BOEM OCEAN SCIENCE

THE SCIENCE & TECHNOLOGY JOURNAL OF THE BUREAU OF OCEAN ENERGY MANAGEMENT

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The Marine Minerals Program: Meeting the Needs of Our Nation's Coastline

The Value of Marine Minerals Program Studies

Preserving History within Sand Extraction Areas

The Marine Mineral Resource Potential of the Pacific Outer Continental Shelf

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ON THE COVER
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Frequently Used Abbreviations

BOEM	Bureau of Ocean Energy Management
GOM	Gulf of Mexico
MMP	Marine Minerals Program
OCS	Outer Continental Shelf
USACE	U.S. Army Corps of Engineers

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Check out the Bureau of Ocean Energy Management website at **www.boem.gov**.

The Director's Message

As Hurricane Sandy advanced toward the Atlantic coast, forecasting models predicted that more than 90 percent of coastlines along the Maryland, Virginia, and Delaware peninsula and beaches and the dunes of New Jersey and New York were likely to erode as a result of this terrible storm. Our bureau is one of the many Federal agencies involved in the recovery and prepared to help restore the coastal landscape altered by Hurricane Sandy.

Since the storm, BOEM has dedicated staff and resources to address the anticipated need for Outer Continental Shelf (OCS) sand to rebuild and protect the Nation's coastline and wetlands. In addition to overseeing the responsible development of offshore energy resources, BOEM manages non-energy mineral resources, including sand and gravel, on the OCS through our Marine Minerals Program (MMP), which is the subject of this issue of *BOEM Ocean Science*. Since 1992, this program has completed 37 projects and conveyed more than 73 million cubic yards of sand and gravel to restore 198 miles of coastline in six States.

BOEM is working with our partners in State and local governments, as well as other Federal agencies, to respond to the needs of areas affected by Hurricane Sandy. We are working to collect information on sand resource availability, as well as environmental concerns, and to develop expedited approval processes in anticipation of projects to replenish beaches, dunes, and other coastal marine habitats damaged by the storm. The MMP plays a significant role in providing environmental, recreational, and economic benefits to the Nation. Working with our partners at all levels of government, we will help replenish and protect our coasts and wetlands.

Tommy P. Beaudreau, Director

Beach restoration at the NASA Wallop's Flight Facility on Wallop's Island, VA. *Photo by Charlie Broadwater, BOEM.*

The Marine Minerals Program: Meeting the Needs of Our Nation's Coastline

For years, the Bureau of Ocean Energy Management (BOEM) has been known for its role in managing offshore energy resources, but—true to its mission—the agency is also increasingly busy managing mineral resources such as sand, gravel, and shell. These resources are critical to coastal States for renourishing beaches, restoring shorelines and wetlands, and protecting inland infrastructure. As resources are depleted closer to shore, States must venture out to the Outer Continental Shelf (OCS) to obtain such resources. That's where the Marine Minerals Program (MMP) comes into play—a small program fulfilling a big need.

Through the MMP, the Bureau began working with coastal States in 1992 to identify and evaluate sand deposits in Federal waters for potential use in beach nourishment projects. Then in 1994, Congress passed Public Law 103-426, which allowed localities, States, and Federal agencies to use OCS sand. The use is considered ***noncompetitive*** when it is for certain nationally beneficial projects, such as shore protection or beach nourishment, for wetlands restoration projects, or for use in construction projects funded, in whole or part, or authorized by the Federal government. BOEM is also capable of holding ***competitive*** lease sales on which any qualified person may submit a bid.

In 2011, BOEM and NASA reached an agreement to provide 3.2 million cubic yards of OCS sand for a beach nourishment project to protect the Wallops Island Facility in Virginia from extensive shoreline erosion.

Some 20 years later, BOEM has conveyed rights to more than 73 million cubic yards of OCS resources for 37 coastal restoration projects in six States. These projects have restored approximately 198 miles of our Nation's coastline, protecting billions of dollars of infrastructure and preserving important coastal habitat for aquatic and terrestrial wildlife species that rely on it for spawning, breeding, and foraging.

Louisiana wetlands at sunset.

As the need for sand increased—a trend that continues to grow—the MMP formed Sand Management Working Groups composed of OCS resource stakeholders, such as localities, States, other Federal agencies, educators, specialists, regulators, policy makers, and end users of mineral resources. Three working groups are in place currently: one in the Gulf of Mexico, one in Florida, and one on the Atlantic Coast.

The MMP is also actively involved in environmental studies and resource evaluations concerning marine and coastal environments. Since 1992, over $20 million has been spent on marine mineral environmental studies. These scientific studies provide information that enables BOEM to effectively manage and make sound decisions. Resource Evaluations, which have historically been completed through cooperative agreements, have been used for joint sand evaluation projects. For example, in 2007 BOEM (then MMS) funded cooperative agreements with Alabama, Mississippi, Louisiana, and Texas, which delineated sand resources in offshore waters for potential use in restoration efforts following Hurricanes Katrina and Rita. An estimated 250 to 300 million cubic yards (or more) of sand resources are needed to restore the coastlines and barrier islands of the affected Gulf States—more than 200 square miles of coastal land was lost in Louisiana alone due to these two storms.

Unless there is an emergency need, preparation of a noncompetitive agreement is a multi-step process that typically takes 12–14 months.

Once an agreement is reached regarding the noncompetitive use of mineral resources, others actually perform the work—often the U.S. Army Corps of Engineers (USACE). In addition to working with USACE, the MMP has collaborated with coastal States, with those States' environmental agencies, and with numerous other Federal agencies, such as the:

- National Park Service
- National Aeronautics and Space Administration
- National Oceanic and Atmospheric Administration
- United States Geological Survey
- United States Navy
- United States Air Force

In the future, the MMP expects States that have never received OCS sand will begin the process to access it. This small program is meeting a big need—helping ensure that marine minerals continue to be removed from the OCS in a safe and environmentally sound manner that avoids or minimizes potential adverse impacts on the marine, coastal, and human environments.

For more information:

BOEM's Marine Minerals Program

www.boem.gov/Non-Energy-Minerals/Marine-Minerals-Program.aspx

Regulations Governing the Marine Minerals Program and Information on Competitive and Non-Competitive Lease Agreements

www.boem.gov/Non-Energy-Minerals/Non-Energy-Legal-Framework.aspx

This house in North Carolina was condemned due to beach erosion along the Outer Banks (Nag's Head). *Photo by Artcphotos/Shutterstock.com.*

Identifying Significant Sediment Resources

Coastal States and other Federal agencies rely on the availability of sand resources, and BOEM must resolve any conflicts that arise when there are competing interests for OCS resources under its jurisdiction. To minimize the potential for conflicts, BOEM considers options for balancing the interests of all potential lessees and other stakeholders when looking at offshore resources. One option under consideration is the development of a process to identify and manage particularly important OCS sand resources. Input from coastal States and other Federal agencies is used to identify OCS areas with high quality sand, gravel, or shell resources suitable for beach nourishment, shore protection, or wetlands restoration projects.

Identifying these important OCS resources is one step in a process through which the MMP is notified of proposed uses of these areas.

The Value of Marine Minerals Program Studies

Along the U.S. coastlines, loss of sand from beaches, dunes, and barrier islands is a serious problem, and BOEM is using its resources to help find solutions and ensure that our Nation's coasts are healthy. The MMP, up until 2010, regularly funded large-scale environmental studies to characterize potential impacts on marine and coastal environments from extraction of mineral resources. In fact, since the early 1990s, BOEM has spent over $20 million on more than 50 marine mineral studies through its Environmental Studies Program.

There are three general areas of environmental research related to the MMP:

- biological studies that examine potential impacts on marine life from sand dredging;
- physical impact studies that consider site-specific alteration of wave and current fields and sediment transport; and
- thematic, state-of-the-art studies that evaluate how dredging techniques possibly affect physical, chemical, and biological resources, or how different mitigation techniques can best diminish possible impacts.

BOEM studies have been conducted at a number of high-potential sites and existing sand borrow areas in Federal waters off the Atlantic and Gulf coasts.

Millions of cubic yards of OCS sand have been safely moved and used for projects in Florida, Louisiana, Maryland, South Carolina, and Virginia, and BOEM expects several other States to begin the process to utilize Federal mineral resources in the coming years. Access to Federal resources is increasingly vital to coastal States in need of restoration and renourishment.

Science is key to guiding BOEM's decisions, facilitating the proper management of the use of OCS marine mineral resources to ensure that risks are minimized. The following summaries highlight a few BOEM-funded studies and capture the range of environmental issues that BOEM must consider in its mission to help protect coastal infrastructure, renourish beaches and rebuild dunes, and restore barrier islands and wetlands.

Review of Biological and Biophysical Impacts from Dredging and Use of Offshore Sand

www.boem.gov/uploadedFiles/BOEM/Environmental_Stewardship/Environmental_Studies/National/NT1111.pdf

This new study, led by Research Planning, Inc., focuses on mapping the possible impact pathways and severity of impacts to biological resources on the OCS from different dredging and conveyance operations. Past research is being reviewed and all sources are being analyzed for information gaps. Previously implemented mitigation measures are being reviewed in terms of their basis and effectiveness. The final product will present an integrated view of the types and nature of impacts that occur and whether or how they are mitigated, as well as specific identification of biological impacts that require additional study. The researchers have already compiled and reviewed over 500 study-related documents. This evaluation will continue into 2013, with a final report due in late Spring.

Hopper dredge used at the NASA Wallop's Flight Facility on Wallop's Island, VA. *Photo by Charlie Broadwater, BOEM.*

New Wave Current Information System (WAVCIS) Ocean Observing Station on Ship Shoal

www.boem.gov/uploadedFiles/BOEM/Environmental_Stewardship/Environmental_Studies/Gulf_of_Mexico_Region/Ongoing_Studies/GM-92-42-119.pdf

Off the central coast of Louisiana, Ship Shoal is a submerged sand body on the OCS with a valuable supply of sand compatible for use on Louisiana's eroding barrier islands. BOEM has been negotiating agreements with Louisiana for barrier island and marsh restoration projects, and many projects are now in construction or in the final stages nearing construction.

Some of Louisiana's restoration projects require large volumes of material from Ship Shoal, so more accurate wave information is useful for improving the quality of physical impact models. These models are used to predict impacts related to the extraction of sand from the shoal. Effects could include physical and circulation changes locally in the borrow area, or unintended shoreline change along the adjacent coast because of the influence of the altered seafloor on wave characteristics.

In 2005 BOEM funded the WAVCIS study conducted by the Louisiana State University (LSU) Coastal Studies Institute. A new WAVCIS station was installed near Ship Shoal and became operational in May 2007; it includes an acoustic doppler current profiler, a sea-surface temperature and pressure gauge, meteorological instruments, data logging, a telemetry system, and a power supply/controller. Utilizing this technology, the station is able to provide near real-time wave information to support numerical wave modeling and dredging operations, which can be used to examine the long-term physical impacts of dredging Ship Shoal.

The invaluable wind, wave, and current data is provided in real-time and provides crucial information concerning the distribution of wave energy during storm events and seasonal climatic or oceanographic dynamics along the Louisiana inner shelf.

The WAVCIS station data is available at http://wavcis.csi.lsu.edu.

Wave-Bottom Interaction and Bottom Boundary Layer Dynamics in Evaluating Sand Mining at Sabine Bank for Coastal Restoration, Southwest Louisiana

www.boem.gov/uploadedFiles/BOEM/Environmental_Stewardship/Environmental_Studies/Gulf_of_Mexico_Region/Ongoing_Studies/GM-92-42-94.pdf

Offshore southwestern Louisiana, Sabine Bank is another substantial sand resource for beach nourishment and coastal restoration projects, possibly able to provide 10-20 million cubic yards of sand. However, before any extraction occurs, it is important to examine the physical effects of dredging; and in the area of Sabine Bank, past research has indicated potentially severe wave climate changes (average condition of waves over a period of time) if large quantities of sand are removed.

One of the main objectives of the Sabine Bank study is to improve the understanding of the local physical processes including waves, currents, sediment transport, and seafloor morphologic change. In particular, BOEM wants to better understand the physical system during cold fronts and tropical storm events. The MMP is working with LSU to collect oceanographic data, implement state-of-the-art physical process models, and validate and assess the models. The modeling is also needed to better predict the physical impacts associated with large-scale removal of sand from Sabine Bank. The study results will be used to determine impacts and evaluate requests for negotiated agreements to access Sabine Bank sand. The final report should be available soon.

Best Practices for Physical Process and Impact Assessment in Support of Beach Nourishment and Coastal Restoration Activities

www.boem.gov/uploadedFiles/BOEM/Environmental_Stewardship/Environmental_Studies/NT-10-31.pdf

Although BOEM has funded more than 20 physical process studies that examined near- and far-field impacts of dredging borrow areas on the OCS, it is important to continue to improve predictions for potential impacts from dredging. This study effort, led by Applied Coastal Research and Engineering (ACRE), will provide BOEM with a better understanding of the principal changes in physical processes due to dredging, including morphologic response related to the modification of offshore bathymetry. In addition, since modeling is time-consuming and costly, the study will help establish criteria that BOEM can use to develop guidelines as to when and why site-specific modeling and higher-cost shoreline impact assessments are necessary.

Draghead on a hopper dredge.

For the study, the inner shelf offshore Myrtle Beach, South Carolina, was chosen as the area to test the performance of a suite of state-of-the-art models against actual observations of physical processes. Data has been compiled and improvements have been made to several community models. ACRE has completed defining model parameters and is undertaking model runs and validation exercises for all four of the model suites. After validation exercises are completed, ACRE will model the effects of different dredging scenarios in an idealized physical and oceanographic setting using the top-performing model.

Improving Emission Estimates and Understanding of Pollutant Dispersal for Impact Analysis of Beach Nourishment and Coastal Restoration Projects

www.boem.gov/uploadedFiles/BOEM/Environmental_Stewardship/Environmental_Studies/NT-10-10.pdf

Environmental analyses for proposed projects using OCS sand resources typically include estimates of potential air pollutant and greenhouse gas emissions from dredge equipment, support vessels, and beach construction equipment. Past analyses have typically predicted that the amount of potential emissions for most air pollutants will be relatively small. However, a number of the emission inventories approach the threshold level for nitrogen oxides where mitigation may be required in areas with poor air quality.

This study seeks to collect information needed to refine the parameters used to estimate air emissions from dredging activities, including operational characteristics, equipment activity profiles, engine loading factors, and pollutant emission factors for different equipment types and fuels. Study deliverables include a new tool that will allow BOEM and stakeholders to use a common data source and methodology to prepare more accurate and consistent emissions inventories. In addition, the study will enhance understanding of the nature of pollutant transport and dispersal from dredges operating offshore.

Conducted by ENVIRON International, the researchers have compiled all relevant data, examining the operational characteristics, activity profiles, loading factors, and emission factors with U.S. dredge operators and the U.S. Environmental Protection Agency. In addition, programming, defining parameters, and testing of the emissions inventory calculator are complete. Modeling plume transport of different pollutants during different dredging and meteorological scenarios is almost complete for a study area offshore Brevard County, Florida. The final report is in preparation.

For more information:

Marine Minerals Program Research and Studies

www.boem.gov/Non-Energy-Minerals/Research-and-Studies.aspx

The Success of Marine Minerals Program Projects

The BOEM Marine Minerals Program (MMP) anticipates more requests for OCS sand in the future. A great deal of information about potential impacts from extraction of offshore sand has been gathered through MMP projects and BOEM-funded studies; going further offshore to more "static" sand bodies is a strategy with less severe impacts to the environment and to the coastal sand supply. Requests for and use of OCS sand have led to 37 projects that have restored 198 miles of the U.S. coastline, through the transference of more than 73 million cubic yards (cy) of sand. Many projects used sand previously identified by BOEM through cooperation with coastal States.

To be prepared for renourishment events while continuing to meet ongoing needs for coastal restoration, the MMP consistently funded research studies and projects, until 2010, that provide the geological and environmental information necessary for rights to OCS sand to be conveyed. The MMP's research funding supplies coastal States and Federal agencies with biological, numerical wave modeling, and programmatic studies with emphasis on potential environmental impacts from dredging.

Did you know?

Federal law requires that the lease applicant submit environmental review documents to BOEM before a lease can be issued.

Gulf of Mexico Restoration

The Gulf of Mexico (GOM) encompasses nearly 600,000 square miles of coastline along Alabama, Florida, Louisiana, Mississippi, and Texas. Its diverse ecosystem is vital to the U.S.—environmentally, economically, and culturally. However, natural events (e.g., tropical storms and hurricanes) and human-made stressors are jeopardizing GOM coastal sustainability because erosion of barrier islands and mainland shorelines reduces coastal communities' storm protection, threatens beaches that support the local tourism economy, and affects numerous species, including sea turtles and shorebirds. To protect the long-term future of the GOM, President Obama established the Restore Act Council to coordinate the conservation and restoration of the U.S. Gulf Coast.

Sand from the OCS plays an important role in GOM restoration projects, as State supplies will not be sufficient to complete long-term, large-scale renourishment projects. The use of Federal sand sources will allow the Gulf States to complete vital and often ongoing projects to mitigate erosion and protect the coast from future storm events.

Along the Gulf Coast of Florida, there are 5,095 miles of tidal shoreline and 436 miles of sandy beaches. Over the past two centuries, Florida has undergone major land use changes, with significant development along its coveted beaches. The modified infrastructure—resulting in ditching and draining, shoreline hardening, runoff, and excess sediments—has contributed to major losses of coastal habitat. Florida is making it a priority to restore critically eroded sandy beaches and dunes for mainland protection, recreation, tourism, and wildlife. The State is also developing a mitigation strategy to restore habitats where damage from storms, transportation and navigation projects, and other impacts from public projects have occurred.

Land loss is also a critical issue in Louisiana, where many cities on the GOM coast are vulnerable to annual damage from tropical storms. From 2005 through 2008, Hurricanes Katrina, Rita, Gustav, and Ike caused a net loss of 328 square miles of coastline, and the *Deepwater Horizon* oil spill in 2010 added further adverse effects. State and Federal funds have been used for land-building projects to mitigate this coastal land loss, but Louisiana's beaches are still in a critical state. Without sufficient OCS sand resources for restoration, another major storm event could threaten to destroy the infrastructure of coastal communities, forcing more than a million citizens to relocate. Louisiana is working with BOEM to acquire sand leases in Federal waters for shoreline restoration projects.

In Mississippi, sea-level rise, wave action, tropical storms and hurricanes, and disruptions in the sediment transport system have caused a continual erosion of its coastal shorelines. Although Mississippi's barrier islands serve as natural storm protection, past dredging of the Pascagoula and Gulfport navigation channels has interrupted the natural sand transport processes along the island chain, resulting in smaller islands with increased open water area between them. This has compromised the islands' ability to protect the mainland from the impacts of storm waves and surge, making restoration a priority. The barrier islands and shoreline are vital to Mississippi, as fishing, gaming, tourism, energy production, manufacturing, and shipping are the lifeblood of the State's coastal economy. The U.S. Army Corps of Engineers Mobile District is working on the Mississippi Coastal Improvements Program and is seeking a negotiated agreement with BOEM to use OCS sand to restore Mississippi barrier islands.

Naples Beach, FL. Beach nourishment occurred in 2005.

The Texas coast covers 268,500 square miles and is defended from storms by a natural beach/dune system of barrier islands and spits. Erosion is a major concern, as the beaches provide the mainland with protection from storm waves and coastal flooding. Erosion makes Texas less resilient to weather and storm events, thus threatening the coastal economy and infrastructure. The erosion has already wiped out a passageway from Galveston to Sabine Pass, consuming 26 miles of State Highway 87. Texas is working to increase the height and stability of existing sand dunes; create new dunes; restore barrier islands, peninsulas, headlands, and beaches with dredged material; maintain natural Gulf and bay shoreline areas for public recreation; and enhance natural habitats along the Texas Coast through restoration and acquisition.

For more information:

Gulf of Mexico Regional Ecosystem Restoration Strategy

www.epa.gov/gcertf/pdfs/GulfCoastReport_Full_12-04_508-1.pdf

Gulf Coast Ecosystem Restoration Task Force

www.gulfofmexicoalliance.org/initiatives/gcertf.html; www.epa.gov/gulfcoasttaskforce/

Longboat Key Beach Renourishment Project

Longboat Key is a well-developed barrier island on the central Gulf coast of Florida with approximately 10 miles of shoreline. Located in Sarasota and Manatee Counties, its beaches have been renourished several times since 1993—and have significantly eroded since 2004. Additionally, Longboat Key beaches were impacted by three hurricanes in August and September 2008, as waves and elevated tides caused an accelerated erosion of the dry beach.

Longboat Key is seeking to complete multiple beach renourishments. However, sand sources in south Florida are decreasing, and the search for "white sand" with comparable grain size is moving farther from project areas. BOEM responded to a request for use of OCS sand, and a compatible Federal resource was identified approximately 12 miles offshore of Anna Maria Island in Manatee County, designated as borrow area (BA) F2. The overall proposed project will draw from five borrow areas (one Federal, three State, and one upland) plus two rehandling sites, for a total potential dredge of 1,302,000 cy of sand by the end of 2014.

The purpose of the project is to provide beach nourishment for storm protection from the north end of Longboat Key in Manatee County to the south end in Sarasota County.

Initially, approximately 310,000 cy of sand from State and Federal waters was placed as an interim nourishment. Beginning in 2013, an island-wide project will place sand along 9.8 miles of shoreline, renourishing the entire length of the beach with BA-F2 and State resources.

Throughout the project, effects on sea turtles, marine mammals, nesting and courting shorebirds, and water quality will be monitored. Nearshore hardbottom habitats within the fill templates will be impacted through direct burial; however, during the 2005–2006 beach nourishment (1,789,332 cy of fill), these impacts were mitigated by construction of an artificial reef, resulting in no additional adverse impacts.

Longboat Key, FL. Beach nourishment is scheduled to begin soon.

Much of the beach has already eroded since the substantial 2005–2006 beach nourishment. Without the OCS sand from BA-F2, resources in State waters may not be sufficient for future nourishments. The Longboat Key Beach Renourishment Project is vital to the island's economy, as the beaches are an important source of revenue and sustained stability for beachfront infrastructure and development.

For more information:

Longboat Key Environmental Assessment

www.boem.gov/uploadedFiles/Longboat%20Key%20FINAL%202012%20EA%20and%20FONSI.pdf

Ship Shoal

Ship Shoal, Louisiana, is one of the most substantial offshore sand resources in the northern GOM. This sand body contains 1.6 billion cy of fine sand situated approximately 12 miles off the coast of Louisiana in 20 feet of water. Several studies have found Ship Shoal to be an ideal source of sand to renourish Louisiana's eroding barrier islands.

Because initiatives to repair Louisiana's coast require large volumes of sand and State resources are relatively scarce, BOEM has been funding Ship Shoal studies consistently since the late 1980s. One of the earliest published scientific papers on the subject resulted from a study conducted by the Louisiana Geological Survey in 1988 and is regarded as a benchmark paper in coastal and marine geology because of its contributions toward better understanding of coastal response to sea-level rise. Since then, BOEM has consistently maintained an active Ship Shoal study program. From 2005 through the present, field surveys and shoal monitoring were conducted to better describe Ship Shoal physical and biological conditions and understand the impacts of sand mining. The Louisiana State University Coastal Studies Institute's WAVCIS provides real-time information for the Ship Shoal area, including wave height, wave period, wave direction, water level, water column velocity profiles, turbidity, surge, and more.

Beach restoration at the NASA Wallop's Flight Facility on Wallop's Island, VA. *Photo by Charlie Broadwater, BOEM.*

The following is a list of select BOEM Ship Shoal studies:

- Blue Crab (*Callinectes sapidus*) Use of the Ship/Trinity/Tiger Shoal Complex as a Nationally Important Spawning/Hatching/Foraging Ground
- Wave Climate Modeling and Evaluation Relative to Sand Mining on Ship Shoal, Offshore Louisiana, for Coastal and Barrier Island Restoration
- Ship Shoal: Sand Resource Synthesis Report
- Environmental Investigation of the Long-Term Use of Ship Shoal Sand Resources for Large-Scale Beach and Coastal Restoration in Louisiana (Ongoing Study Co-funded with Louisiana Department of Natural Resources)
- New WAVCIS Ocean Observing System on Ship Shoal, Louisiana
- Characterization of the Development Potential of Ship Shoal Sand for Beach Replenishment of Isles Dernieres

Obtaining accurate information is essential to fully evaluate impacts from dredging operations. Thanks to the knowledge obtained from studies, BOEM recently granted Louisiana approval to use sand from Ship Shoal to restore 280 acres of beaches and dunes in Lafourche and Jefferson Parishes for the Caminada Headland Shoreline Restoration Project. Three active projects plan to use Ship Shoal sand: Caminada Increment 1 (lease issued, construction anticipated early 2013), Caminada Increment 2 (lease requested and being processed), and Whiskey Island Restoration (lease requested and being processed). The Whiskey Island Restoration project is in the design phase and rapidly moving forward. This is the first time BOEM has provided Louisiana access to Ship Shoal for restoration projects, having signed two negotiated noncompetitive leases with the Louisiana Coastal Protection and Restoration Authority in August 2012.

For more information:

Louisiana Marine Minerals Studies

www.boem.gov/Non-Energy-Minerals/Marine-Mineral-Studies.aspx#Louisiana

Bogue Banks Post-Irene Renourishment Project

Bogue Banks, North Carolina, is a 21-mile stretch of barrier island in Carteret County that is separated from the mainland by Bogue Sound. Over the years, nourishment projects have resulted in approximately 11.6 million cy of sand placed on the beaches of Bogue Banks. Since 1999, however, 6.2 million cy have since eroded off the beach.

Hurricane Irene reached North Carolina in August 2011 and had a severe impact on the beaches of several communities along Bogue Banks, including Pine Knoll Shores, Indian Beach/Salter Path, and Emerald Isle. The result was serious oceanfront beach erosion, with over 800,000 cy of sand lost that year (including all of Emerald Isle running eastward through Ft. Macon), leading to loss of sea turtle and shorebird nesting habitat, infrastructure protection, and potential tourism.

The Post-Irene Renourishment Project, launched in September 2012, will place sand in three locations of the affected shoreline in imminent need: western Emerald Isle, eastern Emerald Isle, and Pine Knoll Shores. The project will provide improved storm protection for public and private infrastructure, minimize structural storm damage, improve public access, further support Bogue Banks' tourism industry, and restore pre-storm shoreline sand volumes for continued natural resource usage.

BOEM has completed a noncompetitive lease agreement with Carteret County to authorize 1,000,000 cy of previously dredged sand from an OCS Ocean Dredged Material Disposal Site approximately three miles south of Beaufort Inlet, North Carolina. A hopper dredge will be used to extract the sand, which will be transported and placed by pipeline along approximately 7.1 miles of the Bogue Banks shoreline.

For more information:

Bogue Banks Environmental Assessment

www.protectthebeach.com/smp/2013%20Irene/project/env%20summary.pdf

Spotlight on a Scientist: Roger Amato

Why did you decide to work for the Department of the Interior?

I joined the U.S. Geological Survey's Atlantic OCS Region Office, a predecessor of the MMS, in 1975. I felt that it would be a good opportunity to get in on the ground floor of a vast area unexplored for oil and gas. As the Atlantic activity waned in the late 1980s, I moved to the fledgling Marine Minerals Program (MMP). A new Office of Strategic and International Minerals had opened in California and I became the Atlantic Region liaison. The California office was moved to Herndon, VA in 1990, and renamed the Office of International Activities and Marine Minerals (InterMar). I joined InterMar that year and started working to establish cooperative programs with coastal States to locate and evaluate new sand deposits for future beach nourishment projects. Among the earliest of these State co-ops were New Jersey, Delaware, Maryland, and Virginia. In addition to the sand co-op program, efforts were also made to lease other seabed minerals including gold off Nome, Alaska, manganese crusts off Hawaii, phosphate off Georgia and the Carolinas, and sulfide ores off Oregon and California. None of these initiatives led to leases, but the sand program continued to grow as States realized they were running out of sand resources in their own waters. In the late 1990s, InterMar was reorganized into the Marine Minerals Program of MMS' Leasing Division, where it currently resides.

What is your educational background and experience and how did it enable you to do your job?

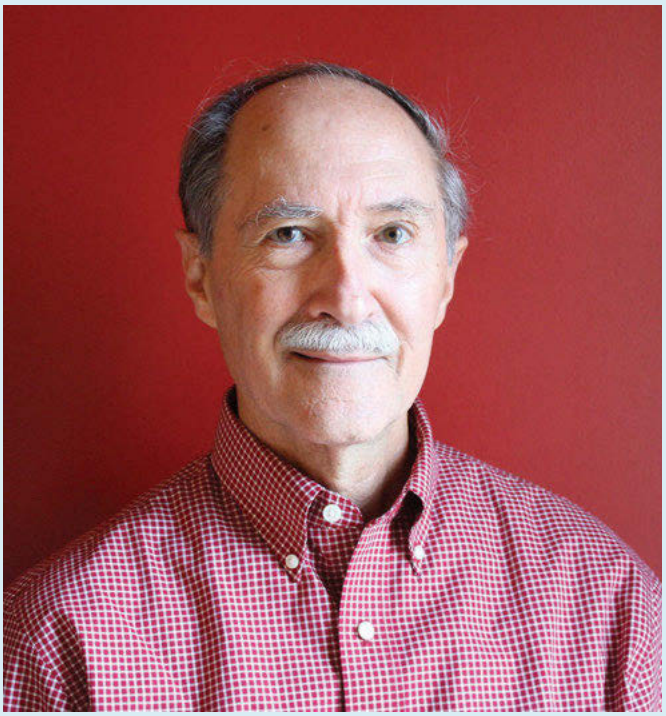
I received BS and MS degrees in geology from Virginia Tech and began working in petroleum exploration for Amoco in Texas. I later joined a geological consulting firm in Washington, DC and conducted mineral exploration both in the U.S. and overseas. The experiences from these jobs helped me greatly in my work in petroleum evaluation in the Atlantic and in the MMP. Attending many training classes and professional meetings during my tenure with MMS and BOEM also provided valuable knowledge and important contacts.

You recently retired from BOEM. What did you most enjoy about working for the agency?

The MMP was especially interesting because there are relatively few people working in it, even worldwide, so I got to know most of them fairly well. Being with the MMP for over 20 years and involved in some of the cooperative programs with the coastal States and the gas hydrate research program for over 15 years has made friendships that have continued after retirement.

Looking back on your career at BOEM, what do you feel is your greatest accomplishment?

Among the greatest accomplishments during my career were having a part in the establishment of the MMP in MMS/BOEM and being involved in the initial evaluation of OCS sand and gravel deposits. In 1993, my atlas of Atlantic offshore sand and gravel deposits was published as an MMS OCS Monograph, which served as the basis for more detailed studies. I was also fortunate to be a part of the first oil and gas evaluation of the Atlantic OCS and the publication of the first reports on some of the key exploration wells drilled in the Atlantic. I am also proud to have had a hand in the establishment of the first permanent gas hydrates observatory in the Gulf of Mexico.



Roger Amato.

You were a key figure in studying hydrates in the Gulf of Mexico. Can you tell us a little more about this research and why it's important?

I became involved in gas hydrate research in 1998 when oversight for the Marine Minerals Technology Centers was given to MMS and I was given the responsibility of managing their funding and research priorities. The Marine Minerals Resources Research Act of 1996 established these centers at several universities and gave the oversight responsibility to the DOI. The center at the University of Mississippi conceived the idea of a permanent gas hydrates observatory in the GOM and established a multi-university research consortium to build and operate it. The consortium eventually included several dozen universities, consultants, and companies as members (see article pages 12-13).

Spotlight on Studies: Gulf of Mexico Hydrates and the Hydrate Research Consortium

Gas hydrates form when gas is surrounded by a cage of water molecules (without chemically bonding) and trapped in marine sediments. These hydrates are rich in energy but not fully understood. Studying gas hydrates is challenging because they are only found in remote and hard-to-reach environments, such as deep water. They are also difficult to extract for laboratory study.

Did you know?

Methane, ethane, propane, nitrogen, carbon dioxide, and other gases can form hydrates.

In the Gulf of Mexico (GOM), hydrates have typically been found in depths greater than 1,476 feet (450 meters); they often consist of water (without salt) and are made up of gases that have migrated up faults from buried hydrocarbon reservoirs. When these gas hydrates occur under the proper pressure, temperature, gas composition, and salinity of pore fluid, they are stable. However, if ongoing sedimentation increases their depth of burial, the temperature of hydrated sediments can increase until they begin to separate, lowering bearing capacity and potentially creating seafloor instability.

Because gas hydrates are susceptible to physical changes such as this, research observations need to be made continuously to understand their transformations. To fulfill this need, the Gulf of Mexico Hydrates Research Consortium was established in 1999, bringing gas hydrate researchers together to conduct *in situ* investigations of gas hydrates and their stability.

The seafloor monitoring station/observatory is located in Mississippi Canyon (MC) Block 118, about 100 miles south of Pascagoula, Mississippi. This site was selected because it has active gas vents, gas hydrates on the surface, mud volcanos, and recently active faults. There are three types of observing systems at the monitoring station — geochemical, microbial, and seismo-acoustic — and funding was provided by BOEM, the National Energy Technology Laboratory (NETL) of the Department of Energy (DOE), and the National Undersea Research Program of the National Oceanic and Atmospheric Administration (NOAA).

Roger Amato was a key figure in studying GOM hydrates. He became involved in gas hydrate research when oversight for the Marine Minerals Technology Centers was transferred to BOEM (then MMS), and he was given responsibility to manage its funding and research priorities.

"The objectives of the program are to monitor an active gas hydrate deposit through temporal changes during small earthquakes, passage of warm water eddies and the loop current," said Amato. In May 2005, the first observing systems, a porefluid sampler and an array of sub-bottom temperature sensors, were installed. By 2010, the site had been thoroughly surveyed both on the surface and subsurface, and about 80 percent of the instrumentation had been deployed. Amato said monitoring data are currently stored in a data logger on site, and the consortium eventually hopes to have a fiber-optic cable from the site to land.

Studies resulting from the observatory are expected to provide researchers with a better understanding of gas hydrates as:

- a geo-hazard to conventional deep oil and gas activities;
- a source of hydrocarbon gases venting to the water column and atmosphere; and
- a future potential source of energy.

Scientists intend to monitor changes in the hydrate stability zone over time, furthering understanding of the hydrocarbon system's role in the environment surrounding the site. The location has already been fortunate for investigators. "The site selection was fortuitous, as it is only 8 miles from the *Deepwater Horizon* well site, making it important as a before/during/after-spill monitoring site," said Amato. After the spill, chemical surveying at two depths showed increased levels of methane where measurable levels had not been seen before, showing chemical changes occurring in the water column. Through this study, these natural gas hydrate changes and their repercussions will hopefully become better understood.

This information is important for seafloor stability and the eventual development of procedures for commercial natural gas recovery, which is critical for the safe placement and operation of subsea equipment, pipelines, and platforms. To date, many program accomplishments have already been made. In 2011,

The Semi-Submersible Helix Q4000 used on the 21-day JIP Leg II Drilling and Logging Expedition. *Photo courtesy of the U.S. Geological Survey.*

new constraints on hydrate formation were established, and multibeam technology was used to measure both volume and frequency of bubble plumes at vents. More recently, by using geochemical data from seafloor arrays and heat flow data, researchers were able to approximate the base of the hydrate stability zone. MC Block 118 is currently under lease for oil and gas exploration, with drilling planned to begin in 2013 or 2014.

GOM Gas Hydrate Joint Industry Project

BOEM is also working with DOE on a multiyear characterization program of gas hydrates in the GOM. This Joint Industry Project (JIP) is being coordinated by DOE, with participation from the U.S. Geological Survey (USGS), the Bureau of Land Management, the Naval Research Laboratory, NOAA, and the National Science Foundation. The JIP aims to turn speculation about gas hydrates as a producible GOM energy resource into a realistic possibility.

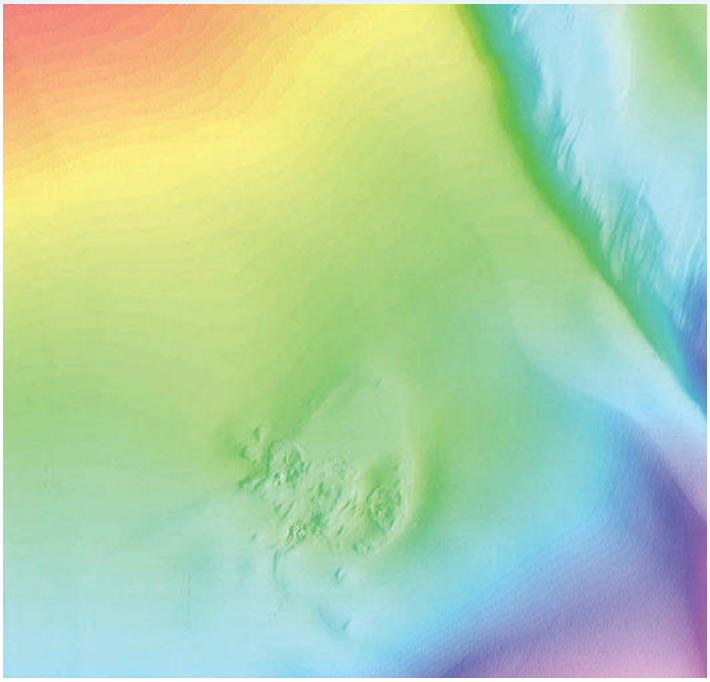
In 2005, the first research cruise to characterize gas hydrates took place, with a second in 2009, and a third cruise in the planning stages. Through these cruises, the JIP seeks to accomplish the following:

- develop and implement a research and technology plan to assist in the characterization of sediments containing naturally occurring hydrates in deepwater;
- assess and understand the potential safety hazards associated with drilling wells through sediments containing gas hydrates;
- develop a database of seismic, core, log, thermophysical, and biogeochemical data to identify current hydrate-containing sites in deepwater;
- plan and execute drilling and coring expeditions to collect data needed to characterize the hydrate-containing sediments; and
- develop wellbore and seafloor stability models pertinent to hydrate-containing sediments.

BOEM allowed the JIP to test a drilling program, and international energy industry companies (under the management of Chevron) sampled gas hydrates at eight OCS locations in three GOM blocks (Atwater Valley Blocks 13 and 14, and Keathley Canyon Block 151). All wells were geophysically logged, and a variety of tasks were conducted, including drilling, coring, and downhole logging operations to assess gas hydrate-related hazards associated with drilling through the clay-dominated sediments. After analyzing results from Leg I, the project was expanded to include assessment of issues related to gas hydrates within coarser-grained sediments.

A comprehensive set of logging-while-drilling data from gas-hydrate-bearing sand reservoirs was collected. Sensors positioned just above the drill bit provided important information on the nature of the sediments and the occurrence of gas hydrate. The complete data set on formation lithology, electrical resistivity, acoustic velocity, and sediment porosity greatly improved the evaluation of the reservoirs. There were some very important discoveries during the drilling expedition. In Walker Ridge and Green Canyon, gas hydrate sand reservoirs between 50 and 100 feet thick were identified, making these sites prime locations for future research drilling, coring, and production testing.

For Leg III, the emphasis of the project is to characterize concentrated gas hydrate occurrence in coarse-grained intervals to help quantify the seismic and geologic hydrate prediction methodologies, as well as cumulative impacts. The research can provide an insight into the behavior of concentrated hydrate occurrence, further helping advance assessments of the marine hydrate reservoir to determine the technical recoverability of gas hydrates. There have already been many exciting accomplishments for the JIP. The project has shown the viability of pre-drill techniques and technologies for hydrate identification and characterization, proven the ability to drill safely in gas hydrate areas, and used advanced logging-while-drilling tools that provided unprecedented 3D images of the hydrate-bearing sediments. In addition, the sites drilled at GOM Lease Block Walker Ridge 313 are currently the deepest gas hydrate research wells in the world.



Color-shaded bathymetric image of the hydrates monitoring station in Mississippi Canyon Lease Block 118 with an unobscured view of the seafloor topography. Each color shade represents 10 ft. of change in elevation. *Map generated by C&C Technology, Inc.*

Initial assessment of GOM gas hydrate resources (released by BOEM) indicated that a mean volume of 21,444 trillion cubic feet (TCF) of methane was in-place in hydrate form, with a possibility of producing 6,710 TCF in the future. With the knowledge gained from the JIP, BOEM can better mitigate potential risks as oil/gas activities move forward, and techniques and technologies for utilizing gas hydrates are developed.

For more information

Gulf of Mexico Gas Hydrate Joint Industry Project

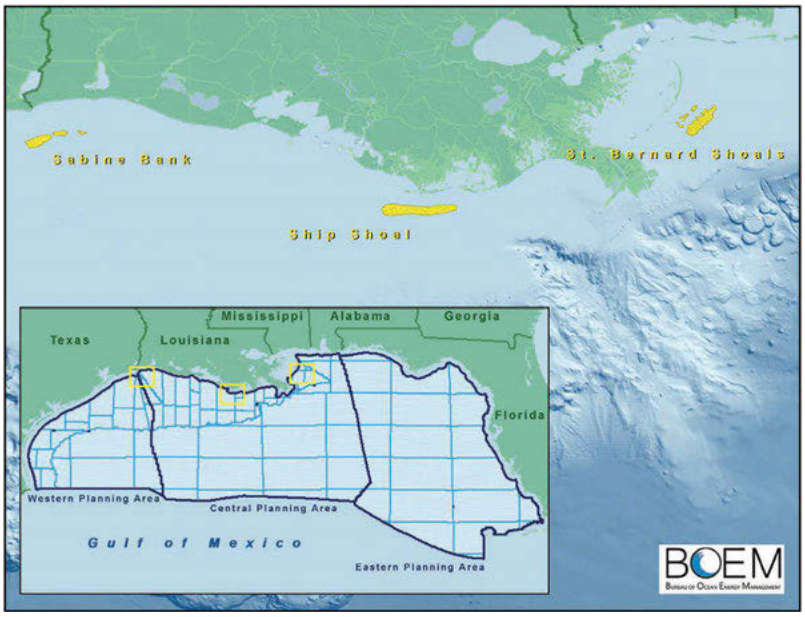
http://energy.usgs.gov/Miscellaneous/Articles/tabid/98/ID/137/Gulf-of-Mexico-Gas-Hydrate-Joint-Industry-Project.aspx

NETL Methane Hydrates R&D Program

www.netl.doe.gov/technologies/oil-gas/FutureSupply/MethaneHydrates/maincontent.htm

Preserving History within Sand Extraction Areas

BOEM manages the rights to OCS sand resources used for coastal restoration and shore protection projects. BOEM's Marine Minerals Program has designated selected sites in the Gulf of Mexico (GOM) as important OCS sand resources to protect the resource from conflicts with other OCS activity, including oil and gas infrastructure installation. However, before any leases or agreements are issued for their extraction, BOEM requires that potential submerged cultural resources within the Area of Potential Effect must be identified.



Map of project areas.

In support of that mission, BOEM has awarded a study to Tidewater Atlantic Research titled "Analyzing the Potential Impacts to Cultural Resources at Significant Sand Extraction Areas." Archaeological resource protection studies evaluate the locations and historical significance of archaeological sites, as well as protect those sites from damage by offshore energy and marine mineral extraction activities. This new study will take place from FY 2012 through 2015 at several sand sources in the GOM either currently or under consideration for future sand extraction, including areas located in dynamic shallow water environments in State waters that have been historically prone to a high occurrence of ship groundings. It will also compare data concerning sand resources in lower energy OCS environments where shipwreck preservation potential is somewhat greater.

The study aims to locate and identify historic shipwreck sites and gain an understanding of potential direct and indirect impacts to these sites from future sediment removal activities, analyzing both existing and newly acquired data. Information on the location, preservation, and extent of shipwreck debris fields within the selected sand resource areas will be collected. This study will support BOEM's Section 106 responsibilities under the National Historic Preservation Act by providing information on potential impacts to sites, which must be considered before BOEM may issue a lease or permit. In addition, BOEM will be able to use the research in its stewardship of OCS minerals management, aiding in strategies for mitigation measures and site protection during future sand leasing activities.

Throughout the study, a variety of techniques and state-of-the-art equipment will be used to complete the objectives. Remote-sensing surveys will employ magnetometer, side-scan sonar, sub-bottom profiler, and sector scanning sonar devices. The team of marine archaeologists, geoscientists, and physical oceanographers will be tasked with:

- Designing and conducting high resolution remote-sensing surveys within OCS sand resources at Ship Shoal, Sabine Bank, and St. Bernard Shoals offshore Louisiana, including site-specific survey designs of potential archaeological resources, refinement of previously collected data sets, and data collection in areas not yet surveyed.
- Identifying up to 10 potential shipwreck sites from the remote-sensing data, and then conducting diver investigations at those selected sites using a variety of archaeological field methods including mapping of site remains, collection of underwater imagery, excavation of test units, and limited artifact recovery.
- Analyzing historical data and imagery to attempt to identify each site, potentially establishing for each vessel the type of ship, date it was built, nationality, ownership, use history, mission, and why it sank.
- Collecting and analyzing sediment cores and other geotechnical, oceanographic, and meteorological data sets to refine the understanding of how sediment dynamics and dredge pit stability may affect archaeological site formation and preservation within OCS sand extraction zones.
- Producing a final report that details the results of the historical, documentary, and field investigations, as well as addressing the state of preservation of each site to aid in establishment of no-impact zones. Recommendations for responsible management and protection of any known or potential shipwreck sites should also be included.
- Developing public outreach materials that detail BOEM's role in OCS marine archaeology and marine minerals utilization, the project's details and results, impacts on historic resources, and discoveries made about the GOM's maritime heritage and archaeological resources.

Information gleaned from the study will aid BOEM in decision making for future marine minerals extraction projects, particularly to help avoid dredging impacts to cultural resources. Determining appropriate dredge set-back buffers around shipwreck sites and other mitigation activities ensure that cultural resources remain intact while OCS mineral resources are best utilized to help mitigate coastal erosion and preserve the Nation's shoreline.

The Marine Mineral Resource Potential of the Pacific Outer Continental Shelf

Offshore extraction of marine minerals that are critical to the U.S. economy and national security may become an important resource managed by BOEM under the Marine Minerals Program in the future, but the concept is not new. In fact, BOEM (then MMS) looked into leases for offshore mining of these resources on the Hawaii, California, and Oregon OCS during the mid- to late 1980s. The marine minerals of interest were cobalt-rich manganese crusts in Hawaii and massive sulfide deposits offshore Oregon and California. During that period, two task forces were established with the States, one with Hawaii and the other with Oregon and California, to assess the economic, engineering, and environmental aspects of ocean mining. A three-year program to assess the mineral and biological resource potential of the Gorda Ridge was completed in 1986. The program discovered large polymetallic sulfide deposits on the Gorda Ridge, located approximately 150 miles offshore northern California and southern Oregon in water depths between 10,000 and 11,000 feet. Task Force-sponsored surveys also resulted in the discovery of extensive deposits of cobalt-rich manganese crusts on seamounts in the Hawaiian OCS and U.S. territories and possessions.

In both cases, MMS opted not to offer the areas for lease due to the adequacy of existing onshore mineral supply sources, market conditions, and consultations with mining companies that expressed the opinion it was premature to consider leasing the areas due to the technological mining constraints. Some 30 years later, demand has increased for products with components that contain copper, lead, zinc, manganese, cobalt and platinum, and rare earth elements (REEs) which are used in color television and flat panel displays (cell phones, portable DVDs, and laptops), rechargeable batteries for hybrid and electric vehicles, important defense applications, such as night vision equipment, and space-based satellites and communication systems. REEs often occur with other elements (e.g., copper, gold, uranium). Higher prices for those metals in recent years may be another reason for the increased interest in offshore mining.

Most REE mining is likely to occur far from our mainland shores. The U.S. Geological Survey estimates that global reserves of 110 million tons are found mainly in China, although Japanese researchers say they have discovered vast deposits at 78 locations on the Pacific Ocean floor at depths of 11,500 to 20,000 feet below the ocean surface in international waters east and west of Hawaii and east of Tahiti.

Mining offshore REE deposits would likely be costly, but it doesn't appear that consumption of products containing REEs will decline any time soon. Global demand for REEs may reach 210,000 tons per year by 2015, according to one estimate (see *Rare Earth Elements: The Global Supply Chain*).

Only time will tell whether mining the sea floor can be commercially viable off our Nation's coasts in the Pacific Region and elsewhere. If so, BOEM's Marine Minerals Program will ensure it is carried out without damaging the diverse life forms found in these delicate offshore ocean environments.

A 1995 report (see *California's Ocean Resources: An Agenda for the Future*) indicated that a wide variety of mineral resources exist off the California coast, including:

- sand and gravel for aggregate from various areas, including the outer continental shelf of Southern California (San Pedro Shelf and San Diego Shelf);
- heavy minerals which could provide sources of titanium, gold, rare-earth elements, and platinum (various areas off the California coast);
- barite nodules on the continental shelf (east of San Clemente Island, southwest of San Nicolas Island, southwest slope of Cortes Bank, Patton Escarpment, southwest of Navy Bank);
- manganese nodules containing manganese, nickel, cobalt, and copper (primarily on abyssal ocean floor and submarine ridges, sporadically on lower continental slope); and
- polymetallic sulfides on ridges (spreading centers), possibly in Northern California offshore areas.

Gold in Alaska

Interest in OCS minerals is also not new in Alaska. Gold was first discovered in 1900 on the beaches of Nome and nearly a century later a Federal OCS lease sale was planned for an area adjacent to State waters under the MMS Marine Minerals Program. However, no bids were received and the sale did not proceed. Some reasons for no bids were the drop in gold price and the availability of mining vessels. Recently, interest in offshore gold mining in Alaska is booming, both commercially and "recreationally!" Small operators, as seen on the TV series "Bering Sea Gold," are operating within State waters. Now, interest may expand to consider the resource potential of the Federal OCS just beyond State waters. In 2012, the BOEM Alaska OCS Region issued a permit under the purview of the MMP to conduct non-invasive sonar and swath bathymetry surveys offshore Nome.

For More Information

Rare Earth Elements: The Global Supply Chain
http://fpc.state.gov/documents/organization/193701.pdf

U.S. Geological Survey, Mineral Commodity Summaries
http://minerals.usgs.gov/minerals/pubs/commodity/rare_earths/mcs-2012-raree.pdf

California's Ocean Resources: An Agenda for the Future
http://resources.ca.gov/ocean/agenda.html

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New Waves

Late-Breaking News & Information

BOEM prepared to help in post-Hurricane Sandy coastal restoration

Wind, waves, storm surge, and flooding from Hurricane Sandy caused severe coastal erosion and damage to beaches, dunes, and wetlands, affecting not only human populations and communities but also wildlife and fragile ecosystems. It has been estimated that Hurricane Sandy caused up to $20 billion in property damage alone. In the aftermath, BOEM is improving its ability to respond to coastal disasters. The Bureau is among the Federal agencies reaching out to states that experienced significant beach and dune damage from the storm.

States in communication with BOEM in recent weeks include Delaware, Florida, Maryland, Massachusetts, New Jersey, New York, North Carolina, and Virginia. Preliminary assessments suggest the greatest needs for Outer Continental Shelf (OCS) sand resources are in distinct coastal segments in New Jersey; Long Island, N.Y.; North Carolina; and possibly Florida.

BOEM worked previously with coastal Atlantic states to identify and quantify potential OCS sand resources that could be used for shore protection projects. BOEM's Marine Minerals Program (MMP) has the capability to identify OCS sand resources needed in the Hurricane Sandy recovery efforts. The bureau will also use and supplement as needed existing environmental analyses conducted over the past 20 years to respond quickly to requests for OCS sand resources for beach nourishment projects.

On November 8th, the US Army Corps of Engineers (USACE) Philadelphia District asked that BOEM participate in the environmental review of the USACE proposal to use OCS borrow areas for the Long Beach Island Storm Damage Reduction Project in central New Jersey. BOEM has since begun working with USACE in the preparation and review of environmental documents to help support recovery efforts. As Atlantic states rebuild their communities, BOEM will lend the expertise of the MMP to this important recovery effort.

Beach erosion in Long Branch, NJ.
Photos by U.S. Geological Survey.