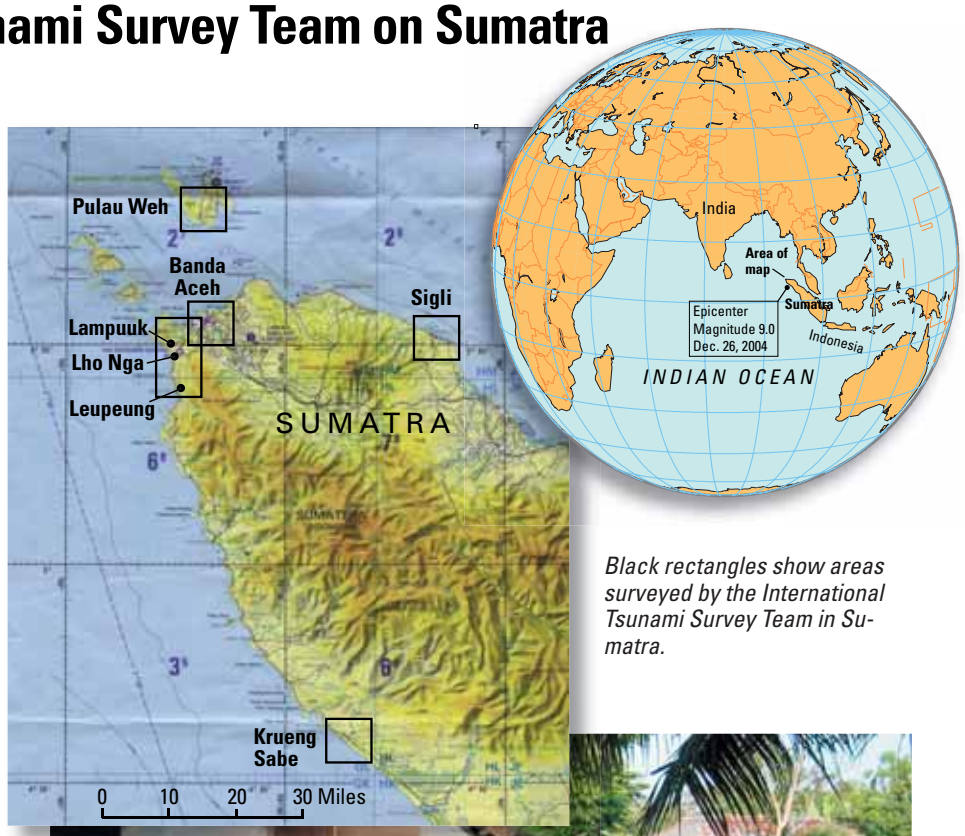
An International Tsunami Survey Team (ITST) studying the effects of the December 26 tsunami on Indonesia's island of Sumatra documented wave heights of 20 to 30 m (65 to 100 ft) at the island's northwest end and found evidence suggesting that wave heights may have ranged from 15 to 30 m (50 to 100 ft) along a 100-km (60 mi) stretch of the northwest coast. These wave heights are higher than those predicted by computer models made soon after the earthquake that triggered the tsunami. "Groundtruthing" the models, which are used to forecast tsunamis for early-warning systems and long-term planning efforts, was one of the main goals of the scientific survey.

The survey was conducted from January 20 to 29 in the province of Aceh, which lies only 100 km (60 mi) from the epicenter of the earthquake and sustained what many consider the worst tsunami damage of all affected areas. About a third of the 320,000 residents of Aceh's capital, Banda Aceh, are dead or missing, accounting for much of Indonesia's toll of more than125,000 dead and 90,000 missing.

Led by **Yoshinobu Tsuji** of the University of Tokyo's Earthquake Research Institute, the survey team consisted of nine scientists from Japan, six from Indonesia, two from France, and two from the United States. The U.S. scientists were **Andy Moore** of Kent State University and **Guy Gelfenbaum** of the U.S. Geological Survey (USGS).

The team collected information about wave heights at the beach and inland, inundation distance (how far inland the water reached), runup elevation (the water's height relative to mean sea level at its

(Tsunami continued on page 2)



Black rectangles show areas surveyed by the International Tsunami Survey Team in Sumatra.

Survey team members. Standing, left to right: ***Budi Waluyo***, ***Takanobu Kamataki***, ***Yuichi Nishimura*** *(leaning over, with cap in hand),* ***Sindhu Nugroho***, ***Rahmat Triyono*** *(wearing red cap),* ***Raphael Paris***, ***Yudhicara***, ***Franck Lavigne***, ***Inyoman Sukanta***, ***Yuichiro Tanioka****, team leader* ***Yoshinobu Tsuji***, ***Hideo Matsutomi****, and* ***Guy Gelfenbaum****. Kneeling in front, left to right:* ***Tsutomu Sakakiyama***, ***Yoshikane Murakami****, and* ***Andrew Moore****.* ***Alphonso*** *was part of the team in Sumatra but is not pictured. Members of the team who contributed from Japan are* ***Masafumi Matsuyama*** *and* ***Yuichi Namegaya****.*

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 May 2005 issue of *Sound Waves* is Thursday, April 14.
Publications: When new publications or products are released, please notify the editor with a full reference and a bulleted summary or description.
Images: Please submit all images at publication size (column, 2-column, or page width). Resolution of 200 to 300 dpi (dots per inch) is best. Adobe Illustrator© files or EPS files work well with vector files (such as graphs or diagrams). TIFF and JPEG files work well with raster files (photographs or rasterized vector files).

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)

farthest reach inland), flow directions, erosion, sediment deposition, and coastal subsidence.

The team gathered some of its information from eyewitness accounts. Though not always reliable (commonly, eyewitnesses are running for their lives as they observe the tsunami), the eyewitness accounts collected in Sumatra provided several consistent pieces of information:

*Survey-team members **Franck Lavigne** (white cap, second from right) and **Alphonso** (far right) collect eyewitness accounts from residents in Banda Aceh. Photograph by **Guy Gelfenbaum**, USGS.*

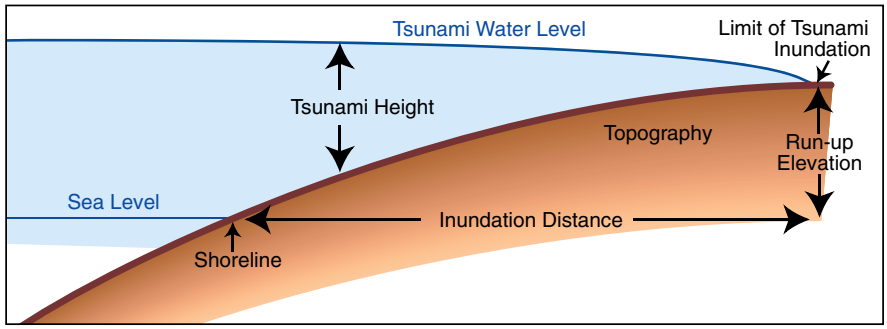
- In Banda Aceh, the city closest to the earthquake epicenter, the tsunami arrived about 15 to 20 minutes after the earthquake was felt.
- Many buildings in Banda Aceh withstood the earthquake shaking but were destroyed by the tsunami waves.
- Likely because of the area's low elevation, the first tsunami wave that struck Banda Aceh did not have time to recede before the arrival of the next wave: the second tsunami wave rode over the first, and the third rode over the second.

Being just landward of the subduction zone where the tsunami-generating earthquake occurred, northwestern Sumatra was struck by a "near field" tsunami. In contrast, areas across the ocean from the earthquake epicenter, such as Sri Lanka, were struck by "far field" tsunamis. The rapid arrival of the tsunami in near-field locations—just 15 to 20 minutes in Banda Aceh—means that a tsunami early-warning system, now in the planning stages for the Indian Ocean, should be accompanied by tsunami education and long-term emergency and land-use planning efforts for the most effective mitigation of tsunami hazards.

Because the tsunami washed out many roads and bridges, the scientists had to hike long distances to reach some field areas, and on several occasions used makeshift rafts constructed from barrels and boards to cross rivers. Despite such complications, they were able to collect much data, which will be used to improve both the scientific understanding of tsunamis and the computer models used to predict tsunami effects.

To measure wave heights, the scientists looked for water stains on buildings and broken branches and debris in trees (where buildings and trees were left standing), then used laser rangefinders to calculate

(Tsunami continued on page 3)



*Some of the tsunami characteristics typically measured by survey teams (see URL **http://walrus.wr.usgs.gov/tsunami/srilanka05/measurements.html**).*

(Tsunami continued from page 2)

the heights. The west-facing coastlines were struck by the highest waves, some more than 30 m high. Waves that wrapped around the island to hit the north-facing coastline of Banda Aceh were lower, about 10 m high, but the area's low-lying land allowed those waves to penetrate far inland. Inundation distances in the province were so large that they were most easily measured from satellite images, where sediment deposited by the waves and vegetation killed by the saltwater are clearly visible. One such image (next page) shows that the waves that struck the villages of Lampuuk and Lho Nga on the west coast met the waves that struck Banda Aceh from the north.

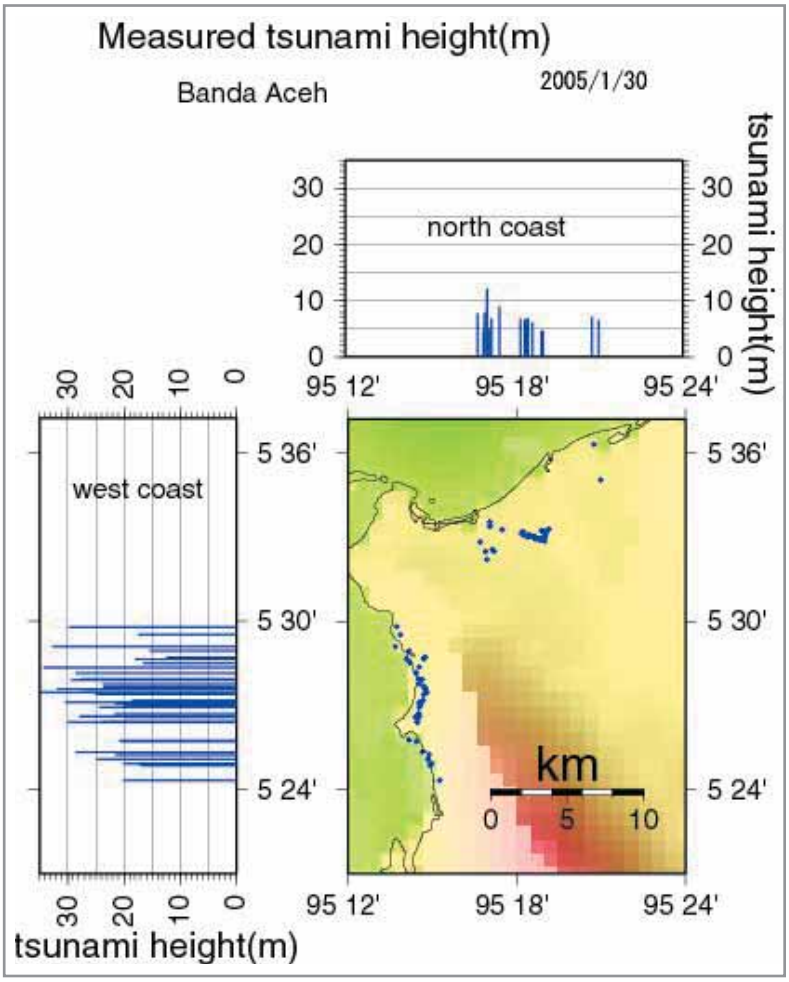
Items broken and bent by the tsunami waves, as well as sedimentary structures in the tsunami deposits, were used to determine flow directions. The scientists found that the large tsunami waves flowed around natural barriers, flooding low-lying areas behind them.

The researchers surveyed beach profiles to document erosion (common near the coast) and deposition (common inland) by the tsunami. Sand eroded from beaches probably provided much of the sand that was deposited inland. The survey team dug trenches in the tsunami deposits to measure their thickness and to examine other characteristics that can shed light on how high the waves were and how fast the water was flowing. Data from the sediment

(Tsunami continued on page 4)

*The powerful tsunami waves snapped off trees, swept buildings from their foundations, and stranded the coal barge and tugboat shown in these photographs taken south of Lho Nga. The line along the cliff where thick green vegetation (above) meets brown rock and rubble (below) marks the elevation reached by tsunami waves here: 31 m (102 ft) above sea level. Wide view southward; closeup view northward. Photographs by **Guy Gelfenbaum**, USGS.*

*Steel beam bent by debris carried in the powerful waves that struck Lho Nga on Sumatra's west coast. Photograph by **Guy Gelfenbaum**, USGS.*



Graphs of tsunami heights measured by the survey team in Banda Aceh (north coast) and along the west coast from Lampuuk to Leupeung.

(Tsunami continued from page 3)

deposits will not only tell scientists about the recent tsunami but also help them recognize and interpret the deposits of ancient tsunamis, which, in turn, will help them better understand an area's tsunami history and its likely tsunami risk (see "USGS Scientists Study Sediment Deposited by 2004 Indian Ocean Tsunami" in *Sound Waves*, February 2005).

Models predict that the type of earthquake that caused the tsunami—a megathrust—will raise the sea floor above the fault rupture and cause subsidence near the coast. So, the team was not surprised to find evidence that coastal land had subsided in Sumatra. Trees with roots and lower trunks submerged in seawater

(Tsunami continued on page 5)

*A mosque is left standing amid the rubble in Banda Aceh. Several mosques survived and may have been saved by the open ground floor that is part of their design. The tsunami waves reached the middle of the second floor. Photograph by **Guy Gelfenbaum**, USGS.*

*Cross-sectional view of tsunami deposits at the village of Lampuuk. A 73-cm thickness of sand was deposited over soil (dark material in bottom center), in beds indicating multiple pulses of sand deposition. The lowermost bed, 45 cm of sand grading upward from coarse to fine, settled from suspension in a single wave and can be used to characterize the wave's height and velocity. Photograph by **Guy Gelfenbaum**, USGS.*

*Brown tones of tsunami deposits and vegetation killed by saltwater show the extent of the tsunami's inundation in this satellite image of northwestern Aceh province. Arrows indicate tsunami flow directions. Note that tsunami waves flowing in from the north met waves from the west in one area. Satellite image acquired using Space Imaging's IKONOS satellite (see URL **http://www.spaceimaging.com/**) and processed by the Centre for Remote Imaging, Sensing and Processing (CRISP), National University of Singapore (see URL **http://www.crisp.nus.edu.sg/tsunami/**).*

***Guy Gelfenbaum** measures coastal subsidence along Sumatra's northwest coast on the basis of trees whose roots and lower trunks are now submerged in saltwater. The land here subsided 1 to 2 m during the earthquake; the treetops were snapped off by the tsunami.*

(Tsunami continued from page 4)

indicate that coastal land subsided 1 to 2 m (3 to 6 ft) in some areas. Japanese team member **Yuichiro Tanioka** and his Indonesian graduate student **Yudhicara** resurveyed parts of Banda Aceh for which older elevation maps were available and discovered that the land there had subsided by 28 to 57 cm (about 1 to 2 ft).

The scientists' efforts were focused mainly around the very northwest end of Sumatra, but they also collected data about 100 km (60 mi) to the south, at Kreung Sabe. Wave heights of 15 m (50 ft) at that site suggest that the tsunami waves may have been unusually high, 15 to 30 m, along the entire 100-km stretch of coast from Kreung Sabe to the northwest tip of the island. USGS scientists hope to return to Sumatra in April to test this hypothesis by measuring wave heights at intermediate points along the coastline and to collect additional data, such as nearshore bathymetry and sediment-deposit profiles. ❁

*Erosion of beach sand is evident in this before-and-after pair of satellite images of the coast at Lampuuk. White structure near the center of the images is a mosque that survived the tsunami. Satellite image acquired using Space Imaging's IKONOS satellite (see URL **http://www.spaceimaging.com/**) and processed by the Centre for Remote Imaging, Sensing and Processing (CRISP), National University of Singapore (see URL **http://www.crisp.nus.edu.sg/tsunami/**).*

USGS Flood-Response Teams Documented Effects of Hurricane Charley in Southwest-Central Florida in August 2004

By Robert Blanchard

Hurricane Charley made landfall at 3:45 p.m. Eastern Daylight Time (EDT) at Cayo Costa, just north of the barrier island Captiva in Lee County, FL, on August 13, 2004. The storm was a Category 4 hurricane with winds of about 140 mph at the time it hit the Florida coast. In the days after the storm, U.S. Geological Survey (USGS) scientists hurried out to document its effects. While researchers from the USGS center in St. Petersburg, FL, were flying over the coast to photograph coastal erosion and deposition (see article in *Sound Waves*, October 2004, at URL **http://soundwaves.usgs.gov/2004/10/**), flood-response teams from the USGS Tampa Hydrologic Data Section were on the ground, measuring streamflow and other effects of the storm throughout southwest-central Florida.

Hurricane Charley's eye wall passed over Punta Gorda and Port Charlotte, snapping utility poles, damaging buildings, and flooding roads. Storm surge from the hurricane

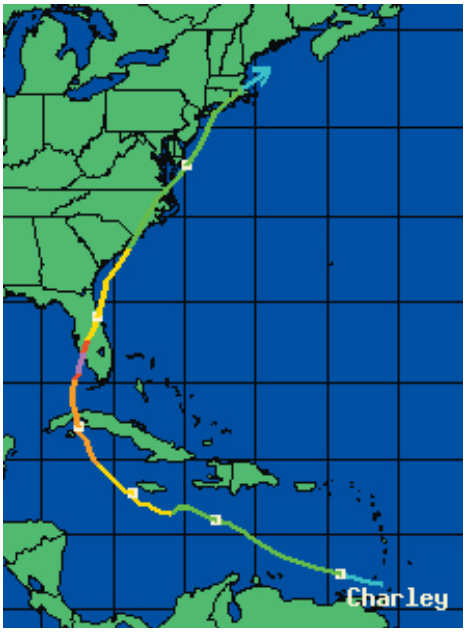
(Hurricane Charley continued on page 6)

Florida storm damage from Hurricane Charley in Arcadia (above) and along Interstate 75 near Punta Gorda (below).

(Hurricane Charley continued from page 5)

was about 4 ft. The center of the hurricane continued northeast at about 25 mph and moved through Fort Ogden, Arcadia, Zolfo Springs, and Wachula, passing Lake Wales at approximately 7:45 p.m. (EDT). Charley moved off the northeast coast of Florida near Daytona Beach at around 11:00 p.m. (EDT) as a Category 1 hurricane. The most intense damage occurred in a band approximately 10 mi wide around the eye wall; less intense damage occurred outward from the center approximately 35 mi. High winds and floodwater from this storm caused damage to public and private property, with an approximate cost to insurers of $7.4 billion (Insurance Information Institute).

Flood-response teams from the USGS Tampa Hydrologic Data Section were deployed after the passing of Hurricane Charley to measure discharge (streamflow), conduct inspections, and make repairs to USGS gauging stations in Charlotte, Sarasota, Manatee, Hardee, Highlands, and Polk Counties. Two stream-gauging stations were destroyed and nine were damaged by the high winds and floodwaters associated with the hurricane. In addition to the flood-response effort, survey crews were sent to flag high-water marks left by the storm surge along the coastline in Charlotte County. High-water marks were used to determine the maximum elevation of floodwaters. Precipitation recorded at three USGS gauging stations in southwest-central Florida ranged from 1.6 to 5.4 inches during the storm.



Track of Hurricane Charley, August 9-15, 2004 (based on data from the National Weather Service). (A larger map, with additional information about windspeeds, is available at URL ***http://soundwaves.usgs.gov/2005/03/fieldwork2.html****.)*

USGS employee (arrow) flags high-water marks from Hurricane Charley storm surge in Charlotte County.

Stream-gauging station, Peace Creek Drainage Canal 02293987, before (above) and after (below) Hurricane Charley.

The Tampa Hydrologic Data Section operates a network of streamflow-gauging stations in southwest-central Florida in cooperation with Federal, State, and local agencies. Data from these stations are crucial for water-supply planning, flood monitoring, emergency response, dam- and reservoir-system operation, establishing flood-insurance rates, and engineering and maintenance of bridges, roads, and other structures. Most of these stations provide real-time data through satellite relay or radio telemetry. The National Weather Service, the Southwest Florida Water Management District, and other agencies use the data to maintain water supplies, forecast floods, and issue flood warnings.

USGS Geologist Invited to Map Tsunami Impacts in the Maldives

By Helen Gibbons and Bruce Richmond

U.S. Geological Survey (USGS) coastal geologist **Bruce Richmond** was invited to the Republic of Maldives, a nation of low-lying atolls south-southwest of India, to help map the impacts of the Indian Ocean tsunami of December 26, 2004. An archipelago of 1,190 coral islands grouped into 26 atolls, the Maldives has an average elevation of just 1.5 m. Waves ranging from 1 to 3.7 m high were reported throughout the archipelago, with the waves sweeping completely across many of the islands.

Because of its low elevation, the tiny island nation has long urged larger, more powerful nations to take action against global warming, fearing that higher sea levels could make much of its territory disappear. December's tsunami demonstrated just how vulnerable the low-lying islands are, affecting all of them to some degree and making more than 10 percent of them uninhabitable. The Maldive government is seeking recommendations to help mitigate

(Maldives continued on page 7)

(Maldives continued from page 6)

future tsunami impacts, and its Ministry of Environment and Construction asked the U.S. Agency for International Development (USAID) for the technical assistance of a geologist. USAID's Office of Foreign Disaster Assistance (OFDA) contacted **Richmond**, who has extensive experience in mapping and assessing the coastal hazards of Pacific Ocean islands, and invited him to participate in field studies to provide expert information on the geologic development of atoll islands and the impact of tsunamis on low-lying islands.

Collapsed building on the island of Gemendhoo, Maldives, one of the islands made uninhabitable by the December 26 tsunami. (Photograph from the Maldives National Disaster Management Centre, URL ***http://www.tsunamimaldives.mv/****.)*

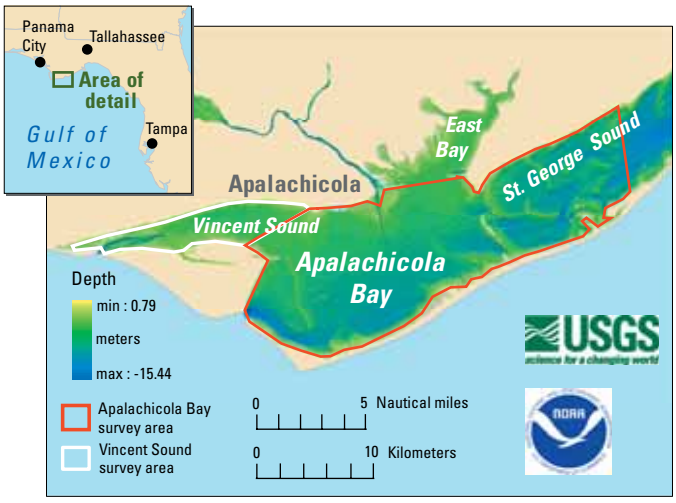
Richmond spent Feburary 18 to March 1 in the Maldives, working closely with Maldivean scientists and personnel from the Ministry of Environment and Construction. The group measured tsunami water levels, runup elevations, inundation distances, and flow directions. They surveyed topographic profiles, measured erosion depths, recorded tsunami-sediment-deposit thicknesses and characteristics, and took georeferenced photographs of tsunami impacts. Still in the Maldives as of this writing, **Richmond** will provide briefings to government personnel before he leaves the island nation, and will later provide a written report of his findings and recommendations. Check future issues of *Sound Waves* for an account of his fieldwork.❁

Mapping Oyster Beds in Apalachicola Bay, FL

By Dave Twichell

The U.S. Geological Survey (USGS) Woods Hole Science Center's research vessel *Rafael*, prickling with acoustic sensors, headed to northwestern Florida in March to probe the shallow muddy waters of Apalachicola Bay to develop an updated map of oyster bed distribution in the bay. Apalachicola Bay is the largest oyster fishery in the Southeastern United States, yet its future health is in question because of the growing interest in damming rivers that drain into the bay to meet urban water needs. The mapping, which is being done in collaboration with the National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center and the Apalachicola Bay National Estuarine Research Reserve, will provide a baseline for future monitoring of the bay. The USGS is taking the lead on collection of sidescan-sonar imagery, bathymetry, and high-resolution seismic data to map the geologic framework of the bay and the distribution of oyster reefs, while NOAA scientists oversee the biological aspects of the study. The Woods Hole "Snowbird" crew headed south in mid-March and will spend a month conducting the geophysical mapping.❁

USGS research vessel Rafael *in Vineyard Sound, near the vessel's homeport in Woods Hole, MA.*



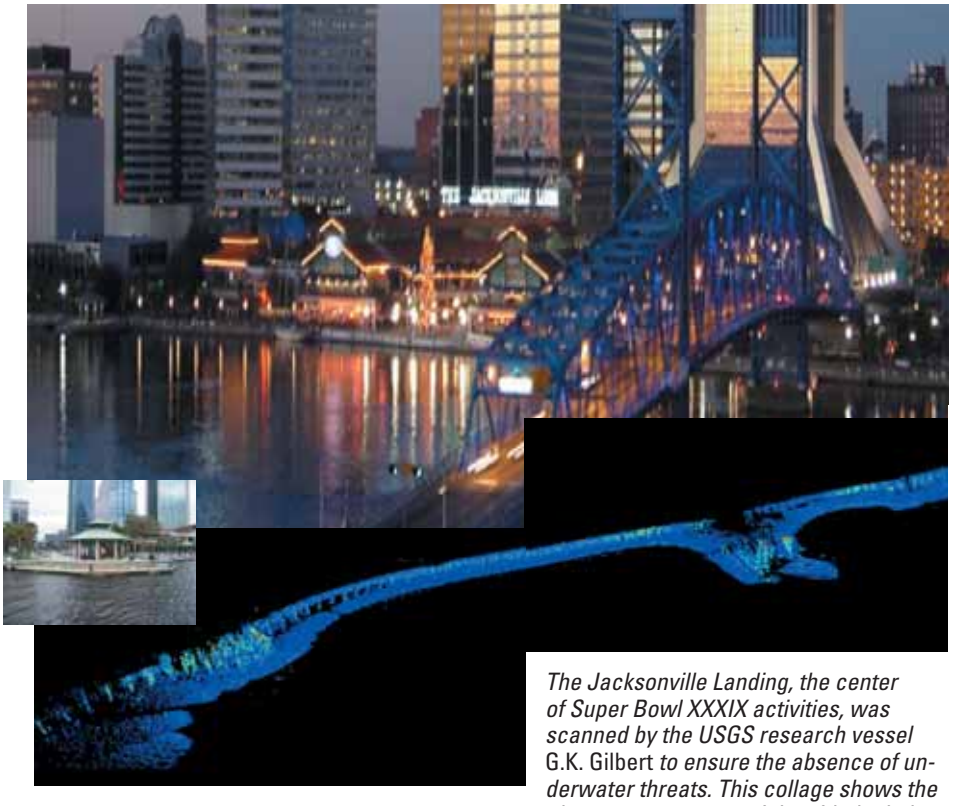
Location of study area in Florida.

USGS Research Vessel *G.K. Gilbert* Helps Secure Super Bowl XXXIX

By Captain Rich Young and John Kloske

The U.S. Geological Survey (USGS) research vessel *G.K. Gilbert*, based in St. Petersburg, FL, augmented security for Super Bowl XXXIX, the National Football League's championship football game played on February 6, 2005, in Jacksonville, FL. The *Gilbert* scanned miles of piers, docks, bulkheads, and bridge abutments along Jacksonville's waterfront with an underwater Mobile Inspection Package (MIP) developed by the University of South Florida's Center for Ocean Technology (USF-COT). USF-COT has been developing the system for two years with funding and oversight provided by the Office of Naval Research and the Coast Guard Research and Development Center. Chief Scientist **John Kloske** (USF) conducted the cruises with Captains **Richard Young** (USGS) and **Dave Bennett** (Eckerd College) at the request of the Jacksonville Sheriff's Office and with the support of the Florida State Department of Community Affairs and the assistance of the Florida Fish and Wildlife Conservation Commission. Operations were coordinated and supervised by the USF National Center for Maritime and Port Security.

The MIP consists of a 3D-imaging sonar and a high-resolution-imaging sonar, a topside camera, and a high-accuracy navigation system. The sonars were mounted on a pole extending 6 ft under the boat. Piers, docks, bridge abutments, and seawalls around downtown Jacksonville's Alltel Stadium were scanned at 3 knots from a distance of 50 ft to inspect them for suspicious objects that could be explosive devices. During the week before the game, the *Gilbert* scanned multiple times more than 2 mi of the St. Johns River shoreline. The Jacksonville Sheriff's Office had designated these areas of special interest because of the security risk posed to Super Bowl activities, including the cruise-ship docks where guests and visiting dignitaries (including two past presidents) would be accommodated. The high-resolution images were analyzed immediately aboard the *Gilbert* and transmitted in real time to a Command and Control Center set up aboard the Florida Institute of Oceanography's research vessel *Suncoaster* (berthed a few miles away) for further analysis by explosives experts from the Jacksonville Sheriff's Office.



The Jacksonville Landing, the center of Super Bowl XXXIX activities, was scanned by the USGS research vessel G.K. Gilbert *to ensure the absence of underwater threats. This collage shows the above-water area at night with the below-water seawall structures that support it, including those beneath the gazebo (inset) on the left and along the St. John's River waterfront to the bridge abutment on the right. Photographs by* ***Steve Untiedt*** *(USF).*

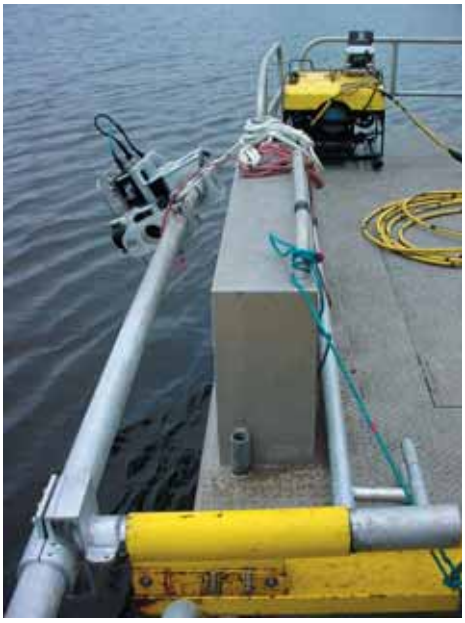
USGS research vessel G.K. Gilbert *(50 ft long) running alongside the Holland America Line's merchant vessel* Zaandam *(780 ft long), one of four cruise ships that provided accommodations for guests and dignitaries in Jacksonville, FL, during Super Bowl XXXIX. Photograph by* ***Steve Untiedt*** *(USF).*

These data were used as a baseline for subsequent scans made before the Super Bowl and will also provide a valuable database for future events. Numerous suspicious objects were detected and subsequently investigated by a remotely

(Super Bowl continued on page 9)

(Super Bowl continued from page 8)

operated vehicle (ROV) equipped with a high-resolution-imaging sonar and a video camera, which determined that most of the objects were construction debris and harbor jetsam. Remaining targets were investigated by sheriff's divers and found not to be explosive devices. This approach reduced the divers' time in the water, which is especially important in the tidally influenced St. Johns River, where dives are restricted to short periods of slack water four times a day. The sheriff's office was pleased with the MIP system and grateful for our assistance, saying it eliminated many hours of dangerous underwater time for divers in the treacherous St. Johns River, which is known for its strong currents, poor visibility, and cold water this time of year.



Two scanning sonar heads are mounted on the end of a swing-down pole off the starboard gunnel of the USGS research vessel G.K. Gilbert. *The remotely operated vehicle (ROV) stands ready on the fantail. Photograph by* ***Steve Untiedt*** *(USF).*

Alltel Stadium in downtown Jacksonville where Super Bowl XXXIX was played. Some spectators came in large yachts that were scanned and checked by divers. Photograph by ***Steve Untiedt*** *(USF).*

With this successful deployment of the MIP system aboard the *Gilbert* to secure the Jacksonville waterfront during Super Bowl XXXIX, the results of post-9/11 port security research and development investments are beginning to be realized, and the safety of our ports and waterways will be significantly enhanced.

Tsunami News Conference in Menlo Park, CA, Puts USGS in Media Spotlight

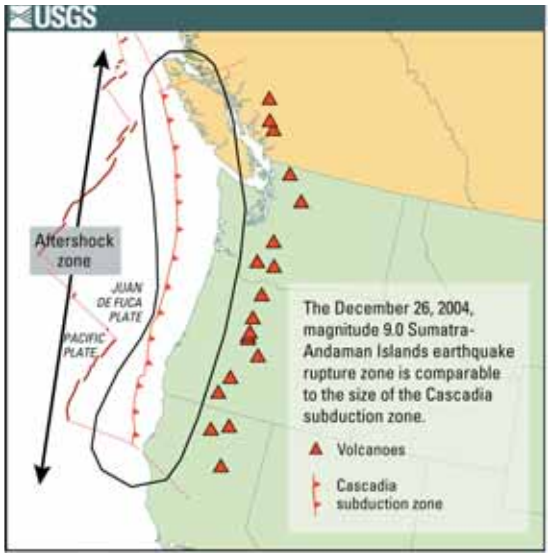
By Helen Gibbons

A news conference about U.S. Geological Survey (USGS) studies of last December's Indian Ocean tsunami, held February 17, 2005, at the USGS science center in Menlo Park, CA, prompted several news stories in major media outlets in the San Francisco Bay area.

Sam Johnson, chief scientist of the Western Coastal and Marine Geology (WCMG) team, which hosted the event, led off the conference with a brief introduction to USGS geologic-hazards research, then turned the podium over to the tsunami experts.

Geophysicist **Eric Geist** described the magnitude 9.0 earthquake that occurred near Sumatra on December 26, 2004, and used computer animation to explain how the earthquake generated the powerful tsunami (see URL **http://walrus.wr.usgs.gov/tsunami/sumatraEQ/**). He compared the subduction zone off Sumatra with the Cascadia subduction zone off the U.S. Pacific Northwest and discussed the possibility of a large earthquake and tsunami in that region. **Geist** also described new earthquake- and tsunami-notification technology developed by the California Integrated Seismic Network (CISN, see URL **http://www.cisn.org/**) under funding from the California Governor's Office of Emergency Services (URL **http://www.oes.ca.gov/**). The new Internet-based application "pushes" real-time earthquake information and notices of the availability of tsunami-warning messages to the user's desktop computer; it can be configured to relay this information by e-mail and trigger both audible and visual alarms. Notification can also be provided to cell phones and pagers, a feature that would be particularly useful in countries where

(News Conference continued on page 10)



A comparison between the subduction zone off Sumatra, where the tsunami-triggering earthquake occurred, and the Cascadia subduction zone off the U.S. Pacific Northwest was one of the items that captivated reporters at the February 17 press conference in Menlo Park, CA. (Modified from figure by ***Pat McCrory****, USGS Earthquake Hazards, at URL* ***http://earthquake.usgs.gov/eqinthenews/2004/usslav/rupture_area-nw.html****.)*

(News Conference continued from page 9)

public warning systems, such as sirens, are impractical but cell phones are quite common.

Geologists **Guy Gelfenbaum** and **Bruce Jaffe** described the initial findings of international tsunami-survey teams in Indonesia (**Gelfenbaum**) and Sri Lanka (**Jaffe**). Measurements of immense waves (more than 30 m high) in northwestern Sumatra and huge tsunami sand deposits (more than 2 million m^3) in Sri Lanka, plus striking photos from both regions, were among the items that captured the reporters' attention. One member of the survey team in Sri Lanka, **Bob Morton**, a geologist at the USGS Center for Coastal and Watershed Studies in St. Petersburg, FL, was not present at the Menlo Park news conference but shared his observations a few weeks earlier with the news media in Florida.

Also absent from the news conference was WCMG team member **Bruce Richmond**, who was preparing to leave for the Republic of Maldives to lend his expertise to a tsunami-survey team in the low-lying atolls of that island nation (see related *Sound Waves* article, this issue).

During the question-and-answer session at the end of the conference, **Bill Ellsworth**, chief scientist of the USGS Earthquake Hazards team, joined the marine scientists to field questions about the earthquake and tsunami.

The hour-long news conference resulted in stories that evening on three local television stations (affiliates of Fox, CBS, and ABC), interviews on a major San Francisco Bay area radio station (KCBS), a front-page story in the *San Francisco Chronicle*, and interest from the *Portland Oregonian*, the *Menlo Park Almanac* (a local weekly), and the Ming Pao News Service, based in Hong Kong.

Later that day, **Gelfenbaum** and **Jaffe** presented a lecture on their tsunami fieldwork to a standing-room-only crowd in a large lecture hall on the Menlo Park campus. The presentation was videostreamed online to more than 300 additional viewers, and an archived copy can be accessed from URL **mms://video.wr.usgs.gov/science/tsunami05.wmv** (requires Windows Media Player for viewing).

New USGS Web Sites About 2004 Indian Ocean Tsunami

By Bruce Jaffe and Eric Geist

Recently posted World Wide Web sites present some of the results of U.S. Geological Survey (USGS) studies of the 2004 Indian Ocean tsunami.

"The December 26, 2004 Indian Ocean Tsunami: Initial Findings on Tsunami Sand Deposits, Damage, and Inundation in Sri Lanka" (URL **http://walrus.wr.usgs.gov/tsunami/srilanka05/**) presents initial findings from USGS scientists **Bruce Jaffe** (Santa Cruz, CA) and **Robert Morton** (St. Petersburg, FL), who were members of a Sri Lanka International Tsunami Survey Team (ITST) that collected data from January 9-14, 2005, to improve the understanding of the December 26, 2004, tsunami (see related article in *Sound Waves*, February 2005, at URL **http://soundwaves.usgs.gov/2005/02/**). The primary goal of the Sri Lanka ITST was to assist Sri Lanka through the team's scientific expertise, especially in developing new techniques for disaster mitigation and prediction. In addition to describing the team's initial findings, the Web site offers clear explanations of common terms in tsunami science, the methods used to gather data during post-tsunami surveys, and the importance of the types of data the team collected. It includes photographs from about a dozen of the areas where **Jaffe** and **Morton** took measurements to document the tsunami and the sand it deposited onshore.

*This photograph from the new Web site about fieldwork in Sri Lanka (URL **http://walrus.wr.usgs.gov/tsunami/srilanka05/**) demonstrates the importance of collecting data soon after the tsunami (cleanup operations had already redistributed some of the sediment and removed some of the debris that the survey team in Sri Lanka might have used to gather information about the tsunami).*

"Tsunami Generation from the 2004 M=9.0 Sumatra Earthquake" (URL **http://walrus.wr.usgs.gov/tsunami/sumatraEQ/**) presents an overview of the earthquake that triggered the tsunami, seismological aspects of tsunami generation, and a visual simulation of the recent tsunami's generation and propagation created by USGS scientist **Eric Geist**. The site describes the tectonic setting where the tsunami-generating earthquake occurred, explains how earthquake characteristics affect a tsunami's intensity, compares the recent earthquake with other tsunami-generating earthquakes, and briefly discusses the techniques and assumptions used to create computer models of the tsunami. Computer models are important tools used to predict tsunami intensity, both for short-term emergency notification and for long-term coastal-zone planning. Three animations of the Indian Ocean tsunami can be viewed on the site: one near the epicenter off northern Sumatra showing the first 33 minutes of propagation, a second showing the first 66 minutes of propagation across the Bay of Bengal from a view looking northwestward, and a third showing propagation across the Bay of Bengal from a view looking southeastward.

Greg Smith Named New Director of USGS National Wetlands Research Center

By Gaye Farris

Gregory J. Smith has been named the new director of the U.S. Geological Survey (USGS) National Wetlands Research Center, headquartered in Lafayette, LA. He replaces **Robert E. Stewart, Jr.**, who has retired from the Department of the Interior after 30 years of service, 25 of those years as director of the center. (See related article, this issue.)

Smith said, "I am honored to join the talented and dedicated staff of the National Wetlands Research Center, and I look forward to building on the important partnerships and science programs that have been a hallmark of the center's history."

Stewart said of his replacement, "The center is indeed fortunate to have **Dr. Smith** as a new director. He has exactly the right skills and experience to lead the center in the 21st century."

Smith has more than 25 years of ecological research and management experience, with a background in population dynamics and environmental toxicology. He has worked in Federal research as well as with a nongovernmental organization and in the private sector. He has developed international science programs in fisheries, invasive species, and ecological research.

Most recently, **Smith** was the wildlife-program coordinator at USGS headquarters in Reston, VA, where he has served in various positions. From 2001 to 2002, he was the science advisor to the International Association of Fish and Wildlife Agencies in Washington, DC. He was acting USGS eastern regional chief biologist from 1997 to 1998 and director at the USGS Great Lakes Science Center, Ann Arbor, MI, from 1996 to 1997. There he managed an ecological-research program that included fisheries, wetlands, ecosystem processes, and invasive species.

From 1989 to 1996, **Smith** was a laboratory manager and later the laboratory director for a private environmental-toxicology corporation in Maryland. The corporation provided scientific studies on marine and freshwater organisms and terrestrial wildlife species to assess the ecological impacts of chemicals for registration by the U.S. Environmental Protection Agency and the U.S. Food and Drug Administration.

From 1988 to 1989, **Smith** managed the U.S. Fish and Wildlife Service's analytical-chemistry program, providing support for research and field investigations involving environmental contaminants. He began his Federal research career at the USGS Patuxent Wildlife Research Center in Laurel, MD, after a postdoctoral fellowship with the University of Wisconsin, Madison.

Smith received a bachelor's degree in biology in 1978 from Northern Michigan University in Marquette, MI. He received a master's degree in wildlife ecology in 1980 and a Ph.D. in wildlife ecology and veterinary science in 1984 from the University of Wisconsin, Madison.

***Gregory J. Smith** is the new director of the USGS National Wetlands Research Center in Lafayette, LA.*

Smith is a member of the Wildlife Society and the Society of Environmental Toxicology and Chemistry. He has served on numerous scientific-review panels and authored a major publication on the impacts of pesticides on wildlife. **Smith** was born in Marquette and now resides in Lafayette. He and his wife, **Kathy**, have two children, **Jennifer** and **Andrew**.

Robert E. Stewart Receives Gulf Guardian Award Before Retiring After 30 Years of Service to DOI

By Gaye Farris

Robert E. Stewart was named a Gulf Guardian by the U.S. Environmental Protection Agency's Gulf of Mexico Program shortly before he retired in January. Previously, he was named Professional Conservationist of 2004 by the Louisiana Wildlife Federation (see article in *Sound Waves*, April 2004, at URL **http://soundwaves.usgs.gov/2004/04/awards.html**).

Stewart worked 30 years for the Department of the Interior, 25 of them as director of the U.S. Geological Survey (USGS) National Wetlands Research Center in Lafayette, LA.

Stewart received a bachelor's degree in biology in 1966 from Jamestown College in Jamestown, ND. He received a master's degree in 1969 and a doctoral degree in 1971 from North Dakota State University in Fargo, where his graduate work included studying forests, wetlands, and waterfowl in the Turtle Mountains of North Dakota and Manitoba, Canada.

(Stewart continued on page 12)

***Robert E. Stewart, Jr.**, retired from the Department of the Interior after 30 years of service, 25 of them as director of the USGS National Wetlands Research Center.*

(Stewart continued from page 11)

Stewart began his Federal career in 1974 working for the U.S. Fish and Wildlife Service on national energy policies in Washington, DC. In 1979, he became the leader of the service's National Coastal Ecosystems Team in Slidell, LA. The team evolved into what is now the USGS National Wetlands Research Center, housed on the research-park campus of the University of Louisiana, Lafayette, since 1992.

Under **Stewart's** leadership, the center's scientists have tackled diverse research issues, employed the latest technology, and produced thousands of publications and maps. The center supports about 200 scientists and support staff, as well as numerous agency and university partnerships.

Stewart received the Department of the Interior's highest honor awards—the Meritorious Service Award and the Distinguished Service Award—for his outstanding vision and leadership in using scientific research and technology to address wetland issues. In 1994, he also was named to the Alumni Hall of Fame of his alma mater, Jamestown College. ❁

Recently Published Articles

Cochran-Marquez, S.A., Moloka'i benthic habitat mapping: U.S. Geological Survey Open-File Report 2005-1070 [URL **http://pubs.usgs.gov/of/2005/1070/**].

Crusius, J., Koopmans, D.J., Bratton, J.F., Charette, M.A., Kroeger, K.D., Henderson, P., Ryckman, L., Halloran, K., and Colman, J.A., 2005, Submarine groundwater discharge to a small estuary estimated from radon and salinity measurements and a box model: Biogeosciences Discussions, v. 2, p. 1-35.

Enright, T.J., and Pegram, K.M.H., 2005, Ecosystems of South Florida: U.S. Geological Survey Open-Report 2005-1021, 1 p. [URL **http://sofia.usgs.gov/publications/ofr/2005-1021/**].

Fernandez, Mario, Jr., Robb, Steve, Doan, Khanh, Stephens, James, and Grabe, Stephen, 2002, Preliminary findings on the distribution of organic carbon-normalized select polycyclic aromatic hydrocarbons in the bottom sediments of the Alafia River-Kitchen Bay, Feather Sound, Pinellas Point, and the Terra Ceia areas in Tampa Bay, June 2002: U.S. Geological Survey Open-File Report 02-480 [URL **http://pubs.usgs.gov/of/2002/of02-480/**].

Gutierrez, B.T., Voulgaris, G., and Thieler, E.R., 2005, Exploring the persistence of sorted bedforms on the inner-shelf of Wrightsville Beach, North Carolina: Continental Shelf Research, v. 25, p. 65-90 [PDF file at URL **ftp://ftp.whoi.edu/pub/usgs/rthieler/gutierrez_et_al_2004.pdf**].

Hall, D.K., Williams, R.S., Jr., Steffen, K., and Chien, J.Y.L., 2004, Analysis of summer 2002 melt extent on the Greenland Ice Sheet using MODIS and SSM/I data [abs.]: Institute of Electrical and Electronics Engineers (IEEE) International Geoscience and Remote Sensing Symposium (IGARSS), Anchorage, AK, September 20-24, 2004, Proceedings, 4 p. [URL **http://glacier-bay.gsfc.nasa.gov/**].

Hapke, C.J., Gmirkin, Rick, and Richmond, B.M., Coastal change rates and patterns; Kaloko-Honokohau NHP, Kona Coast, Hawai'i: U.S. Geological Survey Open-File Report 2005-1069 [URL **http://pubs.usgs.gov/of/2005/1069/**].

Jarrett, B.D., Hine, A.C., Halley, R.B., Narr, D.F., Locker, S.D., Naumann, A.C., Twichell, D.C., Hu, C., Donahue, B.T., Jaap, W.C., Palandro, D., and Ciembronowicz, K.T., 2005, Strange bedfellows—a deep-water hermatypic coral reef superimposed on a drowned barrier island; southern Pulley Ridge, SW Florida platform margin: Marine Geology, v. 214, no. 4, p. 295-307 [URL **http://www.sciencedirect.com/science/journal/00253227**].

Pendleton, E.A., Thieler, E.R., Williams, S.J., and Beavers, R.L., 2005, 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/**].

Song, J., and ten Brink, U.S., 2005, RayGUI 2.0; a graphical user interface for interactive forward and inversion ray-tracing: U.S. Geological Survey Open-File Report 2004-1426 [URL **http://pubs.usgs.gov/of/2004/1426/**].

Storlazzi, C.D., and Presto, M.K., 2005, Coastal circulation and sediment dynamics along West Maui, Hawaii, part IV; measurements of waves, currents, temperature, salinity and turbidity in Honolua Bay, northwest Maui; 2003-2004: U.S. Geological Survey Open-File Report 2005-1068 [URL **http://pubs.usgs.gov/of/2005/1068/**].

ten Brink, U.S., and Geist, E.L., 2005, Submarine slides north of Puerto Rico and their tsunami potential [abs.]: Caribbean Tsunami Workshop, San Juan, Puerto Rico, March 29-31, 2004.

Twichell, D.C., Cross, V.A., Hanson, A., Buck, B., Zybala, J., and Rudin, M.R., 2005, Seismic architecture and lithofacies of turbidites in Lake Mead (Arizona and Nevada, U.S.A.), an analogue for topographically complex basins: Journal of Sedimentary Research, v. 75, p. 134-148.

Williams, R.S., Jr., and Magnússon, M.M., 2005, The 1974 Iceland Glaciological Society spring expedition to Vatnajökull: Jökull, v. 54, p. 89-92. ❁

Publications Submitted for Director's Approval

Barth, G.A., Scholl, D.W., and Childs, J.R., Quantifying the methane content and distribution of natural gas hydrate accumulations in the deep-water basins of the Bering Sea [abs.]: Workshop of the International Committee on Gas Hydrates, 4th, Victoria, British Columbia, Canada, May 9-11, 2005.

Beach, K.S., Walters, L.J., Paul, V.J., Becerro, M.A., and Ritson-Williams, R., Beyond algal occupation on coral reefs; are there short-term impacts of chemically defended seaweed on zooxanthellae photosynthesis in adult *Porites astreoides*? [abs.]: Benthic Ecology Meeting 2005, Williamsburg, VA, April 6-10, 2005.

Calderon, K., Dadisman, S.V., Yobbi, D.K., McBride, W.S., Flocks J.G., and Wiese, D.S., Archive of digital boomer seismic reflection data collected in the Withlacoochee River of west-central Florida during USGS field activity 04SGI01, March 1-5, 2004: U.S. Geological Survey Data Series [DVD].

Fernandez, M., Stout, C., Smith, K., Grabe, S., and Yates, K., Distribution of silt and clay

(Publications Submitted continued on page 13)

(Publications Submitted continued from page 12)

grain size, and select trace metals in bottom sediments of Tampa Bay, July and August, 2003 [abs.]: Gulf of Mexico Integrated Science Tampa Bay Study Annual Science Conference, 4th, Gulfport, FL, February 8-9, 2005.

Fisher, M.A., Bruns, T.R., Ratchkovski, N.A., Brocher, T.M., Pavlis, T.L., Plafker, George, Sliter, Ray, and Geist, E.L., Crustal delamination within the collision zone of the Yakutat Terrane, eastern Gulf of Alaska: Geology.

Fisher, M.A., Langenheim, V.E., Sorlien, C.C., Cochrane, G.R., Sliter, R.W., Wong, F.L., and Dartnell, Peter, Recent deformation along the offshore Malibu coast, Dume and related faults west of Point Dume, southern California: Seismological Society of America Bulletin.

Griffin, D.W., and Lipp, E.K., Waste water and reef health in the Florida Keys [abs.]: Florida Integrated Science Center (FISC) Science Meeting, Orlando, FL, May 3-5, 2005.

Grossman, E.E., Fletcher, C.H., and Harney, J.N., Coral plasticity and community zonation of a windward, Hawaiian reef, Kailua (Oahu), Hawaii: Marine Ecology Progress Series.

Harney, Jodi, Cochrane, Guy, Dartnell, Pete, and Etherington, Lisa, Benthic habitat mapping in Glacier Bay, southeast Alaska [abs.]: Marine Science in Alaska, Anchorage, AK, January 24-26, 2005.

Hart, P.E., and Childs, J.R., National Archive of Marine Seismic Surveys (NAMSS); status report on U.S. Geological Survey program providing access to proprietary data [abs.]: Geological Society of America (GSA) Cordilleran Section and American Association of Petroleum Geologists (AAPG) Pacific Section Joint Annual Meeting, San Jose, CA, April 29-May 1, 2005.

Hein, J.R., McIntyre, B.R., and Piper, D.Z., State-of-knowledge of marine mineral resources in Exclusive Economic Zones of Pacific islands of U.S. affiliation, excluding Hawaii: U.S. Geological Survey Circular.

Holmes, C.W., Determining the rate of environmental change in the subtropical Florida Bay [abs.]: American Geophysical Union (AGU)/North American Benthological Society (NABS)/ Society of Exploration Geophysicists (SEG)/ Solar Physics Division of the American Astronomical Society (SPD/AAS) Joint Assembly, New Orleans, LA, May 23-27 , 2005.

Hostettler, F.D., and Rostad, C.E., Forensic fingerprinting of oil-spill hydrocarbons in a methanogenic environment [abs.]: Pacifichem 2005, Honolulu, HI, December 15-20, 2005.

Jaffe, L.A., Hilton, D.R., Porcelli, D., Swarzenski, P.W., Baskaran, M., and Kulongoski, J.T., U-Th-Ra-Rn-He relationships in Mojave River Basin groundwaters [abs.]: Annual Goldschmidt Conference, 15th, Moscow, ID, May 20-25, 2005.

Kellogg, C.A., Deep-water coral microbial ecology [abs.]: Florida Integrated Science Center (FISC) Science Meeting, Orlando, FL, May 3-5, 2005.

Krebs, J.M., Brame, A.B., and McIvor, C.C., Estuarine fish assemblages in natural and altered wetland habitats of Tampa Bay, Florida; summary of year 1 [abs.]: American Fisheries Society, Florida Chapter Annual Meeting, Ocala, FL, February 22-24, 2005.

Kuffner, I.B., Walters, L.J., Becerro, M.A., Paul, V.J., Ritson-Williams, R., and Beach, K.S., Perpetuating phase shifts; inhibition of coral recruitment by macroalgae and cyanobacteria [abs.]: Benthic Ecology Meeting, Williamsburg, VA, April 6-10, 2005.

Kuffner, I.B., Walters, L.J., Becerro, M.A., Paul, V.J., Ritson-Williams, R., and Beach, K.S., The role of macroalgae in perpetuating the degraded state of coral reefs in the Florida Keys [abs.]: Florida Integrated Science Center (FISC) Science Meeting, Orlando, FL, May 3-5, 2005.

Lisle, J., Characterization of the native microbial communities in Floridan aquifer waters targeted for aquifer storage and recovery (ASR) applications, south-central Florida: U.S. Geological Survey Open-File Report, 30 p.

McGann, Mary, Grossman, E.E., and Takesue, R.K., Is *Trochammina hadai* Uchio a native or introduced foraminifer in Padilla Bay, Washington, USA? [abs.]: North American Paleontological Convention, Halifax, Nova Scotia, Canada, June 19-26, 2005.

Noble, M.A., and Xu, Jingping, Internal tide events and their impact on near-field plume dispersion at potential LACSD outfall sites, app. B *in* Modeling dispersion of effluent from candidate outfalls off Los Angeles: Los Angeles County Sanitation District.

Reich, C.D., Halley, R., and Swarzenski, P., Marine groundwater studies in Biscayne National Park, south Florida [abs.]: Florida Integrated Science Center (FISC) Science Meeting, Orlando, FL, May 3-5, 2005.

Sliter, Ray, Normark, William, and Gutmacher, Christina, Multichannel seismic-reflection data acquired off the coast of southern California—part A, 1997, 1998, 1999, and 2000: U.S. Geological Survey Open-File Report.

Smoak, J.M., Krest, J.M., and Swarzenski, P.W., Geochemistry of the Amazon estuary [chapter in book]: Kluwer.

Swarzenski, P., On the geochemistry of Tampa Bay; from submarine ground-water discharge to water-column light attenuation: Gulf of Mexico Integrated Science Tampa Bay Study Annual Science Conference, 4th, Gulfport, FL, February 8-9, 2005.

Swarzenski, P., Kroeger, K., Reich, C., Blake-Collins, B., and Greenwood, J., Submarine ground-water discharge (SGD) and associated nutrient fluxes to the coastal ocean: Florida Integrated Science Center (FISC) Science Meeting, Orlando, FL, May 3-5, 2005.

Valentine, P.C., Carman, M.R., Blackwood, D.S., and Heffron, E.J., Ecological observations of the colonial tunicate *Didemnum* cf. *lahillei* in a New England tide pool and strategies for managing invasive ascidian species [abs.]: International Invasive Sea Squirt Conference, Woods Hole, MA, April 21-22, 2005.

Valentine, P.C., Collie, J.S., Reid, R.N., Asch, R.G., and Guida, V.G., The invasive tunicate *Didemnum* sp. on Georges Bank—ecological observations and potential effects on groundfish and scallop fisheries [abs.]: International Invasive Sea Squirt Conference, Woods Hole, MA, April 21-22, 2005.

Waite, W.F., Kirby, S.H., Winters, W.J., Pinkston, J., and Mason, D.H., Thermal conductivity in methane and tetrahydrofuran hydrates: Geophysical Research Letters.

Walters, L.J., Downs, C.A., Kuffner, I.B., Becerro, M.A., Paul, V.J., and Ritson-Williams, R., Cellular-level impacts of macroalgae and cyanobacteria on competent larvae of the hard coral *Porites astreoides*: Benthic Ecology Meeting, Williamsburg, VA, April 6-10, 2005.

Xu, Jingping, (Ir)regularity of sand ripple patterns—a field observation [abs.]: Geological Society of America (GSA) Cordilleran Section and American Association of Petroleum Geologists (AAPG) Pacific Section Joint Annual Meeting, San Jose, CA, April 29-May 1, 2005.