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Reasearch

Passing the Torch—Water-Quality Monitoring by the USGS and the Yukon River Inter-Tribal Watershed Council

By Paul Schuster and Helen Gibbons

As **Jay** leans over the side of **Bub's** boat, he notices that the boat is facing downriver. "Hey, **Bub**, spin the boat; we got to be facing upriver." One last rinse to go—filling the syringe all the way up, he discharges the water over his shoulder toward **Bub**. "Got to make sure not to contaminate the sample," **Jay** says with a grin. After one more look at the detailed protocol from the field manual, he collects water in the syringe, carefully adds a filter and needle, and transfers the water to serum bottles that will be sent to a laboratory for analysis. **Jay** and **Bub** are two of 20 volunteer water technicians collecting data for the Yukon River Inter-Tribal Watershed Council (YRITWC) water-quality program, managed by the council's science department. YRITWC is an indigenous grassroots organization dedicated to the protection and preservation of the Yukon River watershed (URL **http://www.yritwc.com/**).

The Yukon River flows 2,300 mi from its headwaters in Canada to its mouth at the Bering Sea, draining a huge area (twice the size of California) that hosts one of the most diverse ecosystems in North America. The river is also fundamental to the ecosystems of the eastern Bering Sea and the Chukchi Sea, providing most of the freshwater runoff, sediment, and nutrients entering those water bodies. In the Yukon River watershed—a varied landscape of glaciers, mountains, wetlands, and tundra—live more than 20,000 indigenous people who use its resources for all aspects of their lives, including drinking water, food, transportation, bathing, and ceremonial and traditional practices.

Indigenous people and Western scientists alike have observed troubling changes in the Yukon River watershed, including changes in freshwater fish and anadromous salmon (which live most of their lives in saltwater and return to freshwater to spawn), increasing incidence of tumors and cysts in fish and wildlife used as subsistence food, elevated levels of atmospherically transported contaminants in fish near the headwaters of the Yukon River, and warming of the Yukon River basin's climate during the past several decades. This warming has resulted in a longer growing season, partial melting of permafrost, drying of upland soils, shrinking of wetlands and lakes, and increased fire frequency. Continued warming has the potential of making vast amounts of organic carbon and nutrients currently stored in permafrost available for decomposition and for release to nearby wetlands, lakes, and streams.

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*YRITWC volunteer water technician **Jay Hootch** collects a water sample from the Andreafsky River, a tributary of the Yukon River, for dissolved-gas analysis.*

The Yukon River is one of the largest rivers in the world that is relatively undisturbed, with no dams, no dikes, and no levees. In this relatively pristine watershed, the effects of climate change and human activity can be observed with particular clarity.

Sound Waves

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Research, continued

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This release will have global effects on the atmospheric concentrations of such greenhouse gases as carbon dioxide and methane; it may also have regional effects on all levels of stream productivity in the Yukon River watershed, including salmon populations.

To better understand the response of the Yukon River basin to climate change, the U.S. Geological Survey (USGS) began a water-quality study in October 2000 (URL **http://ak.water.usgs.gov/yukon/**). During the 5-year-long study, USGS scientists monitored water discharge and made repeated water- and sediment-chemistry measurements at numerous sites along the Yukon River and all of its major tributaries. Rivers are great integrators of what's happening in their watersheds; water chemistry measured at any point in a river reflects a complex combination of the natural processes and human activities that occur upstream. The water-quality database produced by the USGS study provides valuable baseline information about conditions in the watershed and will facilitate proper management of watershed resources as conditions change in response to a changing climatic regime.

While the USGS was winding down its water-quality study, the YRITWC was ramping up plans to conduct its own long-term monitoring and assessment program (URL **http://www.yritwc.com/prog/wq/waterquality.htm**). It soon became apparent that both organizations could benefit from collaboration. Thus began the process that USGS hydrologist **Paul Schuster** calls "passing the torch."

Collecting data and samples from beneath the ice during onsite training in Kotlik, Alaska, March 2004.

In fall 2004, the Alaska regional director of YRITWC, **Rob Rosenfeld**, contacted **Schuster**, a principal investigator in the 5-year-long USGS study, and asked whether the USGS would be interested in providing guidance and assistance in the development of YRITWC's water-quality-monitoring program. Over the next several years, through conference calls, training sessions, and hands-on workshops, a strong relationship was built, and continues to grow, between the USGS and the YRITWC.

Working closely with YRITWC scientific research staff, the USGS has coordinated and conducted twice-a-year training sessions in water-quality sampling, held both in classrooms and in the field. The YRITWC has successfully adopted USGS protocols, methods, and techniques in water-quality sampling and has transferred these skills to

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***Paul Schuster** (right) gives a water-quality-monitoring demonstration at a YRITWC Summit (biannual meeting) in Moosehide, Yukon Territory, Canada, August 2005.*

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many members of Tribes (U.S.) and First Nations (Canada) throughout the Yukon River basin. "We've taken what we learned during our 5-year study on the Yukon River and streamlined it into a real layman's approach to water quality," said **Schuster**. As a result, growing numbers of qualified water technicians are volunteering for the YRITWC water-quality program.

Starting in March 2006, the first field measurements and water samples were collected by the indigenous people of the Yukon River basin under the supervision of the YRITWC and the USGS and sent to laboratories in Boulder, Colorado, for analysis by scientists with the USGS Water Resources Discipline's National Research Program (URL **http://water.usgs.gov/nrp/**). By the end of the 2006 sampling season, nearly 50 volunteers had collected more than 800 samples at 20 sites throughout the basin, 6 of which are sites where the USGS collected water-quality data during its 5-year-long study. The program continued to grow in 2007, with more than 50 volunteers collecting from 25 sites and almost doubling the number of samples.

In March 2007, Environment Canada (URL **http://www.ec.gc.ca/**) sponsored a 3-day water-quality-sampling training in Whitehorse, Yukon Territory, Canada, to expand the YRITWC water-quality-monitoring program into Canada, which contains a third of the entire Yukon River basin, including the headwaters. Instructors included **Schuster** (hydrologist USGS), **Bryan Maracle** (lead scientist, YRITWC), **Rob Phillips**, **Bev McNaughton**, and **Andrea Ryan** (hydrologists, Environment Canada), and **Bob Truelson** (water-quality specialist, Yukon Territorial Government). Participants included personnel from YRITWC, the Water Survey of Canada (URL **http://www.wsc.ec.gc.ca/**), and nearly a dozen water technicians from several First Nations interested in joining the program. This first workshop spurred multiyear funding through the Yukon Territorial Government; a second workshop was held in Whitehorse in April 2008. With this expansion into Canada, the YRITWC water-quality program is becoming unified on a watershed scale, without regard to political boundaries.

Schuster is happy to say that "the torch has been passed." Through the collaborative efforts of the YRITWC and the USGS, the 5-year baseline database completed by the USGS in September 2005 is on its way to being extended to 8 years and beyond, and many sampling sites have been added to the network. The YRITWC supervises field measurements of pH, water temperature, specific conductance (a measure of salinity), and dissolved oxygen, along with the collection of a suite of water samples following USGS protocol. USGS National Research Program laboratories in Boulder, Colorado, and Reston, Virginia, provide in-kind analytical support, measuring dissolved organic carbon, greenhouse gases, major ions, nutrients, trace metals, and oxygen/hydrogen isotopes. The YRITWC also intermittently selects and sends samples to private laboratories for contaminant analyses.

The ever-growing water-quality database is shared among the YRITWC, the USGS, and other interested parties. As the Yukon River basin responds to climate change over the coming decades, this detailed, long-term baseline of water-quality information from the Yukon River will be invaluable, enabling future generations of scientists and resource managers to understand the changes that are occurring, predict future changes, and make decisions about our global and regional resources.

***Bryan Maracle**, science coordinator for YRITWC, demonstrates a calibration technique to water technicians at a March 2008 workshop in Fairbanks, Alaska.*

Water technicians practice CO_2 sampling on the Tanana River, March 2007.

The YRITWC took advantage of an unusual opportunity to supplement its monitoring program in summer 2007, by making continuous water-quality measurements along 1,200 mi of the Yukon River during the Yukon River Healing Journey—a canoe trip from Moosehide, Yukon Territory, Canada, to Russian Mission, Alaska. Similar data collection—using state-of-the-art water-quality probes towed behind canoes—will take place this summer in the Puget Sound/Strait of Georgia basin straddling the United States-Canadian border between Washington State and British Columbia. There, Tribes and First Nations comprising the Coast Salish peoples will conduct water-quality measurements in the Salish Sea—the large inland water body encompassing Puget Sound in the United States, the Strait of Georgia in Canada, and the Strait of Juan de Fuca between the two countries—during their annual Tribal Journey in July 2008 (see "USGS Will Collaborate with Coast Salish Indigenous Peoples to Measure Water Quality in the Salish Sea," *Sound Waves*, May 2008, URL **http://soundwaves.usgs.gov/2008/05/**). Traditional modes of transport, such as canoes, are optimal for this type of research; a propelled vessel, even at its slowest speed, travels fast enough to cause air pockets to form around the water-quality probes, interfering with the probes' performance and resulting in inaccurate data. Towing water-quality probes behind canoes is an excellent example of meshing traditional ways with modern science to move toward a shared goal—understanding our environment.

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The collaboration between indigenous peoples and the USGS is about connecting people in a common cause. Such collaboration empowers the indigenous peoples, as stewards of the land and the water, to begin a process of collecting information through modern science and using traditional ecological knowledge as a guide to new areas of research. The result is a truly unique product that will assist in the management of the watershed's rapidly changing resources. This work strengthens the preservation of the culture and traditional ways of life for people of the Yukon River basin.

Participants in March 2008 workshop, after collecting the first sample of the year on the Tanana River at Nenana, Alaska.

New Method to Estimate Sea-Ice Thickness

By David Douglas and Jessica Robertson

Sea ice plays an important role in the Earth's climate system and provides an important habitat component for several marine mammal species. Scientists recently developed a new modeling approach to estimate the thickness of Arctic sea ice. It's the only hemisphere-scale model based entirely on relationships among historical observations. Developed by scientists with the U.S. Geological Survey (USGS) and the Russian Academy of Sciences, Moscow, the new model is described in the February 15 issue of *Journal of Climate* (v. 21 no. 4, p. 716-729).

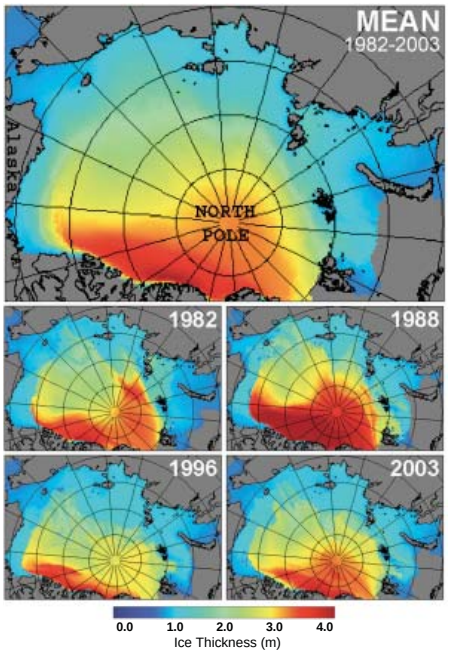
Reductions in Arctic sea ice during the past decade have elevated scientific and societal questions about the likelihoods of future scenarios. Is the recent sea-ice decline an indicator of anthropogenic forcing that will lead the Arctic to an unprecedented future of reduced ice cover, or is the decline simply an ephemeral expression of natural low-frequency climate oscillations that will eventually return the Arctic to prior conditions? This unanswered question has significant ramifications for Arctic ecology as well as the Earth's climate system, and it is being rigorously investigated by numerous scientists throughout the world.

One of those scientists is USGS research wildlife biologist **Dave Douglas**, who developed and implemented the new model with colleagues **Gennady Belchansky** and **Nikita Platonov** of the Russian Academy of Sciences. The authors began collaborating on sea-ice studies nearly 20 years ago because sea ice is the primary habitat for populations of polar bear and Pacific walrus that extend across the United States-Russian border.

Using the new technique, the thickness of Arctic sea ice was estimated monthly from 1982 to 2003. Results showed that average ice thickness and total ice volume fluctuated together during the early study period, peaking in the late 1980s and then declining until the mid-1990s. Thereafter, ice thickness slightly increased, but the total volume of sea ice did not. The authors propose that the total ice volume stayed constant during the study's latter years because while the ice was thickening in the high latitudes of the Arctic, the surrounding sea ice was melting. Sea ice, however, can become only so thick, and if Arctic sea ice continues to melt, the total volume of sea ice in the Arctic will decrease.

The most dramatic losses in sea-ice cover have occurred since 2003, and as scientists acquire newer data, they will apply the new model to study recent years of ice thickness and volume change.

The modeling approach uses sea-ice-motion data to follow parcels of ice backward in time at monthly intervals for as long as 3 years while accumulating a history of the solar radiation and air temperature to which the ice was exposed. The model was constructed by fitting these data with an ice parcel's known thickness to determine how the thickness of sea ice changes in response to different environmental conditions. Data on the known thickness were obtained from historical surface-coring studies, as well as ice-draft measurements made by military submarines during Arctic cruises.



Mean January sea-ice thickness during the 21-year study (top panel). Ice motion tends to compress and thicken the sea ice along the northern Canadian Arctic Archipelago and northern Greenland (bottom of map). Thickness fluctuated over decadal time scales (lower panels), illustrated by the first (1982) and last (2003) years of study and the intervening years of maximum (1988) and minimum (1996) mean ice thickness.

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"Sea ice is affected by the accumulation of environmental factors to which it has been exposed," said USGS Director **Mark Myers**. "Understanding the natural variability of sea-ice thickness is critical for improving global-climate models. Sea ice regulates energy exchange and plays an important role in the Earth's climate system."

The new model, built on historical observations, complements thermodynamic models that simulate ice thickness. Science benefits from having different models; comparing different model outputs can help improve predictive capabilities. Many scientists worldwide are using satellite and ground observations of the Arctic's atmosphere, ice, and ocean to gain a better understanding of how changes at the top of the world affect ecosystems both locally and globally.

For additional information about this research, listen to a podcast interview with **David Douglas** at URL **http://www.usgs.gov/corecast/details.asp?ID=62**, visit the USGS "Remote Sensing and Sea Ice" Web site at URL **http://alaska.usgs.gov/science/biology/remote_sensing/sea_ice.html**, and (or) read the recently published article: Belchansky, G.I., Douglas, D.C., and Platonov, N.G., 2008, Fluctuating Arctic sea ice thickness changes estimated by an in-situ learned and empirically forced neural network model: Journal of Climate, v. 21 no. 4, p. 716-729, doi: 10.1175/2007JCLI1787.1 [URL **http://ams.allenpress.com/perlserv/?request=get-archive&issn=1520-0442**].

Polar bears (recently listed as threatened under the Endangered Species Act) and Pacific walruses are Department of the Interior trust species. Both species use sea ice for various aspects of their life history. Polar bears can effectively catch seals, their primary prey, only from the surface of the sea ice. Walruses use sea ice as a platform for resting while foraging on benthic invertebrates that flourish on the continental shelves of the Bering and Chukchi Seas. Photographs by USGS and U.S. Fish and Wildlife Service.

Airborne Lidar Processing System (ALPS) Workshop

By Emily Klipp and Jamie Bonisteel

A workshop on the Airborne Lidar Processing System (ALPS) was held February 12-15, 2008, at the U.S. Geological Survey (USGS)'s Florida Integrated Science Center (FISC) office in St. Petersburg. Led by **Jamie Bonisteel** (Jacobs Technology contractor at the USGS), the workshop's primary objective was to educate attendees on how to use the ALPS software to explore and process lidar (light detection and ranging) data and imagery acquired by Experimental Advanced Airborne Research Lidar (EAARL). EAARL is an airplane-mounted lidar system used to survey both onshore and nearshore topographic features, such as coral reefs, nearshore benthic habitats, coastal vegetation, and sandy beaches (URL **http://coastal.er.usgs.gov/remote-sensing/advancedmethods/eaarl.html**). ALPS is a custom-built system for postflight processing of EAARL data (URL **http://coastal.er.usgs.gov/remote-sensing/advancedmethods/lidar.html**). **Bonisteel** revised the original ALPS manual—which was written by **Amar Nayegandhi** (Jacobs Technology/USGS), **John Brock,** (USGS), and **C. Wayne Wright** (National Aeronautics and Space Administration [NASA])—to include updates to the software, as well as tools for the software that were not in the original manual.

*ALPS instructor **Jamie Bonisteel** (left, Jacobs Technology/USGS) helps **Mark Adams** (National Park Service, Cape Cod National Seashore) with batch processing of lidar data.*

EAARL is an example of a lidar system that uses light of a blue-green wavelength (532 nm) to determine the distance to an

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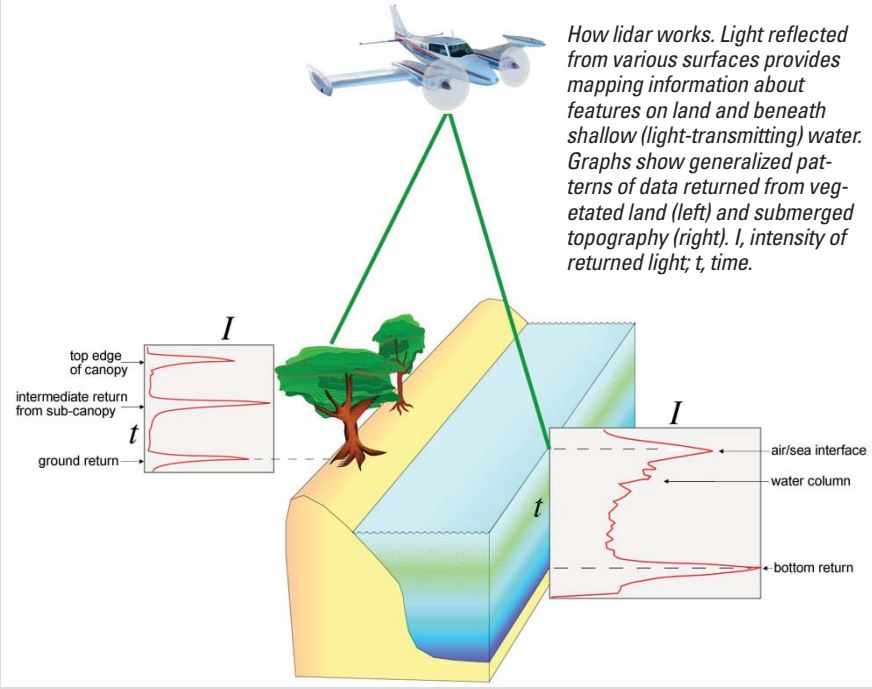
object. The distance is resolved by recording the travel time of a transmitted pulse at the speed of light. The system measures submerged topography and adjacent coastal-land elevations simultaneously by using raster-laser scanning with full-waveform (multipeak) resolving capabilities. (A raster-laser uses two suspended mirror assemblies, one mounted perpendicular to the other, to sweep the laser beam back and forth over a line in two dimensions.)

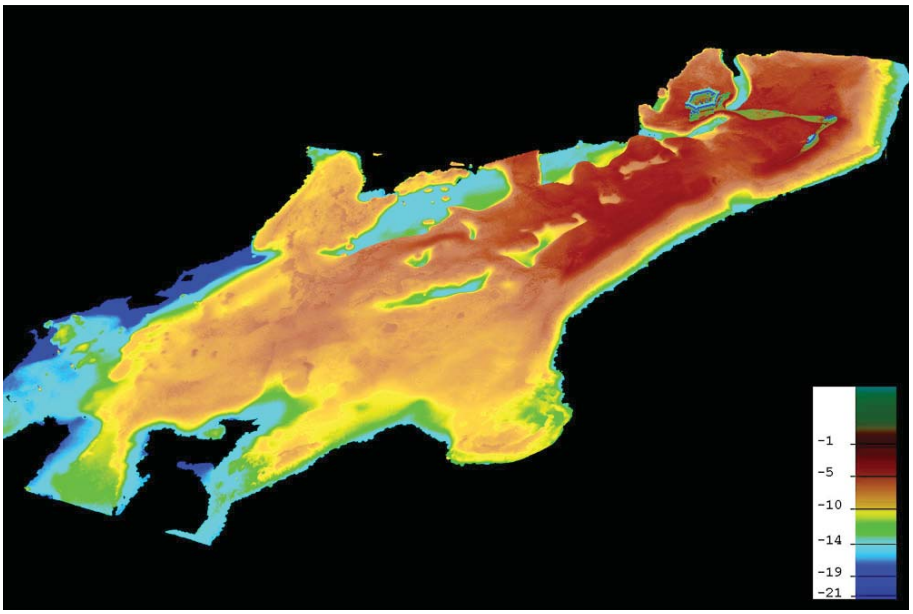
The ALPS software, created by using open-source programming software operated on a Linux platform, enables the exploration and processing of EAARL data in either interactive mode (working with one file) or batch mode (working with multiple files). ALPS also allows for the creation of digital-elevation models (DEMs) of bare-earth (elevation of ground surface beneath vegetation), canopy-top (elevation of top of vegetation), and submerged (elevation of seabed) topography. The EAARL system uses an Earth-centered coordinate and reference system, which eliminates the need to reference submerged-topography data relative to water level or tide gauges.



How lidar works. Light reflected from various surfaces provides mapping information about features on land and beneath shallow (light-transmitting) water. Graphs show generalized patterns of data returned from vegetated land (left) and submerged topography (right). I, intensity of returned light; t, time.

The workshop provided hands-on training for attendees, allowing interaction with modules developed for lidar-raster and waveform investigation and digital-camera-image playback. The class covered processing workflow—the series of steps involved in converting raw lidar data to DEMs that represent submerged, bare-earth, or canopy topography—including tools to filter and edit data either manually or in an automated way. The training class also provided an opportunity for users to become more familiar with the EAARL lidar waveforms and to explore the use of these waveforms in various scientific, monitoring, and inventory activities.

Throughout the weeklong course, attendees learned how to load EAARL mission-day and ancillary data; browse lidar waveforms, red-green-blue (RGB)/color-infrared (CIR) images, and flight lines concurrently; process and analyze flight-line segments; determine the roll bias (effect of the plane's motion on the data); prepare data for batch mode; perform batch processing; process data for submerged topography (bathymetry); define bathymetry parameters; apply a random-consensus filter (RCF), iterative random-consensus filter (IRCF), and batch filter; perform manual editing; apply batch datum conversions; use manual editing tools; and, finally, create DEMs by using ALPS and GlobalMapper.❁

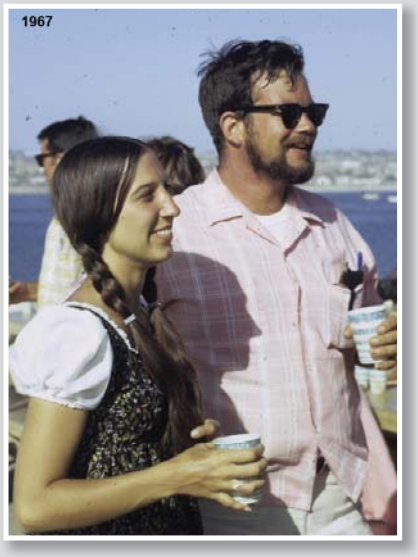


Digital-elevation model (DEM) of the sea floor off Garden, Bush, and Long Keys in Dry Tortugas National Park (about 65 mi west of Key West, Florida), created from EAARL data. The keys are visible in upper right (compare with photograph at URL ***http://soundwaves.usgs.gov/2005/09/fieldwork4.html****). Depths are color-coded: blue shades are deeper, orange and red shades are shallower. Scale at lower right in meters.*

Remembering Bill Normark

Bill Normark: USGS Marine Geologist, Mentor, Winemaker

By Jane Reid and Homa Lee



***Bill Normark** and his wife **Dorothy Jean (DJ)** in 1967 (left) at the apartment of **David J.W. Piper** in La Jolla, California; and in 2004 (right), sharing their homemade wine at a celebration of the 50th anniversary of the USGS campus in Menlo Park, California.*

> "At sea a fellow comes out. Salt water is like wine, in that respect."
>
> —Herman Melville

U.S. Geological Survey (USGS) research geologist **Bill Normark** passed quietly away on Saturday, January 12, 2008, at home with his wife, **DJ**, at his side, after a 7-year fight against cancer. **Bill** was an emeritus scientist who had retired from the USGS last October.

Bill is particularly well known for his work on the characteristics and depositional patterns of turbidite-fan deposits, including studies of the Monterey, Navy, and Hueneme Fans off central and southern California, the Laurentian Fan off eastern Canada, and the Amazon Fan off Brazil. With his closest collaborator, **David J.W. Piper** of the Geological Survey of Canada, **Bill** coauthored some 30 papers about the architecture, sediment type, and growth patterns of fan deposits, both ancient and modern. It is safe to say that turbidite fans, turbidity-current flows, and the mechanisms of moving large amounts of terrigenous sediment to the deep sea through hyperpycnal (density driven) flows formed the core—though only one part—of **Bill's** scientific interests.

*Branch chief **Ed Clifton** (right) congratulates **Bill** (left) and **Randy Koski** on recovery of massive sulfide from the southern Juan de Fuca Ridge off Oregon in 1981, marking the first discovery of hydrothermal-vent activity in the northeastern Pacific Ocean. The rock in front of them is basalt brought up in the same dredge haul that recovered massive sulfide.*

Bill was a major participant in many groundbreaking scientific discoveries, starting in the 1960s. During his graduate-student years, **Bill** worked with **Fred Spiess** of Scripps Institution of Oceanography on some of the first deep-water mapping efforts—including Deep Tow, the first deep-towed, remotely operated vehicle for high-resolution bathymetric and magnetic mapping of the sea floor—and was hired at the USGS in 1974, partly owing to this expertise. **Bill's** initial research for the USGS included working with the National Aeronautics and Space Administration (NASA)'s Jet Propulsion Laboratory on using digital unmanned, tethered vehicles for deep-sea mapping; investigating the depositional processes and resource potential of deep-sea fans; and researching marine sedimentary environments and the formation of sedimentary rocks.

In 1979, **Bill** was aboard the submersible *Alvin* at 21° north on the East Pacific Rise when the first hydrothermal black-smoker vents and chimneys were discovered. Unaware of the intense heat of the fluid (later determined to be approximately 350°C), the *Alvin* pilot drove through the smoke, and only afterward, when they discovered that the vent fluid had melted PVC piping holding a temperature probe, did the pilot and scientists realize that they had put themselves at risk. A scientific article reporting this discovery won **Fred Spiess** and his coauthors, including **Bill**, the 1980 Newcomb-Cleveland Prize for best paper published in the journal *Science* (v. 207, no. 4438, p. 1421-1433, URL **http://www.sciencemag.org/cgi/content/abstract/207/4438/1421**).

Because of his sea-floor-mapping experience, **Bill** led the early 1980s' USGS program researching hydrothermal-mineral deposits on ocean-spreading centers—primarily on the Juan de Fuca Ridge (off Washington and Oregon) and the Gorda Ridge (off Oregon and California)—in

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Remembering Bill Normark

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collaboration with the National Oceanic and Atmospheric Administration (NOAA) and academia. At the same time, he fostered the Geological Survey of Canada's hydrothermal-mineral program.

During the USGS GLORIA (Geological LOng-Range Inclined Asdic) mapping program (URL **http://coastalmap.marine.usgs.gov/gloria/**), which used sidescan sonar to map the entire U.S. Exclusive Economic Zone (from U.S. coastlines out 200 nautical miles), **Bill** led efforts to map the sea floor around the Hawaiian Islands in 1986. **Bill** and various USGS colleagues, including **Jim Moore** and other scientists from the Volcano Hazards Team, identified gigantic submarine debris avalanches—some of the largest mass failures on Earth—off nearly all the volcanic edifices in the Hawaiian Ridge chain. The sheer scale of these failures suggests major tsunami potential, which has important implications for monitoring of the active south flank of Kilauea Volcano on the Big Island of Hawai'i.

From 1988 to 1995, **Bill** stepped back from research to serve the USGS as the Western Regional Associate Chief Scientist and as the first Regional Geologist (acting). During this time, **Bill** continued his research activities and served on several Ocean Drilling Program (ODP) advisory panels. In addition, **Bill** was a Joint Oceanographic Institutions/U.S. Science Advisory Committee Distinguished Lecturer (URL **http://www.joiscience.org/usssp/dls**) for 1995-96, participated as one of two sedimentologists on ODP Leg 155 to the Amazon Fan, and was a member of the Leg 155 editorial team. During much of his career, **Bill** served on the editorial boards for several journals, including *Geology*, the *Journal of Sedimentary Petrology* (now *Journal of Sedimentary Research*), *Marine Geodesy*, and the *Giornale di Geologia*. Immediately after his management time, **Bill** spent 6 months observing the Geological Survey of Canada at the USGS Chief Geologist's behest to learn how the Canadian agency's regional structure could be adapted to the USGS.

In 1996, **Bill** returned to active research within what is now called the Western Coastal and Marine Geology Team, to concentrate on two general topics: (1) pathways and eventual sinks of sediment and contaminants moving from the coastal zone to the deep sea, and (2) identification of offshore hazards in southern California. His research included high-resolution stratigraphy of several California fan systems and age constraints on recent offshore fault movement and submarine landslides along California continental margins. In particular, he found widespread evidence of earthquake and tsunami hazards, including very recent deformational events at

(Bill Normark continued on page 9)

***Bill** (to right of instrument frame) and others prepare equipment for deployment during a cruise to the southern Juan de Fuca Ridge off Oregon, 1982.*

***Bill** debarks from the submersible* Alvin *after a 1984 dive on the southern Juan de Fuca Ridge off Oregon*

***Bill's** many talents included playing the bassoon (far-left photograph, with **Gretchen Luepke** on flute, **Keith Kvenvolden** on recorder, and **Roland von Huene** looking on) and a related instrument called a racket (left, with **Keith Kvenvolden** on recorder).*

Remembering Bill Normark

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the west end of the Santa Monica Basin, large submarine slides off southern Santa Monica Bay, and active faults in the northeastern basin margin. In addition, **Bill** studied the size, timing, and tsunamigenic effect of a large submarine landslide off the Palos Verdes Peninsula that occurred approximately 7,500 years ago. **Bill** also worked on the identification of natural oil and gas seeps offshore Point Conception and in the western Santa Barbara Channel, was part of the team that discovered the first methane hydrate in offshore southern California, and found abundant evidence for shallow gas accumulations in sediment fill at the east end of Santa Monica Basin. (See related articles in *Sound Waves*, March 2006 and November 2003, URLs **http://soundwaves.usgs.gov/2006/03/research.html** and **http://soundwaves.usgs.gov/2003/11/**.)

In the early 2000s, **Bill** used geophysical data collected some 20 years earlier during the hydrothermal-minerals program to determine the fate and scale of humongous late Pleistocene flood deposits in the deep sea, showing that multiple pulses of water from glacial Lake Missoula (in what is now western Montana) carried nearly 1,500 km^3 of sediment out of the ancestral Columbia River mouth. Hyperpycnal flows carried the sediment along the Cascadia Channel and through an opening in the Blanco Fracture Zone. From there, much of the sediment was channeled hundreds of kilometers westward over the Tufts Abyssal Plain, but the tops of many of the flows continued southward and were diverted by the Mendocino Fracture Zone into the box-canyon topography of Escanaba Trough (southern Gorda Ridge), where the sediment was trapped after a journey of more than 1,100 km from the Columbia River mouth. (See article and map in *Sound Waves*, December 2000/January 2001, URL **http://soundwaves.usgs.gov/2001/01/outreach6.html**.)

Bill was the first author of at least 90 peer-reviewed papers among the more than 230 papers (and some 150 presentations) that carry his name, and acted as chief or co-chief for about half of the more than 60 research cruises on which he went to sea. The Department of the Interior (DOI) recognized **Bill's** outstanding career with the DOI Meritorious Service Award (1986) and Distinguished Service Award (2002), and the USGS promoted him to Senior Scientist status in April 2006. In addition, **Bill** received the Michael J. Keen Medal (2003) from the Geological Survey of Canada for contributions to the field of marine geoscience and the Francis Shepard Medal (2005) from the Society for Sedimentary Geology (SEPM) for Sustained Excellence in Marine Geology. In 1986-87, he was an American Association of Petroleum Geologists (AAPG) Distinguished Lecturer. In 2004, he was elected as a Fellow to the American Geophysical Union in both the Ocean Sciences and Tectonophysics sections.

Bill *bowled, too! Shown here with* ***Dot Baron*** *(center) and* ***Homa Lee*** *(right), his partners on the team "Shipwrecked" in the USGS Mixed Trios Bowling League in 2005.*

Bill wanted to be remembered, in part, for his relationship with the Geological Survey of Canada, including his fostering of their hydrothermal-vents research program and the months he spent at the agency in 1998 observing its regional management structure. In a similar vein, his relationships with and mentoring of many international and local graduate students, particularly at Stanford University, were immensely important to him.

To those who knew **Bill**, his collaborative efforts with scientists in other USGS programs and outside the USGS, both within and external to his areas of expertise, are legendary, as is his scientific and personal generosity. An expert amateur winemaker, **Bill** freely shared his knowledge and his wines, and he could always suggest a great place to eat anywhere in the world. His humorous sense of the absurd and commitment to noting details gave him an unparalleled view of science and Government service. ❁

(Right to left) ***Bill*** *and wife* ***DJ*** *converse with colleague, good friend, and partner-in-winemaking* ***Dave Scholl*** *during a birthday celebration for* ***Dave*** *in 2004. Inset:* ***Dave*** *impersonates* ***Bill*** *at a 2006 USGS gathering.*

Remembering Bill Normark

Tributes to Bill Normark

Excerpts from tributes in the Book of Bill, *compiled by* ***Florence Wong*** *and presented to* ***Bill*** *on the occasion of his retirement in 2007, and from spoken tributes at the celebration of* ***Bill's*** *life held at Stanford University on February 9, 2008.*

"You are among the most kind, considerate, and dynamic scientists to have graced the halls of the U.S. Geological Survey. You have always given a tremendous amount of your time, particularly to students and those just starting their professional careers, and never hesitated to include others when your creative genius started to flow." —**Mary McGann**, USGS

"I am surprised that someone as famous and busy as Bill was willing to dedicate a significant proportion of his workday to educating a very naive undergraduate geology major. … This is probably a familiar story for many of the students fortunate enough to work with Bill." —**Jake Covault**, Stanford University

"We all know **Bill** as an accomplished researcher and scientist, as skillful as any at running the government paperwork gauntlet, but only we students have the pleasure of experiencing **Bill** the mentor. The effect **Bill** has had on my development as a researcher has been significant: from the seemingly little, nitpicky items related to finishing a manuscript, to the big-picture questions and general approach to science, and everything in between." —**Brian Romans**, Stanford University

"Some people might refer to the twenty-dollar bill as a 'Jackson,' but to many of us it was called a 'Normark,' a unit of measure for dinner at a fine restaurant. …I had the good fortune of being one of [the students mentored by **Bill**, who] generously shared of his experience and encouraged those around him to grow, both scientifically and personally. …And I do now have a string of favorite restaurants along the west coast—where companionship and good food and wine are much more memorable than the number of 'Normarks'." —**Jan Morton**, USGS

"I was amazed with [**Bill's**] calm in the face of adversity, which we had plenty of—lost equipment, broken equipment, broken ships, exploding septic systems … and of course the notorious Juan de Fuca storms. … Still, the cruises were a joy due to the spirit of teamwork and **Bill's** unflappable leadership." —**Stephanie Ross**, USGS

"I first met **Bill Normark** in 1984, when I was a young Program Manager Assistant at Ifremer in Paris. … The second time, in 1989, I was aware of **Bill's** celebrity and talent. … I was impressed by his kindness, his curiosity, and his patience, which were as big as his science, his spirit, and his experience." —**Bruno Savoye**, Ifremer, Brest, France

(Tributes to Bill continued on page 11)

Andrea Fildani *(left) and* ***Bill Normark****, at* ***Fildani's*** *wedding in Sasso, Italy, May 29, 2006.* ***Fildani*** *wrote: "How an Italian boy ended up in the U.S. and married a Missouri girl is probably a story too long for this book … but I have to say that one of the most compelling reasons why this happened is related to* ***Bill****. As a young scientist in Italy, I always wanted to work with* ***Bill****," which he eventually did, as a graduate student at Stanford University (Ph.D., 2004).* ***Fildani*** *now works for Chevron Energy Technology in San Ramon, California. He coauthored (with* ***Dave Scholl*** *and* ***DJ Normark****) an obituary for* ***Bill*** *in the May 27, 2008, issue of* Eos *(v. 89, no. 22, p. 203-204).*

"**Bill** made his dramatic debut in the 1975 Pick and Hammer Show, when he and **Ed Clifton** introduced to the world the "Mudders Brudders" Siamese twins. Their satire was every bit as good as that of the Smothers Brothers (remember them?). This twosome continued their antics in the inaugural Pick and Anchor show where, with **Bill** on banjo and **Ed** on guitar, they bade a priceless farewell to the old Hiller Building. What fun we had!" —**Gretchen Luepke Bynum**, USGS (retired)

Remembering Bill Normark

(Tributes to Bill continued from page 10)

"In all of our lives we have a very few teachers, coaches, and mentors who truly shape who we are, where we arrive, and how we comport ourselves along the way. For me, **Bill** is among that small pantheon. **Bill's** legacy is larger than his own life. He taught me how to teach and create opportunities for others; it is a geometric progression that he leaves in his wake." —**Grant Lichtman**, Francis Parker School

"I was so lucky to have landed under your **[Bill's]** wing at the USGS. My education there was not only geological, but under your guidance also oenological, gastronomical, musical, and lots of fun. … I salute you, a regular, fun-loving guy who happens to be a very famous scientist, accomplished winemaker, teacher, and friend." —**Chris Gutmacher**, USGS (retired)

*"I still have fond memories of **Bill's** 'tube-worm feast' on the Atlantis II, 1984, Juan de Fuca Ridge." Photograph sent by **Ellen Kappel**, Geoscience Professional Services, Inc.*

"…thank you, **Bill** (and I don't forget **DJ**), for 40 years of friendship, for at least seven cruises together, for at least 20 fine papers together, for many productive hours together spent brainstorming at our kitchen table. … You became so much a part of our family (with the help of the USGS) that your quite distinctive portrait is to be found in our children's first attempts at photography." —**David J.W. Piper**, Geological Survey of Canada

"I think that you [**Bill**] and I were lucky to work during the best years of clastic sedimentology. … it was your work with **David Piper** that made so many useful comparisons between modern and ancient, and contributed significantly to the models that emerged about 1978. … I congratulate you on all of the contributions you have made over the years." —**Roger Walker**, Emeritus Professor, McMaster University, Hamilton, Ontario, Canada

"Your contributions extend beyond pure science to the realm of scientific leadership, and your numerous awards attest to the esteem in which you are held by your colleagues. (However, I must ask the question: Which is more important to you, the Shepard Medal or the Gold Medal for the Gewurtztraminer?)" —**Ed Clifton**, USGS Emeritus Scientist

***Many additional tributes** were sent to **Bill**, in PowerPoint presentations and email messages too numerous to include here.* ❁

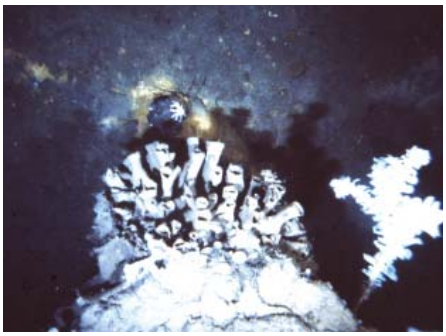
The (Slow) Ascent of the *Sea Cliff*

By Mark Holmes, University of Washington

***Mark Holmes**, now a research professor of oceanography at the University of Washington, served as the first certified civilian copilot/equipment operator during a 1986 dive in the submersible* Sea Cliff *with **Bill Normark** and* Sea Cliff *Commanding Officer **Bruce Bosshard**. In this excerpt from a tribute sent to **Bill** on the occasion of his retirement from the USGS, **Mark** recalls the nerve-racking ascent at the end of the dive:*

"…On **Bruce**'s command I dutifully dropped the ascent weights. Nothing happened. Normally, I would then have started toggling off the selectable weights, but they had already been dropped during our barely controlled bottom approach. At first we thought it was a minor problem; we're just stuck to the bottom by sediment 'suction.' So **Bruce** powered us off the bottom. And back we fell, tail first. We tried this three times, and when the stern hit bottom the third time (hard), I noticed a sudden 30-kilo-ohm electrical 'leak' in the stern shroud. I reported this and **Bruce** got very quiet, his eyes scanning all gauges and meters. … this was when an unspoken communication occurred between the three

(Sea Cliff *continued on page 12)*



Deep-tow-camera image of a sponge colony atop a sulfide mound in Escanaba Trough, Gorda Ridge, taken in 1986 from the research vessel S.P. Lee. *Camera and sampling data from this cruise were used to plan the* Sea Cliff *dives that took place later that summer.*

Remembering Bill Normark

(Sea Cliff *continued from page 11)*

of us that we had a very serious problem somewhere in the sub and that we were going to have to be creative in order to reach the surface again. **Bruce** told me to pump the VBS [variable-ballast system] like mad and to give the side pod thrusters the full 150 amps. I did as I was told, and at that point I looked over and down at you [**Bill**]. I have never, before or since, seen anyone's eyes so wide. … I knew my eyes were just as wide. We called *Lee* [the ship at the surface] and told them we were surfacing under thruster power. Then we kept our eyes glued to the fathometer as we slowly gained altitude, time 0130, Saturday 7/19. Even as a rank novice in the copilot business, I could see from the amp-hour meters that it was going to be a close-run thing. … We were very quiet, occasionally snacking, and now and then just looking at each other while willing *Sea Cliff* to the surface. We knew that there were last-ditch steps to take, such as jettisoning batteries, manipulators, etc., and even unbolting the sphere from the hull. … I'm pretty sure that I wasn't the only one who wondered how long it would take to mobilize *Alvin* or *Turtle* to come rescue us after the batteries ran out and we returned to 3,250 m. Days? Weeks? How much O_2? How much LiOH? How many PB&J sandwiches? I'll always remember that trip. We surfaced at 0530, after a 4-hr-long trip that should normally have taken only 1.5 hours using passive positive buoyancy instead of electric thrusters. There were over 900 amp-hours on both 60-volt batteries, twice the drain that a normal dive would have imposed. Good old *Sea Cliff*. Recovery was smooth, thanks to the Navy's skill and the continued calm seas. … So, raise a cup of tea (or something stronger) to *Sea Cliff*, *Transquest*, NESCA, and SESCA for me. I'm toasting our friendship as you read this. And thanks for your service and dedication to an organization that we both love."

The research vessel S.P. Lee*, on which* ***Bill's*** *USGS colleagues waited for the* Sea Cliff *to surface.*

The motor vessel Transquest*, the support ship that carried the* Sea Cliff *and its crew to a rendezvous with* ***Bill*** *on the* S.P. Lee.

Bill Normark *(left) and* ***Mark Holmes*** *debark from the U.S. Navy's deep-submergence vehicle* Sea Cliff *after their dive to Escanaba Trough.*

The event also remains vivid in the memories of those who waited at the surface for the Sea Cliff *to appear. Here is an excerpt from a tribute to* ***Bill*** *written by USGS scientist* ***Jan Morton****:*

"…For several long hours we watched the *Sea Cliff* ascend to the surface, with the navigation showing us that the ascent rate was much too low. The occupants of the submersible, including **Bill**, were not overly communicative, so we waited and tried to will the sub to the surface. Never so glad to see that mustache as when **Bill** and his companions finally were aboard. …"

Pisces Dive P5-78, Hawai'i

By Jim Moore

USGS geologist ***Jim Moore*** *(now a USGS emeritus scientist with the Volcano Hazards Team) worked with* ***Bill Normark*** *during USGS mapping of the U.S. Exclusive Economic Zone (from the coast out 200 nautical miles) around the Hawaiian Islands. In a tribute to* ***Bill*** *on the occasion of his retirement from the USGS,* ***Jim*** *recalls a submersible dive off the Big Island of Hawai'i:*

In June of 1988, **Bill Normark** and I joined forces for a series of submersible dives off the west side of the Island of Hawai'i. We then moved to the south cape of Hawai'i to explore and sample a reef at 500-ft depth. The reef lies atop the South Rift Zone ridge of Mauna Loa Volcano.

On dive P5-78, pilot **Al Whitcombe**, **Bill**, and I (all big men) were crammed in the small pressure hull of *Pisces* descending to the ocean floor. We were suddenly attacked by a school of large kahala fish (also called amberjack). About four of these fast-swimming fish averaging 3 ft or more in length darted erratically around the submersible and rammed the boat, causing it to rock and shudder. Loud noises resonated within, and we feared for the integrity of the sub. Perhaps the fish were alarmed by this strange monster that invaded their domain, and were intent on chasing it away. They destroyed two external lights and broke and bent other light standards and equipment before giving up the attack. Later inspection revealed that

(Pisces *continued on page 13)*

Remembering Bill Normark

(Pisces *continued from page 12*)

the fish suffered more damage than they inflicted on the sub. Blood and fish tissue were lodged in the light standards. Despite greatly reduced illumination, **Bill** enthusiastically carried on the mission, and we collected several coral and lava samples.

More excitement came at the end of the dive. During the 8 hours below the surface, gale-force winds developed and the sea became angry. This made the transfer by small boat—in heavy seas—difficult from the *Pisces* back to the mother ship. The small boat rose and fell rapidly on 8-ft swells as it moved adjacent to the larger vessel. The trick was to jump at just the right time, so that the boat wasn't too high above the level of the deck or, worse, below the deck. Two burly deckhands stood by the open gunwale ready to grab the jumper in the swashing water that swept the deck. **Bill** jumped a bit too early when the boat was too high. One seaman slipped when he tried to break **Bill's** fall, and they both fell on the deck, where **Bill** broke his foot. Fortunately, this was our last dive in the program, and we transited directly to Kona for medical attention. ❁

Bottom photograph from Pisces *dive P5-78 shows surface of a drowned coral reef at about 150-m (500 ft) water depth off Ka Lae (South Point), Hawai'i. Note shells of boring clams and some dissolution of the carbonate rock. Image approx 2 m wide.*

USGS St. Petersburg Office Dedicates New Building to Congressman C.W. Bill Young

By McCarron Best and Ann B. Tihansky

On March 28, 2008, the U.S. Geological Survey (USGS) Florida Integrated Science Center office in St. Petersburg (FISC-St. Pete) hosted a dedication ceremony for the newest addition to the C.W. Bill Young Marine Science Complex, the "Phase III" building. Nearly 200 guests, including local dignitaries and business leaders as well as representatives from local, State, and Federal agencies, attended the event. **Jack Kindinger**, Associate Center Director, FISC-St. Pete, and his staff welcomed attendees to the dedication and open house. Guest speakers were **Congressman C.W. Bill Young**; **Robert Doyle**, USGS Deputy Director; **Lisa Robbins**, USGS oceanographer; **Judy Genshaft**, President, University of South Florida; **Peter Betzer**, President and CEO of the St. Petersburg Downtown Partnership; and **Martin Normile**, Community Foundation of Tampa Bay. The USGS honored **Congressman Young** by dedicating the "Phase III" building to him nearly 20 years to the day after the first USGS offices were located in a doctor's office in downtown St. Petersburg.

Speakers at the dedication included (left to right) ***Robert Doyle, Lisa Robbins, Congressman Young, Peter Betzer, Martin Normile, Judy Genshaft,*** *and* ***Jack Kindinger****.*

The new building, the third within the USGS campus, encompasses an area of 11,400 ft^2 and features six state-of-the-art laboratories, a dive locker, and 12 offices. It's the latest addition to the C.W. Bill Young Marine Science Complex, which includes the University of South Florida (USF)'s College of Marine Science (URL **http://www.marine.usf.edu/**) and its Center for Ocean Technology (URL **http://www.marine.usf.edu/COT/**), the USGS FISC-St. Pete (URL **http://coastal.er.usgs.gov/**), the Florida Fish and Wildlife Research Institute of the Florida Fish and Wildlife Conservation Commission (URL **http://floridamarine.org/**), the Tampa Bay Estuary Program (URL **http://www.tbep.org/**), the Southwest Regional Office of the National Oceanic and Atmospheric Administration (NOAA)'s National Marine Fisheries Service (URL **http://swr.nmfs.noaa.gov/**), Florida Sea Grant (URL **http://www.flseagrant.org/**), Eckerd College (URL **http://www.eckerd.edu/**), and the State of Florida Institute of Oceanography (URL **http://www.marine.usf.edu/FIO/**).

Located along the waterfront in downtown St. Petersburg, the Marine Science

(Building Dedication continued on page 14)

(Building Dedication continued from page 13)

Complex is unique because it includes multiagency and multidisciplinary teams of scientists working together, reaching across their scientific fields, and combining their areas of expertise to focus on issues impacting Florida, the Nation, and the world.

"The overwhelming support of the USGS by so many people, especially the St. Petersburg Downtown Partnership, the USF College of Marine Science, and **Congressman Young**, has made this vision and today's ceremony possible," said **Barry Rosen**, FISC Director. "This firm commitment, shared by local and national partners, has created a world-class marine-science research community in St. Petersburg."

The ceremony began with **McCarron Best** singing the National Anthem. Associate Center Director **Jack Kindinger** then welcomed the attendees and introduced the speakers. **Lisa Robbins** spoke of the history of the newest building and how the state-of-the-art equipment within it is used daily to advance scientific research at the center. **Judy Genshaft** spoke of how collaborative efforts between USF and USGS over the years continue to benefit both organizations. **Genshaft** highlighted the collaborative spirit by having several of the guest speakers use arm gestures to spell out the initials of the Congressman's name (CWY). **Peter Betzer** and **Martin Normile,** both instrumental in developing the initial vision for the Marine Science Complex, emphasized the value of community partnerships and the great strides the joint complex has made over the years in furthering scientific research. **Congressman Young** recognized the important work being done at the center and its relevance to issues that affect the Nation and the world.

After the speeches, **Jack Kindinger** unveiled the commemorative plaque that recognizes the newest building as "Phase III." With the new building officially dedicated, USGS staff led tours of the facility for the attendees.

Before and after the dedication, guests were invited to tour the new laboratories and visit the Normile Conference Room to view scientific displays and talk with scientists about current research projects. Research displays included "The Florida Shelf Mapping Project," presented by **Lisa Robbins**; "FISC Coral Reef Research," presented by **Ilsa Kuffner**; "Coastal Change Hazards: Hurricanes and Extreme Winter Storms," presented by **Karen Morgan**; "Natural Climate Variability in the Gulf of Mexico: Implications for the Future," presented by **Lisa Osterman** and **Kathy Tedesco**; "The South Florida Information Access (SOFIA) in Support of Priority Ecosystem Science & Everglades Depth Estimation Network (EDEN)," presented by **Heather Henkel**; "Marsh to Mangrove Wetland Conversion in Tampa Bay, Florida," presented by **Ellen Raabe**; and "Integrated Remote Sensing Applications for the Ecosystem-Based Management of Coastal Parks, Sanctuaries, and Preserves" and "Definition of High-Resolution Northern Gulf Coast Geomorphology using Aircraft LIDAR," presented by **Amar Nayegandhi**. Additional scientific information shared through interactive poster sessions before and after the dedication was of great interest to those who attended the events.

Guests mingle in the lobby before the ceremony.

The dedication coincided with the 20th anniversary of the USGS in St. Petersburg. In March 1988, after a highly competitive process involving 24 universities, it was announced that the USGS had selected St. Petersburg as the home for a new national research center which would house scientists in the recently created National Coastal Geology Program. Research topics would include coastal erosion, marine pollution, coral reefs, and marine hard-mineral resources. At the June 1989 dedication of the first building, the original historical Studebaker Building, then-USGS Director **Dallas Peck** commented, "We are looking forward to the partnership with USF and others in the Florida community that will make the Center for Coastal Geology a world-class focus for understanding and solving some of the critical problems facing the Nation's coastal resources."

After 20 years, this vision of partnership and community involvement continues to grow. By the time the March 2008 dedication was over, staff and visitors were more aware of the far-reaching value of scientific research and the powerful role that community partnerships have had in creating unique opportunities within the C.W. Bill Young Marine Science Complex and the surrounding community.

Special thanks are extended to **Janice Subino**, who photographed the event. The FISC Web site (URL **http://fisc.er.usgs.gov/**) contains a link to an article about the building dedication.❁

Congressman Young *(right) and* ***Jack Kindinger*** *proudly display the plaque recognizing "Phase III," the third and newest addition to the C.W. Bill Young Marine Science Complex on the USGS campus.*

USGS Deputy Director Robert Doyle Addresses St. Petersburg Downtown Partnership in Florida

By McCarron Best

After the dedication of the new "Phase III" building at the St. Petersburg campus of the U.S. Geological Survey (USGS)'s Florida Integrated Science Center (FISC) on March 28, 2008 (see article, this issue), USGS Deputy Director **Robert Doyle** addressed the local business community at the quarterly St. Petersburg Downtown Partnership luncheon held at the Hilton Hotel. **Doyle** emphasized the importance of the work being done by each member organization of the C.W. Bill Young Marine Science Complex and how important it is to continue to foster an integrated approach to scientific research. He highlighted how scientific work done by the USGS and the other members of the Marine Science Complex contributes to the community, not only through the research itself but also by stimulating economic growth in St. Petersburg and surrounding areas. **Doyle** also spoke about the importance of the open house held annually on the USGS FISC campus in St. Petersburg and the moral imperative we all share to foster the interest in science that is so vital to society and to creating young scientists of the future.❁

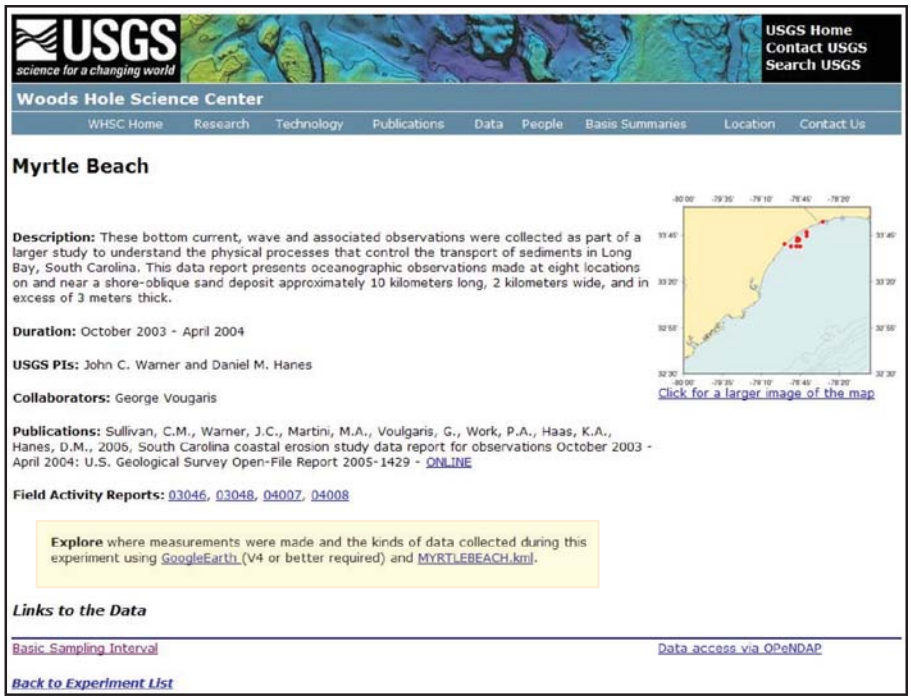
*USGS Deputy Director **Robert Doyle** addresses the St. Petersburg, Florida, business community at the quarterly Downtown Partnership luncheon.*

A New Tool for Investigating Coastal-Sediment-Transport Data in Google Earth

By Ellyn Montgomery and Rich Signell

U.S. Geological Survey (USGS) scientists in the Coastal and Marine Geology Program (CMGP) recently implemented a new way of browsing CMGP's sediment-transport data by using the virtual-globe program Google Earth (URL **http://earth.google.com/**). **Ellyn Montgomery** and **Rich Signell** of the USGS Woods Hole Science Center created Keyhole Markup Language (KML) files for CMGP sediment-transport experiments in the Atlantic and Pacific Oceans, the Gulf of Mexico, and the Adriatic Sea. The KML files employ Google Earth placemarks with information balloons to display metadata fields for each file, enabling intuitive investigation of data collected during each experiment. The creators, **Montgomery** and **Signell**, anticipate that users will benefit from the convenience of using Google Earth to browse through the data.

The homepage "USGS Woods Hole Science Center Moored Time Series Data" (URL **http://stellwagen.er.usgs.gov/**) contains links to pages about the sediment-transport experiments, organized by region and experiment. All the experiment pages have a similar structure; in this article, we use the Myrtle Beach experiment as an example. Once the KML files were made, a new section was added to each experiment page that provides a link to the KML file (highlighted in yellow on the reproduced Web page above).


USGS science for a changing world

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Myrtle Beach

Description: These bottom current, wave and associated observations were collected as part of a larger study to understand the physical processes that control the transport of sediments in Long Bay, South Carolina. This data report presents oceanographic observations made at eight locations on and near a shore-oblique sand deposit approximately 10 kilometers long, 2 kilometers wide, and in excess of 3 meters thick.

Duration: October 2003 - April 2004

USGS PIs: John C. Warner and Daniel M. Hanes

Collaborators: George Vougaris

Click for a larger image of the map

Publications: Sullivan, C.M., Warner, J.C., Martini, M.A., Voulgaris, G., Work, P.A., Haas, K.A., Hanes, D.M., 2006, South Carolina coastal erosion study data report for observations October 2003 - April 2004: U.S. Geological Survey Open-File Report 2005-1429 - ONLINE

Field Activity Reports: 03046, 03048, 04007, 04008

Explore where measurements were made and the kinds of data collected during this experiment using GoogleEarth (V4 or better required) and MYRTLEBEACH.kml.

Links to the Data

Basic Sampling Interval | Data access via OPeNDAP

Back to Experiment List

Sample experiment page, showing link to a KML file highlighted in yellow.

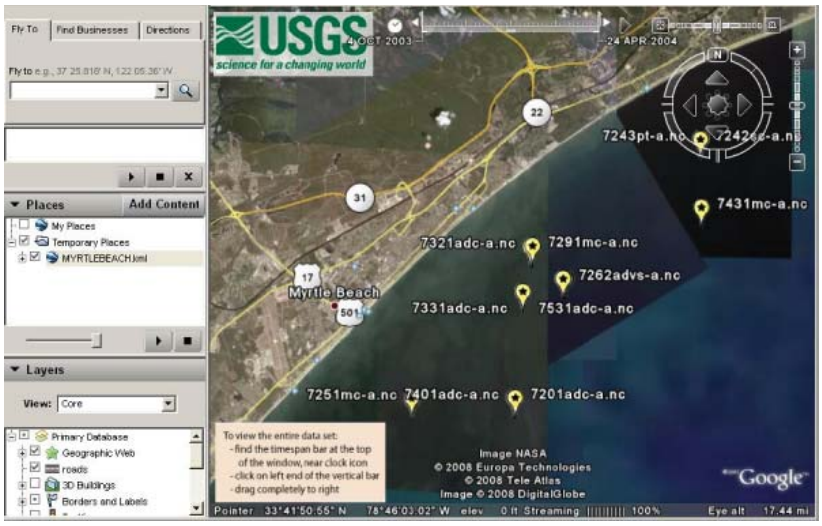
(New Data Tool continued on page 16)

(New Data Tool continued from page 15)

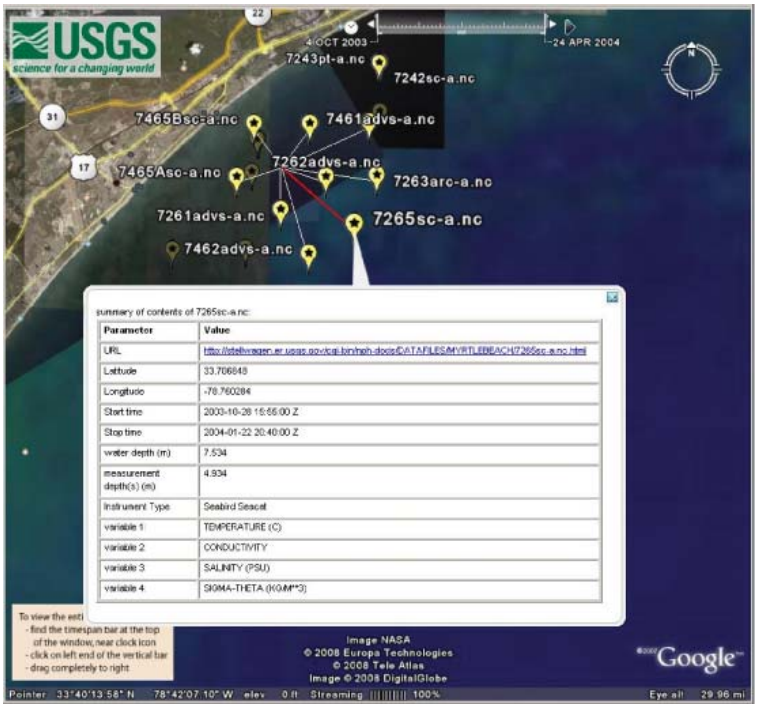
Most browsers launch Google Earth automatically when a KML file is selected. Once launched, Google Earth opens the KML file and zooms in to show the area surrounding the instruments deployed for the experiment (see sample display at right). Yellow icons indicate placemarks associated with data files. The text beside each placemark is the name of the file, whose contents are summarized in a window, or "information balloon," that opens when the placemark is selected. A time slider (semi-opaque horizontal bar at center top of Google Earth views to right) shows the duration of the experiment. The KML file opens with only the beginning of the experiment shown; sliding the bar to the right causes more time to be displayed. The time slider is especially useful with multiyear monitoring programs, for which the user might want to display only those files collected in a particular year.

If several instruments were deployed in one location, the files for some of them will be hidden in the initial Google Earth view. In such cases, clicking on a yellow icon will force an expansion of the items, showing the co-located files connected to the central location by lines. The Google Earth view at right shows such an expanded view of all the files available at a particular location. The expanded view also shows the information balloon displaying metadata for the selected file. The metadata fields listed for all files include position, duration, types of variables collected, water depth, measurement depth, and the URL of the Web page where data are posted. If an entry is missing in the metadata, it will be indicated in the display as "unavailable". The example file contains temperature and conductivity measurements collected at 4.934 meters below the water surface, from which salinity and density (sigma-theta) were computed.

Perhaps the most important metadata field is the URL of the Web page where the data file is provided by our OPeNDAP server. When that URL is clicked, a new Web-browser tab opens to display an OPeNDAP viewer, which allows more detailed browsing of the attributes and data in the file. OPeNDAP is open-source software for data access across the network widely used in the Earth-science community (see URL **http://opendap.org/**). A DAP-enabled client can use the URL to directly access any of the data identified in the file. This is a tremendous advantage in that a user does not have to download data files in order to use them; the client simply requests the data over the network and uses it as it is supplied.



Initial Google Earth display of the KML file MYRTLEBEACH.kml.



Expanded view of co-located files, plus information balloon containing metadata from file 7265sc-a.nc.

The KML files that define what is displayed in the Google Earth views were created by using a user-contributed Google Earth toolbox for Matlab, and software that **Montgomery** and **Signell** developed to extract metadata from the NetCDF (Network Common Data Format) data files to create an information balloon for each instrument or file. For information on how to acquire the software and adapt it to your data, please contact **Ellyn Montgomery** at **emontgomery@usgs.gov** or (508) 457-2356.

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