NOAA Ship *Okeanos Explorer*

Exploration of NE Canyons and Continental Margins
Cruise EX1204: May 29th - June 13th, 2012
Norfolk, Virginia to Davisville, Rhode Island

...::: EX1204 Survey and Mapping Team :::...

Photography by Carl VerPlanck

Backscatter Imagery (67°38'45" W, 40°15'37" N)

Figure 4: Backscatter data draped over bathymetry data: Gilbert and Lydonia Canyon.

The EX1204 North East Canyon Exploration, one of five missions contributing to the overall Atlantic Canyons Undersea Mapping Expeditions (ACUMEN), aims to produce high quality backscatter imagery. Backscatter data refers to the intensity of the ship's EM 302 (30 kHz) multibeam sonar's acoustic signal after it is reflected back from the bottom. When studying sediments, the intensity is collected as decibel values, and is interpreted in terms of seabed softness or hardness. Being more reflective, hard bottoms produce a higher intensity. In the ocean, these areas posses greater potential to serve as habitats for deep sea corals (Packer et al. 2007).

Three research vessels are contributing to the 2011-2012 ACUMEN project. Leading the charge, NOAA Ship *Okeanos Explorer* will survey the offshore and deeper portions of the canyons and will produce backscatter imagery with horizontal grid resolution of 20 meters or finer. NOAA Ship *Ferdinand Hassler,* equipped with a multibeam system ideal for waters 600 meters and shallower, will focus on surveying the heads of the canyons. NOAA Ship *Henry Bigelow* will photograph and document biology existing at locations selected based on backscatter and bathymetry data integrated with other datasets in a habitat suitability model developed by the Northeast Fisheries Science Center. The results will also provide excellent ground truth information to the multibeam backscatter data.

Bubble Trouble (71°18'39" W, 39°57'51" N)

Figure 3: Bathymetry with acoustic interference.

NOAA Ship *Okeanos Explorer* is equipped with multibeam as well as single beam sonar systems. A pulse of sound is emitted from a transmitter on the hull of the vessel, which is then reflected off the seafloor and back to a receiver. Applying basic physical principles, the speed of sound, and the two-way travel time are used to determine the depth to the seafloor. The speed of sound in the water column is largely affected by temperature, salinity and pressure. Six times more sensitive to changes in temperature, and twice as sensitive to changes in salinity than to changes in pressure, the speed of sound in water travels approximately 1500 meters per second as opposed to 340 meters per second in the air.

As one may expect, storms at sea do not provide favorable conditions for surveying. As wave heights increase, the ship begins to pitch and roll more drastically generating turbulence while crashing into the waves. This can lead to a form of acoustic interference called "bubble sweepdown," which occurs when bubbles travel along the ship's hull mounted sonar transducers. These bubbles give rise to a faster return signal, attenuation of the acoustic signal and ray refraction which all lead to less accurate computations of the seafloor depth. Above is an example of data collected from Expedition EX1204 during a storm on June 5th, 2012, with wave heights reaching over three meters.

Hudson Canyon (72°1'41" W, 39°19'10" N)

Figure 2: (a) Hudson Canyon and (b) Hydrographer Canyon.

Hudson Canyon is the largest continental shelf breaking canyon off the Eastern Coast off the United States. Formation of this large underwater feature began during the Pleistocene era specifically during the time of the last glacial maximum when sea level was 400 feet lower than what it is today. Glacial water run-off into the Hudson River began to carve out its associated canyon in the new ocean. Today the canyon stretches more than 80 km and spans 12 kilometers at its widest point. Its walls reach heights over 1000 meters and are comparable to those of the Southwest's Grand Canyons, which shoot upwards just over 1600 meters from its base. Similar to how the Hudson Canyon was shaped by the southeast flow of the Hudson River, today it continues to be eroded by oceanic currents. Now however, the flow is in the opposite northwest direction and is mostly due to the lunar M2 tides and various internal waves which are produced by a number of different mechanisms (Hotchkiss and Wunsch, 1982). This current process of erosion brings nutrient rich cold water from the depths and pushes them up through the heads of canyons providing ideal conditions for ecosystems with high biodiversity. This was apparent during the EX1204 expedition when the ship's navigation and bridge teams had to maneuver around fishing gear and vessels on numerous occasions near the heads of canyons while surveying.

Derived Bathymetry (72°53'19" W, 38°36'10" N)

Figure 1: Resolution obtained by (a) satellite and (b) multibeam.

The first comprehensive global seafloor topography became available by analysis of data collected by a system of orbiting satellites. One satellite gathered altimetry data of sea surface height while another, in combination with shipboard measurements, determined gravitational field anomalies that result from geological features. The depth to the seafloor was calculated through a series of algorithms using the two data sets (Smith and Sandwell, 1997). Horizontal and vertical resolutions of 10-15 kilometers and 0.03 meters (~1 inch) were achieved, respectively. Now, research vessels equipped with multibeam sonar are able to survey sites at a much finer resolution, providing data that is beneficial for multiple purposes including navigation, geological, geophysical, biological and archaeological research.

Expeditions aboard the NOAA Ship *Okeanos Explorer* have mapped North East canyons in an effort to help understand the geomorphology and diverse habitat of these areas. Specifically, great interest has been expressed by the North Fisheries Science Center (NEFSC), Virginia Sea Grant and Mid Atlantic Regional council on the Ocean (MARCO) to conduct mapping explorations over this region.

Hotchkiss, F. S., and Wunsch, C. (1982) Internal waves in Hudson Canyon with possible geological implications, *Deep-Sea Research*, 29, 415-442.

Packer, D. B., Boelke, D., Guida, V., and McGee, L.-A. (2007) State of deep coral ecosystems in the northeastern US region: Maine to Cape Hatteras, *The State of Deep Coral Ecosystems of the United States*, p. 195-232.

Smith, W. H. F., and Sandwell, D. T. (1997) Global seafloor topography from satellite altimetry and ship depth soundings, *Science*, 277, 1957-1962.

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