USGS

Sound Waves Coastal and Marine Research News from Across the USGS

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Fieldwork

Scientists Study Coastal Erosion at Cape Hatteras, North Carolina

By John Warner, Jeff List, Rob Thieler, Jesse McNinch, Kevin Haas, George Voulgaris, and Marinna Martini

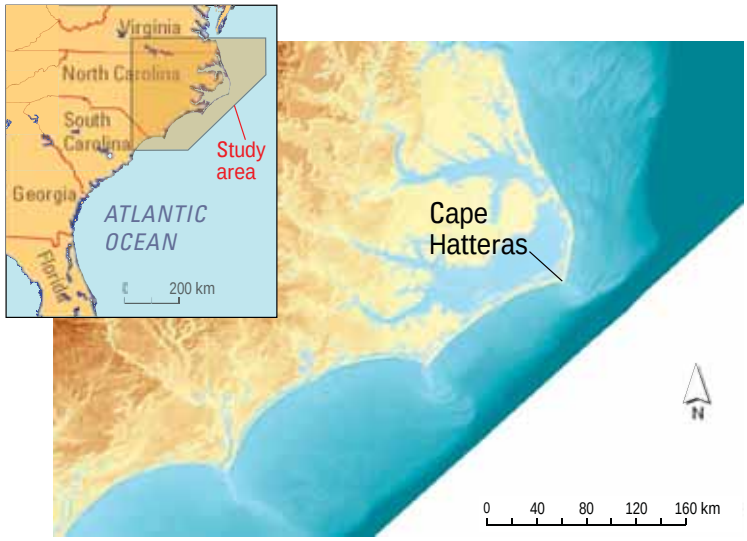
A strange sight was observed on the beaches at Cape Hatteras, North Carolina, last February. A large white vehicle—or was it a boat?—drove across the sandy beach, headed directly into the crashing waves, and maneuvered out to sea. The Light Amphibious Resupply Cargo (LARC) vehicle, operated by the U.S. Army Corps of Engineers (USACE) from Duck, North Carolina, was part of a multi-organizational coastal-erosion study involving scientists from the U.S. Geological Survey (USGS), the USACE, the University of South Carolina, and Georgia Tech Savannah, in cooperation with the National Park Service Outer Banks Group. The study investigated processes responsible for alongshore delivery of sediment to the cape's point, and the mechanisms that transport sediment from the point farther offshore.

The study involved many different types of field activities. We deployed oceanographic instruments in the nearshore to measure surface waves and ocean currents. The surf zone is a challenging environment, and the deployment of instruments here requires specialized gear and highly trained personnel. The LARC transported divers into the surf zone, where they used a jetpump to insert long pipes into the sandy seafloor. The

(Cape Hatteras continued on page 2)

The Light Amphibious Resupply Cargo (LARC) vehicle transporting divers and gear into the surf zone for deployment of oceanographic instruments.

Long pipes were jetted into the seafloor to support instruments on a cantilever arm.



North Carolina coastline, showing location of Cape Hatteras.

Sound Waves

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Deadline: The deadline for news items and publication lists for the September issue of *Sound Waves* is Tuesday, July 20.
Publications: When new publications or products are released, please notify the editor with a full reference and a bulleted summary or description.
Images: Please submit all images at publication size (column, 2-column, or page width). Resolution of 200 to 300 dpi (dots per inch) is best. Adobe Illustrator© files or EPS files work well with vector files (such as graphs or diagrams). TIFF and JPEG files work well with raster files (photographs or rasterized vector files).

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Fieldwork, continued

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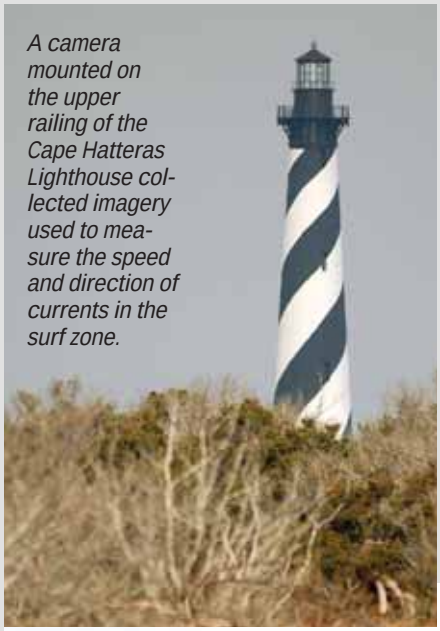
divers then attached instruments to the pipes, which held the instruments in place during the study.

The speed and direction of currents in the surf zone were measured remotely with a camera mounted atop the Cape Hatteras Lighthouse. The camera took pictures during daylight hours at a rate of 3.3 frames per second, and the images were recorded on a computer. Processing of the images will track foam lines to estimate the speed and lateral variability of currents moving alongshore (near and generally parallel to the coastline).

WERA radar system used to measure the speed and direction of surface currents.



A camera mounted on the upper railing of the Cape Hatteras Lighthouse collected imagery used to measure the speed and direction of currents in the surf zone.

Other instruments measured the spatial variability of surface currents, using a WERA very high frequency (VHF) radar system. The WERA, which has separate transmit and receive arrays, was installed along the dune line at a site occupied by the lighthouse before it was moved inland about 10 years ago to protect it from coastal erosion. The WERA measured surface currents as far out as 14 km from shore and approximately 14 km along the coast, on a grid with spacing approximately 150 m on a side.

We performed a dye study to estimate alongshore-transport rates and to learn

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what dye could reveal about lateral mixing in the surf zone. Uranine dye, a nontoxic substance, was placed in dissolvable bags and deployed from a sophisticated launching mechanism (large slingshot). Photographs taken from a single-engine aircraft flying at 1,000 ft are being analyzed to infer alongshore-transport directions.

A Coastal Lidar and Radar Imaging System (CLARIS) used lidar (light detection and ranging) to measure dune heights and beach topography, and X-band radar to measure the intensity of breaking waves, which is used to estimate offshore bathymetry. The CLARIS system is ideal for measuring offshore bar locations and sand movement during storms when powerful waves are breaking.

The deployment was covered by a local online news organization, the *Island Free Press*, in an article and slide show posted February 18, 2010, at **http://islandfreepress.org/2010Archives/01.28.2010-USGeologicalSurveyCoastalErosionStudyIsComingtoCapePoints.html**.

This project is part of a larger study—the Carolina Coastal Change Processes Project—led by USGS Coastal and Marine Geology Program scientists in Woods Hole, Massachusetts, to understand regional sediment dynamics along the coastline of North and South Carolina. Visit **http://woodshole.er.usgs.gov/project-pages/cccp/** to learn more about the project, and click on the "Cape Hatteras Field Study" link (**http://woodshole.er.usgs.gov/project-pages/cccp/html/capehatteras.htm**) to learn more about the work described in this article. A similar study conducted last year on Diamond Shoals was highlighted in the April 2009 issue of *Sound Waves*, posted at **http://soundwaves.usgs.gov/2009/04/fieldwork3.html**.

Dissolvable bags containing uranine dye were launched into the surf zone. Aerial photographs revealed the path of the tracer (bright green) in the nearshore.

CLARIS (Coastal Lidar and Radar Imaging System) uses lidar (light detection and ranging) to measure coastal topography and X-band radar to estimate offshore bathymetry (water depths).

We thank the following personnel for their dedication and hard work during the deployment: USGS divers **Chuck Worley**, **Dann Blackwood**, **Sandy Baldwin**, **Michael Casso**, **BJ Reynolds**, and **Jordan Sanford**; photographer **Don Bowers**; USGS technicians **Jonathan Borden** and **Brandy Armstrong**; USACE LARC personnel **Ray Townsend**, **Jason Pipes**, and **Mike Forte**; Georgia Tech Savannah students **Stephanie Smallegan**, **Adam Sapp**, **Thomas Gay**, and **Xiufeng Yang**; University of South Carolina technicians and students **Jeff Morin** and **Kumar Nirnimesh**; and Virginia Institute of Marine Science student **Kate Brodie**.

Geological Impacts of the February 2010 Tsunami in Chile

By Bob Morton

On February 27, 2010, a magnitude 8.8 earthquake occurred in relatively shallow water offshore of the central coast of Chile. With a rupture zone nearly 500 km long, the earthquake generated a series of tsunami waves that inundated the shore along more than 550 km of coastline (see related *Sound Waves* article at **http://soundwaves.usgs.gov/2010/04/research2.html**). In response to requests for assistance from the Chilean government through UNESCO (United Nations Educational, Scientific and Cultural Organization), the U.S. Geological Survey (USGS) sent a team of scientists to collaborate with Chilean scientists in investigating the geological impacts of the tsunami. The purpose of the 10-day trip (April 24-May 2) was to better understand the 2010 event and to provide information for improved modeling and prediction that can be used to mitigate loss of life and damage from future tsunamis.

The USGS tsunami geology team consisted of (in alphabetical order) **Mark Buckley**, **Guy Gelfenbaum**, **Bob Morton** (team leader), and **Bruce Richmond**. Chilean scientists, who provided in-country logistical support and assistance in the field, were **Adriano Cecioni**, a geology professor at the University of Concepción, and students from the university, including **Osvaldo Artal**, **Constanza Hoffmann**, and **Felipe Perez**.

The USGS team selected five sites for comprehensive investigation along a 200-km segment of coast both north and south of the earthquake epicenter that included diverse geological settings (delta plain, deeply embayed alluvial valley, coastal plain near river mouth). All of the sites were selected because their geological settings made them efficient catchments for tsunami deposits and therefore excellent recorders of the 2010 tsunami and potential recorders of past extreme events. At four of the five sites studied, detailed measurements were made of topography, flow depths, flow directions and flow-direction histories, tsunami-inundation distances, vertical erosion, and sediment deposition. The measurements were made in a manner consistent with data collected by USGS scientists during previous post-tsunami surveys, such as those conducted in Papua New Guinea after the 1998 tsunami (**http://walrus.wr.usgs.gov/tsunami/**

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Google Earth image (above) shows general locations of the five study sites. Shaded rectangle on map of Chile (right) shows approximate extent of the February 2010 earthquake rupture zone.

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itst.html), in Peru after the 2001 tsunami (**http://walrus.wr.usgs.gov/peru2/**), in Sri Lanka (**http://soundwaves.usgs.gov/2005/02/**, **http://walrus.wr.usgs.gov/tsunami/srilanka05/**) and Sumatra (**http://soundwaves.usgs.gov/2005/03/**, **http://walrus.wr.usgs.gov/tsunami/sumatra05/**) after the 2004 Indian Ocean tsunami, and in Samoa and American Samoa after the 2009 tsunami (**http://soundwaves.usgs.gov/2009/12/**, **http://walrus.wr.usgs.gov/news/samoaabout.html**).

At each of the sites, the team made some important scientific observations that add to our growing understanding of tsunami impacts. For example, the Chilean tsunami caused substantial erosion and deposition that both decreased and increased local coastal-plain elevations by as much as 1 m. The tsunami erosion was concentrated near the shore, where wide areas of land were planed off, soil was scoured from around the bases of trees, and return flow incised channels as deep as 1.6 m. Tsunami deposits, including some boulder-size clasts, were found at all sites, and the sand deposits extended to near the limit of inundation except at one site. The abundance of plane-parallel stratification in some deposits and the presence at one site of large sand waves indicate that at least some of the sediment was transported as bed load (rolled and pushed along the land surface) and not as suspended load (suspended in the water). The team also found evidence that vegetation height and density controlled tsunami-deposit thickness, and measurements were made to characterize and quantify the vegetation density at several sites. At the two open-coast sites, there was clear evidence of multiple strong onshore waves that arrived at different times and from different directions. The multiple onshore flow directions likely resulted from upward vertical displacement along the rupture zone at locations both north and south of the field sites. The flow-direction history that we interpreted in the field at one site was confirmed by an eyewitness account of the sequence of wave directions. The maximum observed tsunami-inundation distance (2.35 km) was up an alluvial valley.

A full report of the team's observations was recently released as USGS Open-File Report 2010-1116, *Geological Impacts and Sedimentary Record of the February 27, 2010, Chile Tsunami—La Trinchera to Concepción* (**http://pubs.usgs.gov/of/2010/1116/**).

Pine tree whose trunk and branches were snapped off by the tsunami. The tree's exposed roots, still in place, show that the tsunami caused at least 110 cm of vertical erosion of the coastal plain at Constitución.

Tsunami sand and cobble deposit, 73 cm thick, at Constitución.

After conducting their fieldwork, the USGS team was honored with a breakfast reception at the Santiago home of the U.S. Ambassador to Chile, **Paul Simons**. Attending the reception were leading Chilean scientists and ranking government officials, including **Sergio Barrientos**, Director of the Chilean Seismological Service,

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University of Chile; **Patricio Winckler**, School of Marine Sciences and Natural Resources, University of Valparaíso; **Juan Díaz**, Professor of Marine Geology and Geophysics, School of Marine Sciences, Catholic University of Valparaíso; **Ricardo Norambuena**, UNESCO Coordinator of Coastal Programs; **María José Castañeda**, Chief of Staff to the Minister, Ministry of the Environment; **Capitán Andrés Enríquez**, Chief of Plans and Operations, Hydrographic and Oceanographic Service of the Navy; **Vicente Nuñez**, Director, National Office of Emergency Ministry of the Interior; **Mary Brett Rogers-Springs**, Environment, Science and Technology Economic Section of the U.S. Embassy; and **Dinah Lee Arnett**, Environment, Science and Technology Public Affairs Section of the U.S. Embassy. During the reception the USGS team made several contacts that have already proven beneficial in obtaining important scientific information that supplements our observations. ❁

Attendees at a reception hosted by the U.S. Ambassador to Chile honoring the USGS tsunami geology team. From left to right: ***Patricio Winckler***, ***Sergio Barrientos***, ***Andrés Enríquez***, ***Dinah Arnett***, ***Juan Díaz***, ***Mark Buckley***, ***Vicente Nuñez***, ***Bob Morton***, ***Guy Gelfenbaum***, ***Paul Simons***, ***Mary Brett Rogers-Springs***, *and* ***Ricardo Norambuena***.

Murky Waters

USGS tracks sediment on Molokai's reef

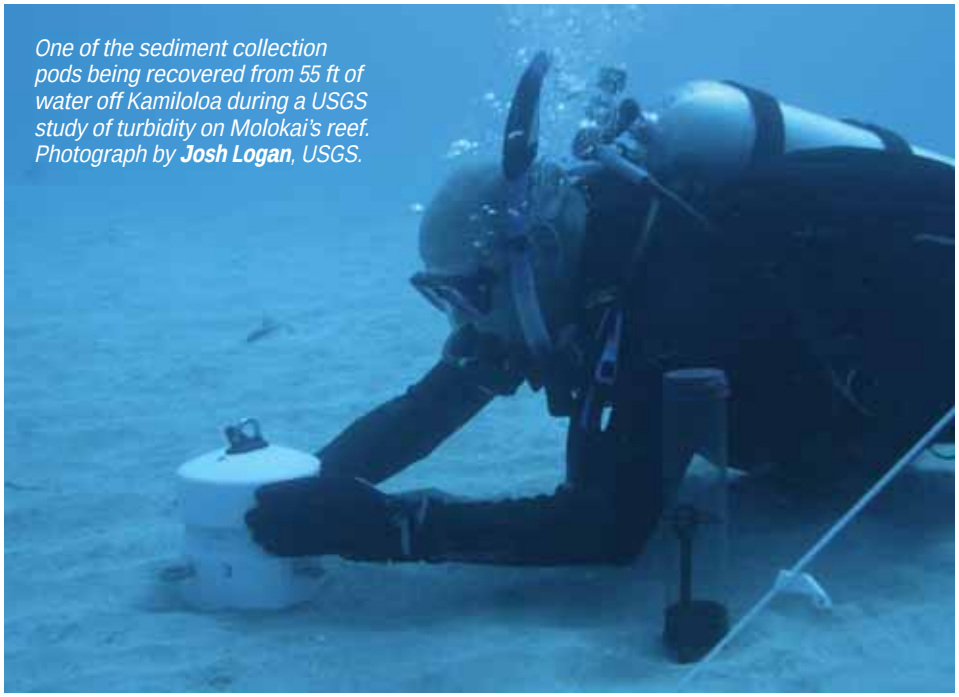
By Catherine Cluett

[Reprinted, with permission, from the June 9, 2010, issue of the *Molokai Dispatch*]

Ever looked at the muddy water off Molokai's south shore and wondered what it would take to clean up the reef? That's the question researchers from the United States Geological Survey (USGS) looked to answer last month with a study on the reef's turbidity, or murkiness.

The study is part of a larger ongoing study that examines the effects and possible solutions to erosion mauka-side [on the mountainsides] that results in sedimentation of Molokai's reefs.

"Anyone who lives on Molokai knows how brown the water gets," said lead researcher **Mike Field**, a marine geologist with USGS. In 2008, **Field** co-authored *The Coral Reef of South Molokai, Hawaii: Portrait of a Sediment-Threatened Fringing Reef*, a nearly 200-page full-color report [**http://pubs.usgs.gov/sir/2007/5101/**].



One of the sediment collection pods being recovered from 55 ft of water off Kamiloloa during a USGS study of turbidity on Molokai's reef. Photograph by ***Josh Logan****, USGS.*

Field questioned how long it would take for natural processes to clean up the reef if erosion from the uplands ceased. To find out, he looked at sediment particle concentration and the rate at which those particles travel. **Field** and his team completed the research in four days in May.

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"We're still trying to learn things that we had half answers for," **Field** said.

Based on initial estimates, he said it will take sometime between 10 and 30 years for natural processes to clean up the reef if contributing erosion is halted.

The Process

Turbidity is a natural process caused by waves and ocean currents. Waves redistribute sediment and transport it across reefs. On a calm day, the reef looks relatively clean, **Field** said, whereas trade winds make the water look murky.

Field and his team picked conditions and time of day when turbidity would be at its peak: the highest tides of the month and in the afternoon when the tide is turning and trade winds are blowing. **Field** placed instruments on the reef floor to measure currents, water temperature and collect sediment samples. They also ran a picket line between Kawela and Kaunakakai Wharf to measure where turbid water flushes out of the reef as the tide turns to calculate how much sediment is being washed out and how fast it is moving.

"We [now] know how many particles leave the reef every day," **Field** said.

In addition, **Field** took advantage of another tool to study water flow mauka to makai [from mountains to the sea]—black carbon particles from last year's brushfire that burned 8,000 acres of Molokai's hillsides. Collecting the tiny pieces of carbon that had washed into the reef proved an indicator of direct run-off and how far the particles traveled since the fire.

Field and his team are now analyzing their results. He said the study will probably be published in a journal by the end of the year.

"We've done computer modeling and we're starting to get a good idea," **Field** said.

The Variables

Those natural processes, however, are dependant on many variables—most importantly, what happens in mountain regions overlooking the reefs.

That's where collaboration with other scientists studying vegetation and erosion comes in. **Jim Jacobi**, another USGS scientist, is simultaneously compiling vegetation maps of the watershed area, plant distribution, and trends in ungulate (goat and deer) populations that directly affect erosion rates.

Jacobi found that when the Kawela watershed was first sampled in 2008, over 99 percent of the area was bare ground, largely due to grazing feral goats. When the same area was surveyed again last year, plant cover had increased by 27 percent.

Another USGS colleague, **John Stock**, found that the rate of erosion on the Kawela mountainside today is about 100 times higher than the rate at which an island would normally erode.

"If the hill slopes were re-vegetated [it] could vastly slow erosion to what it should be," **Field** said. And that would reduce the turbidity we see on the Molokai reef, he added.

Other variables in the equation include rising sea levels, which will change the energy and dynamics on the reef and lead to possible increased shoreline erosion, according to **Field**.

"Molokai is an ideal place to work," said **Field**. "[Turbidity on the reef] is a very real problem." He added he has also received great cooperation from residents and assisting organizations such as The Nature Conservancy.

Future turbidity studies may be even more high-tech. **Field** mentioned a "tracer project" he's planning for next year that will trace individual particles from the Kawela watershed to the reef.

[See this article in the *Molokai Dispatch* at **http://themolokaidispatch.com/murky-waters**.]❁

Nile Delta Natural-Gas Potential is Significant

By Mark Kirschbaum and Jessica Robertson

An estimated 223 trillion cubic feet (tcf) (mean estimate) of undiscovered, technically recoverable natural gas is present in the Nile Delta Basin Province in the eastern Mediterranean region. Undiscovered, technically recoverable resources are those that have yet to be discovered but, if found, could be produced by using currently available technology and industry practices.

This study is the first U.S. Geological Survey (USGS) assessment of this basin to identify potentially extractable resources. The USGS also recently completed an assessment of the adjacent Levant Basin Province, estimated to contain 122 trillion tcf (mean estimate) of undiscovered, technically recoverable natural gas. (See related *Sound Waves* article at **http://soundwaves.usgs.gov/2010/05/research3.html**.)

"The Nile Delta Basin Province has significant natural-gas potential, with estimated resources comparable to some of the other large provinces around the world and bigger than anything we have assessed in the United States," said USGS Energy Resources Program Coordinator **Brenda Pierce**. "This assessment furthers our understanding of the world's energy potential, helping inform policy and decision makers about potential future energy supplies."

"This study is particularly germane in light of recent attention given to natural-gas resources as a potential bridging fuel in a transition to a carbon-constrained global economy," said **Pierce**. "Taken together, the Nile Basin and Levant Basin assessments establish the eastern Mediterranean region as having world-class potential for undiscovered natural-gas resources."

Natural gas is used for various purposes, primarily for electricity generation in the industrial, residential, and commercial sectors. The Nile Delta Basin Province also holds an

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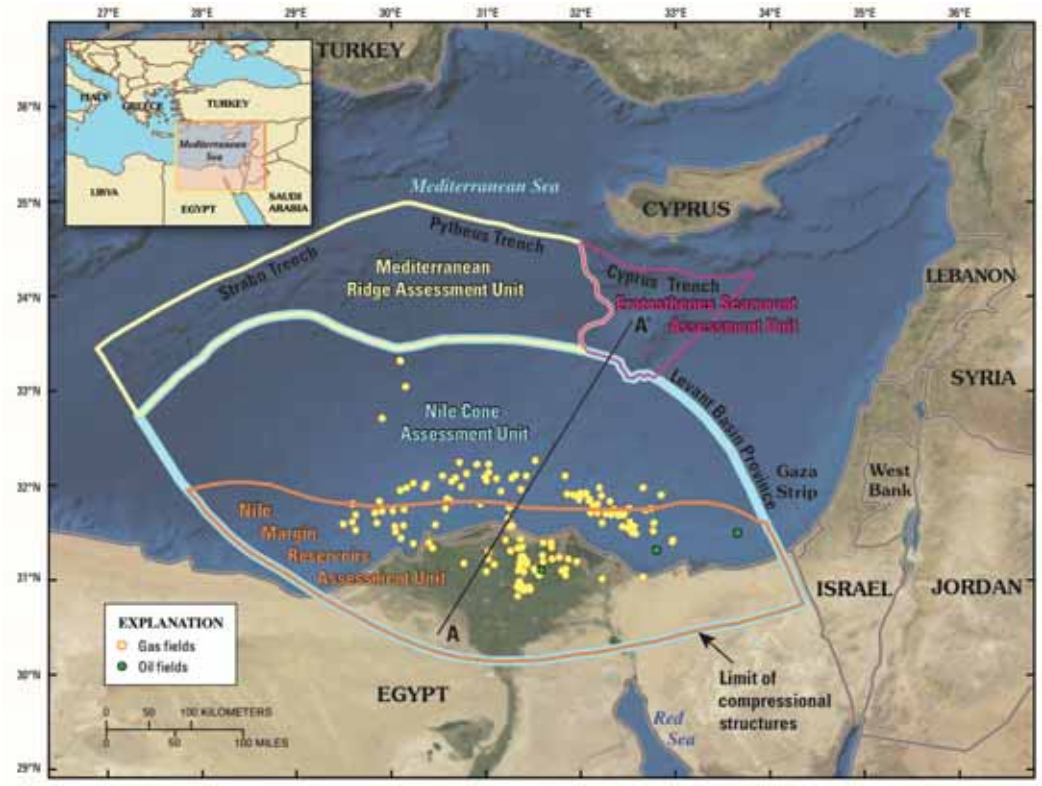
estimated 1.7 billion barrels of undiscovered, technically recoverable oil and 5.9 billion barrels of natural-gas liquids (mean estimates). Worldwide consumption of petroleum in 2008 was about 31 billion barrels.

The USGS conducted this assessment as part of a program to estimate the undiscovered, technically recoverable oil and gas resources of priority petroleum basins around the world. To learn more about this assessment, please see USGS Fact Sheet 2010-3027, "Assessment of Undiscovered Oil and Gas Resources of the Nile Delta Basin Province, Eastern Mediterranean," at **http://pubs.usgs.gov/fs/2010/3027/**; and visit the USGS Energy Resources Program Web site at **http://energy.usgs.gov/**.



*Eastern Mediterranean region, showing locations of four assessment units in the Nile Delta Basin Province. (Map not definitive for political boundaries.) Modified from figure 1 in USGS Fact Sheet 2010-3027 (**http://pubs.usgs.gov/fs/2010/3027/**).*

Girls Scouts Explore Geology Through Joint Educational Program Between the USGS and the Association of Women Geoscientists

By Heather Schreppel and Ann Tihansky

More than 50 Girl Scouts of middle- and high-school age participated in a weekend geology camping trip on March 13 and 14, 2010. The trip, "Discovering Geology Weekend," was designed to encourage interest in the natural sciences through hands-on experiences that increase understanding of hydrologic interconnections, societal impacts on karst landscape (distinctive landscape that forms above soluble limestone bedrock), and the importance of natural-resource stewardship. The program was supported through a grant from the Association of Women Geoscientists (AWG), whose local members partnered with the U.S. Geological Survey (USGS). **Ann Tihansky** and **Heather Schreppel** of the USGS St. Petersburg (Florida) Coastal and Marine Science Center worked with **Allison Amram** (AWG) and the Girl Scouts of West Central Florida to arrange, plan, and lead the 2-day geologic adventure.

During the first day, the girls toured an operating limestone quarry in Brooksville, Florida, where **Alan Pagels** (Vulcan Materials Co.) gave an educational overview about why limestone is mined and showed examples of the fossils that occur in these deposits. The girls then explored the quarry grounds, filling tote bags with their own fossil discoveries. Next, they toured a variety of ecosystems unique to karst landscapes, including caves and springs. In the upland recharge area, where water enters the ground and infiltrates down to the water

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***Ann Tihansky** and a few Girl Scouts examine **Alan Pagels'** fossil collection from a limestone quarry in Brooksville, Florida.*

(Discovering Geology continued from page 8)

table, **Tihansky** talked about the interconnection of sinkholes, caves, and springs within the karst landscape of west-central Florida. The girls then hiked to Dames Caves in the Withlacoochee State Forest. After a discussion about cave safety, the Girl Scouts eagerly explored the caves and surrounding forest. They discovered a bat, some rare ferns, and fresh mud deposits! Leaving the upland cave area, they traveled to a spring run and watched water discharge from the landscape. The Girl Scouts learned teamwork as they coordinated paddling rowboats through the spring-fed Chassahowitzka River.

The second day of the trip included a visit to the Crystal River National Wildlife Refuge Center. The girls enjoyed lunch on the dock and an educational session from **Tihansky** and AWG members **Mary Yeargan**, **Cathleen Jonas**, and **Sharon Gilberg**. They learned about Florida's geologic past and framework and received a hands-on lesson in karst. **Yeargan** shared her sand collection with the girls, teaching them a bit about sand provenance (the rocks and areas from which the sand grains were derived).

Ivan Vicente of the U.S. Fish and Wildlife Service provided a momentous ending to the trip by giving the girls access to Three Sisters Springs, where they were able to observe more than 50 endangered West Indian manatees taking refuge in the warm spring water. **Dennis Farmer**, a volunteer from the Friends of the Chassahowitzka National Wildlife Refuge Complex, briefed the girls on proper behavior around the manatees and explained how the manatees depend on the springs as a refuge.

Worksite field trips and interactions with role models have been shown to have important impacts on girls' academic and career choices. The Girl Scout Council received many positive comments about the March "Discovering Geology Weekend" and hopes to offer the trip again.❁

***Ann Tihansky** uses a hands-on approach with sugar cubes, sand, and clay to demonstrate the properties of porosity, permeability, and solubility.*

The girls discover the joys of spelunking as they descend into one of the Dames Caves.

Two Girl Scouts learn the meaning of teamwork while paddling a rowboat in the Chassahowitzka River.

Access to the dock at Three Sisters Springs in Crystal River provides a unique opportunity for an up-close view of several endangered West Indian manatees.

The "Discovering Geology Weekend" Girl Scouts and their trip leaders assemble on a few big rocks in the Brooksville Quarry for a group photo.

Visitors Enjoy Earth Science Day at the USGS Campus in Menlo Park, California

By Helen Gibbons

The rumble of the Quake Cottage could be heard all over campus on Earth Science Day, when approximately 1,000 schoolchildren explored displays and hands-on activities at the U.S. Geological Survey (USGS) in Menlo Park, California. Students in grades 2 through 6 and their teachers and chaperones enjoyed 30 presentations set up especially for the event, held April 22, 2010, to coincide with the 40th anniversary of Earth Day.

The students created human seismic waves, put together plate-tectonic puzzles to "Reunite Gondwana" (a "supercontinent" in the Southern Hemisphere 225 million years ago), drove a remote-controlled rover designed to explore Earth and other planets, matched rock samples with outcrop areas on geologic maps, compared the eruptive styles of Mount St. Helens and Kilauea, and, yes, got shaken up in the Quake Cottage, a Mobile Earthquake Simulator demonstrated by the Safe-T-Proof Disaster Preparedness Co. USGS scientists hosting the event spent the day talking with visitors and teaching them about the Earth through a range of activities.

Among the displays with coastal or marine themes were:

- **"Fly Over the Sea Floor,"** hosted by **Pete Dartnell**, in which students took virtual flights over underwater terrain as revealed by USGS bathymetric data.
- **"Microfossils and Tree Rings, Age and Climate Change,"** hosted by **Mary McGann** with assistance from **Holly Olson** and **John Barron**, in which students examined tree rings and the microscopic shells of single-celled marine animals called foraminifera, and learned how their characteristics are used to determine ages and past climate conditions.
- **"Coral Reef Ecosystems,"** hosted by **Nancy Prouty** with assistance from **Susie Cochran**, in which students played a coral-reef "I Spy" game and used coloring pages to learn about coral and coral-reef ecosystems.
- **"Topographic Salad-Tray Models,"** hosted by **Mike Torresan** and **Carol Reiss** with assistance from **Tracy Conrad**, in which students stacked clear plastic trays with a contour line on each to create 3D models of Angel Island (in San Francisco Bay) and Monterey Submarine Canyon in Monterey Bay.
- **"How Clean Is Clean?"**, hosted by **Brent Topping** and **James Kuwabara,** in which students used a conductivity meter to guess which water was which (ocean water, bay water, tap water, bottled water, high-purity lab water).

*USGS Director **Marcia McNutt** works with brothers **Nathan** (far left), **Ryan** (second from right), and **Ethan Chi** (right) to match rock samples to outcrop areas on a geologic map. Third from right is USGS scientist **Dan Mosier**, who created and hosted the activity. Photograph by **Paul Laustsen**, USGS.*

***Director McNutt** looks on as USGS geochemist **Jim Kuwabara** helps young visitors use a conductivity meter to determine the origin of various water samples. Photograph by **Francis Parchaso**, USGS.*

A special guest at this year's event was USGS Director **Marcia McNutt**, in town to address employees at an all-hands meeting the following day. **Director McNutt** explored each exhibit, speaking with presenters and visitors, and trying her hand at the interactive exercises.

The enthusiasm of all who attended made it clear that the day was a hit, and thank-you e-mails received afterward by Earth Science Day Coordinator **Christy Ryan** confirmed the general thumbs-up.

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(Earth Science Day continued from page 10)

Here are excerpts from teachers' e-mails:

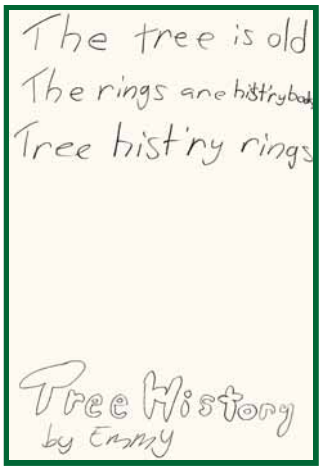
"Thank you for the very best field trip I have ever been on (and I have been teaching for 10 years)…." **Amy Reeber**, Buchser Middle School, Santa Clara, California.

"…It was awesome to witness the excitement and interest that our kids displayed as they toured the exhibits. We would like to express our gratitude to you and all the others who helped make this day a great success." The Second Grade Team, Cherry Chase School, Sunnyvale, California.

"The sun came out, the temperature rose—the day was SPECTACULAR!!!! Our parent chaperones were so impressed, and the kids just couldn't get enough of the exhibits…." **Susan Smyth**, Monroe Middle School, San Jose, California.

And here's a thank-you note from a homeschooling mom:

"We had so much fun at Earth Science Day! We spent a long time at the table where the boys placed rocks where they are found on the map of CA. It made us curious about the rock collection that the boys have in our backyard. We liked the topographic salad trays so much that we brought home the Angel Island map to make one of our own. We also enjoyed the volcano exhibits, especially the one that demonstrated what happens when a volcanic lake is saturated with carbon dioxide. The boys had fun driving the robotic rover over rocks, checking water purity, and trying out the earthquake machine. After several games of Jeopardy in the library, I managed to convince the boys it was time to go. By this time it was two o'clock and we hadn't had lunch yet. However, we had to stop at the interesting exhibits outside. We were really impressed with the turkey baster with sand in the bulb, and the ping-pong-ball examples in the exhibit about liquefaction. After learning about fault lines and safer buildings, we finally left at 2:30 p.m. As you can see, we had a great time! We really appreciate all the work USGS put into making Earth Science Day, and all of the friendly scientists who patiently answered our numerous questions. Thank you!" **Erica Chi**, mom to **Ethan** (age 9), **Ryan** (7), and **Nathan** (5).



*Students inspect a round from a coast live oak (*Quercus agrifolia*) approximately 130 years old. Labels mark interesting events, such as scars caused by fires and thin rings caused by droughts. (Photograph by* ***Francis Parchaso****.) At the Poetry Corner, where students were invited to write poems about science, a student wrote a poem inspired by the tree-ring activity.*

To learn more about Earth Science Day at the Menlo Park campus, please visit **http://volcanoes.usgs.gov/about/edu/esd/2010/index.php**.

Harnessing the Power of Coastal and Marine Data for Science and Society: The Knowledge Management Workshop

By Fran Lightsom

For centuries humans have collected scientific data to better understand their world. Today's technological advances are making it possible to gather increasingly more precise data in staggering amounts, causing even nonscientists to quickly assimilate such terms as kilobyte, megabyte, gigabyte, terabyte, and beyond (peta-, exa-, zetta-, and yotta-, for those of you who like to look ahead). The U.S. Geological Survey (USGS) is part of this trend, with scientists gathering data in myriad studies around the country. Among the agency's unsung heroes are those who focus on how best to organize, preserve, and serve those data to maximize their usefulness to scientists, managers, and the general public. In the USGS Coastal and Marine Geology Program, this task is performed by the Knowledge Management Project.

To share ideas and brainstorm improvements in data handling, members and associates of the Knowledge Management Project held a workshop on March 16-18, 2010, at the USGS Woods Hole Coastal and Marine Science Center in Woods Hole, Massachusetts. Participants included USGS employees from offices in Woods Hole; St. Petersburg, Florida; Santa Cruz and Menlo Park, California; Denver, Colorado; Reston, Virginia; and Kahului, Hawai'i; as well as a partner from the University of Colorado, Boulder. Invited talks updated workshop participants on Data.gov, a Web site designed to increase public access to datasets generated by the Executive Branch of the Federal Government (presented by **David Govoni**); the National Biological Information Infrastructure Ocean Biodiversity Information System (NBII/OBIS) USA, a one-stop source for biogeographic data collected from U.S. waters and oceanic regions (**Philip Goldstein** and **Mark Fornwall**); data management at the USGS Central Energy Resources Sci-

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ence Center (**David Ferderer** and **Greg Gunther**); the 2010 USGS Data Integration Development Project (**Sky Bristol**); options for an information-management system to support the National Framework for Coastal and Marine Spatial Planning (**Sky Bristol**); and the USGS Geology Discipline's National Policy and Procedural Manual for Sample Collections Management (**Brian Buczkowski**). The agenda also included a poster session and an optional field trip to view coastal change at Cape Cod National Seashore.

A recurring theme during the workshop was the creation of "Data SPAs," single points of access (SPAs) for the major data types created and used by coastal and marine scientists. Groups of data specialists discussed requirements and options for Data SPAs for each data type. Web services were considered for making the Data SPAs accessible and useful for Coastal and Marine Spatial Planning, as well as for USGS data integration. Data SPAs were also discussed as a component of the USGS Coastal and Marine Geology Program's Web presence, along with other information services and Web-site features.

USGS Coastal and Marine Geology Program Coordinator **John Haines** addressed workshop attendees on Thursday morning. **Haines** emphasized the importance of a comprehensive national information system for responding to the critical demands of the National Framework for Coastal and Marine Spatial Planning, as well as the Ocean and Coastal Mapping Integration Act. He advised data managers to be prepared to address high-priority but short-deadline data requests that can be expected throughout the development of a comprehensive information system.

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*Participants broke into small groups to discuss different data types. Here, **Dave Govoni** (left) and **John O'Malley** discuss Data.gov and the "Open Government Directive." Also present were **Dennis Krohn**, **Florence Wong**, and **Chris Polloni**. Photograph by **Chris Polloni**.*

***Jon Childs** (left) and **Chris Polloni** are ready to enjoy 3D imagery on the Geowall (a computerized visualization system) at Tuesday evening's poster session. Photograph by **Ann Tihansky**.*

*During a post-meeting field trip on coastal change at Cape Cod National Seashore, **Ted Keon**, Director of Coastal Resources for the town of Chatham, explains tidal-inlet-formation processes at Chatham Harbor. Holding the map is **Graham Giese**, Director of the Land-Sea Interaction Program at the Provincetown Center for Coastal Studies. Holding the USGS quadrangle is undergraduate **Meghan Grady**, and to the right of **Grady** is her advisor **Mark Borrelli**, a coastal geologist at the center. In foreground with back to camera is **Barbara Dougan**, Cape Cod National Seashore Education Specialist. All were presenters at the field trip. Photograph by **Chris Polloni**.*

*USGS Coastal and Marine Geology Program Coordinator **John Haines** (far right) addresses participants on the final morning of the Knowledge Management Workshop. Composite of photographs by **Chris Polloni**.*

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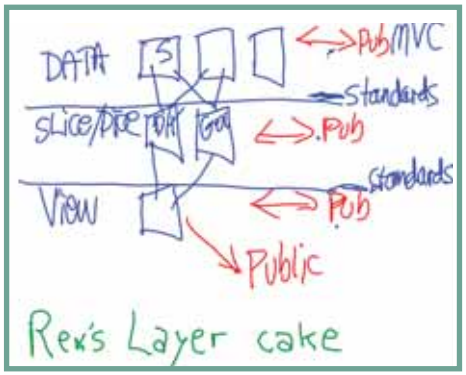
The workshop ended with a recommendation from **Rex Sanders** that Data SPAs be constructed in a modular fashion (a.k.a. "Rex's Layer Cake Model"), with appropriate standards-based interfaces between services that (a) store data, (b) select and subsample data to match requests, and (c) present data to meet the requirements of customers or software clients. These modules could be reconfigured relatively quickly in response to short-deadline requests, while also constituting a comprehensive information architecture for coastal and marine geologic data at the USGS.

Several of the program-wide groups that convened during the workshop are continuing to work together on modular Data SPAs for USGS coastal and marine data.



► ***Rex Sander's*** *Layer Cake Model for structuring single points of access to data (Data SPAs).*

USGS Sedimentologist David Rubin to Receive Pettijohn Medal

The Society for Sedimentary Geology (SEPM) announced in May that U.S. Geological Survey (USGS) scientist **David Rubin** will receive the society's 2011 Pettijohn Medal. The Francis J. Pettijohn Medal for Sedimentology is awarded in recognition of excellence in sedimentology, with nominees being persons who have a significant record of outstanding contributions in sedimentary geology, including all aspects of sedimentology and stratigraphy.

SEPM President **Paul M. (Mitch) Harris** notified **Rubin** that he had been chosen to receive the Pettijohn Medal, which will be presented at the society's annual meeting in Houston, Texas, April 10-13, 2011. Nominations for the award are submitted from the sedimentary-geology community, by both members and non-members of SEPM. A special committee reviews the submissions and selects the nominee they think is most deserving. The committee's report is then reviewed by the SEPM Council, who grant final approval. See a list of previous award recipients at **http://sepm.org/awards/pastwinners.htm**.

A few of **Rubin's** many accomplishments in the field of sedimentary geology have been highlighted in past *Sound Waves* articles:

- **Rubin's** long-term studies of sedimentation in the Grand Canyon have led to changes in how the Bureau of Reclamation operates Glen Canyon Dam (**http://soundwaves.usgs.gov/2002/06/research2.html**).
- Partly to facilitate this Grand Canyon work, **Rubin**, along with colleague **Henry Chezar**, invented the Underwater Microscope System, affectionately known as the "Eyeball" (**http://soundwaves.usgs.gov/2001/06/research.html**). This revolutionary new tool for conducting grain-size analysis of surficial sediment received a patent in 2004 (**http://soundwaves.usgs.gov/2004/03/research.html**).
- **Rubin's** computer animations depicting the formation of bedding structures, particularly cross-beds, have proved extremely valuable in the interpretation of complex bedding patterns exposed in outcrops (**http://soundwaves.usgs.gov/2006/11/pubs.html**).
- When scientists thought they saw the first firm, direct evidence for flowing water on the surface of Mars in images of cross-beds in a crater rim, they asked **Rubin** to review their work, invited him to participate in the National Aeronautics and Space Administration (NASA) press conference in which they announced the discovery (**http://soundwaves.usgs.gov/2004/04/**), and asked him to coauthor some of the resulting scientific papers.

David Rubin *in Grand Canyon.*

Rubin's center director, **Michael D. Carr** (USGS Pacific and Coastal Marine Science Center) spoke for many when he wrote to **Rubin**: "The USGS certainly is fortunate to count you among our most outstanding scientists. Thank you for your continuing leadership in the scientific community and USGS science."

Visiting Students from the Netherlands Contribute to Modeling Morphologic Change in the Pacific Northwest

By Guy Gelfenbaum

U.S. Geological Survey (USGS) scientist **Guy Gelfenbaum** and the USGS Pacific Coastal and Marine Science Center are sponsoring two visiting student scientists, **Emiel Moerman** and **Martijn Monden**, for 2 1/2 months this summer in Menlo Park, California. Both students are working on their M.S. degrees in Coastal Engineering at the Technical University of Delft in the Netherlands. Their projects are part of a Cooperative Agreement between the USGS and Deltares (an independent Dutch research institute in the field of water management and building in delta areas) to conduct joint research on coastal-sediment transport and morphodynamics.

Emiel Moerman

Martijn Monden

Emiel Moerman is working with **Gelfenbaum** and with **Edwin Elias**, a visiting scientist from Deltares, on morphological modeling of the mouth of the Columbia River. Anthropogenic influences, such as jetty construction and river damming, have resulted in pronounced morphological changes in the Columbia River littoral cell, an area of the coast that is isolated sedimentologically from adjacent coastal areas. The processes responsible for the morphological changes within this complex area are not fully understood. Process-based numerical modeling of sediment transport and morphologic change is widely recognized as a valuable approach for understanding and predicting coastal morphological evolution. Therefore, USGS and Deltares are collaborating on the development of process-based numerical models to better understand the morphodynamics of the Columbia River littoral cell. The overarching aim of this study is to develop and test methods and modeling approaches in the application of long-term morphologic modeling of the mouth of the Columbia River. The estuary of the Columbia River is the most important link in the sediment budget of the Columbia River littoral cell. As a consequence of the jetty constructions and river damming, the ebb-tidal delta of the Columbia River moved offshore, and the main channel deepened and stabilized in position. Adjacent shores initially underwent rapid accretion (building seaward) as a consequence of the jetty constructions, but this accretion was followed by equally rapid erosion. Calibration and validation of long-term morphological modeling of the mouth of the Columbia River is necessary to make long-term predictions, to identify the influences of the different processes on the morphological change, and ultimately to support management decisions.

Martijn Monden is working with **Gelfenbaum**, **Eric Grossman**, **Andrew Stevens**, and **Edwin Elias** on morphodynamic modeling of restoration of the Nisqually River delta in Puget Sound. Since the late 1800s, large parts of Puget Sound have been diked for agricultural purposes, resulting in the loss of nearly 80 percent of intertidal wetlands. These wetlands play an important role as a habitat for waterbirds, salmon populations, and numerous species of plants, and in filtering the water from sediments and contaminants. Multiple large-scale projects are currently underway to restore these critical habitats, bringing back natural fluvial, estuarine, and tidal processes. One of the largest of these projects takes place in the Nisqually Delta, where in November 2009 the Brown Farm Dike was removed, reconnecting an area of 308 ha (1.2 mi^2) of the Nisqually National Wildlife Refuge with Puget Sound. The goal of this project is to research what will happen to the morphology of the Nisqually Delta area after the dike removal. This research will be conducted by means of numerical modeling, using the modeling program Delft3D, with special focus on the influence of vegetation. Model results will be compared with field observations, obtained as part of the Nisqually River delta-restoration-monitoring program (**http://www.nisquallydeltarestoration.org/science.php**).

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