COLLEGE of CHARLESTON
DEPARTMENT OF GEOLOGY AND ENVIRONMENTAL GEOSCIENCES

BEAMS

Bathymetric Analysis of the Monterey Canyon using Multibeam Sonar

Charles McHugh and Dr. Leslie Sautter

Dept. of Geology and Environmental Geosciences, College of Charleston

NOAA Ship *Okeanos Explorer*

Abstract

The bathymetry of the Monterey Canyon, located off the coast of Monterey, California, was mapped using multibeam sonar. The Monterey Canyon extends 146 kilometers offshore with a vertical relief of nearly 3600 meters, greater in width and relief than the Grand Canyon (Carlson and Normark, 2003). Each year the Canyon serves as a conduit to hundreds of thousands of cubic meters of sediment that barrels downslope between its walls. In the past, these turbidity currents have destroyed expensive scientific sensors. In order to better understand turbidity currents and their behavioral patterns, a detailed bathymetric map and numerous cross-sections of the canyon seafloor were created using data collected in 2011 by the NOAA Ship *Okeanos Explorer* equipped with Kongsberg EM302 multibeam sonar. Bathymetric data were processed using CARIS HIPS & SIPS 7.1 post-processing software. This study will add to our knowledge of turbidity currents and their processes, which might prevent future damage to instruments vital to research.

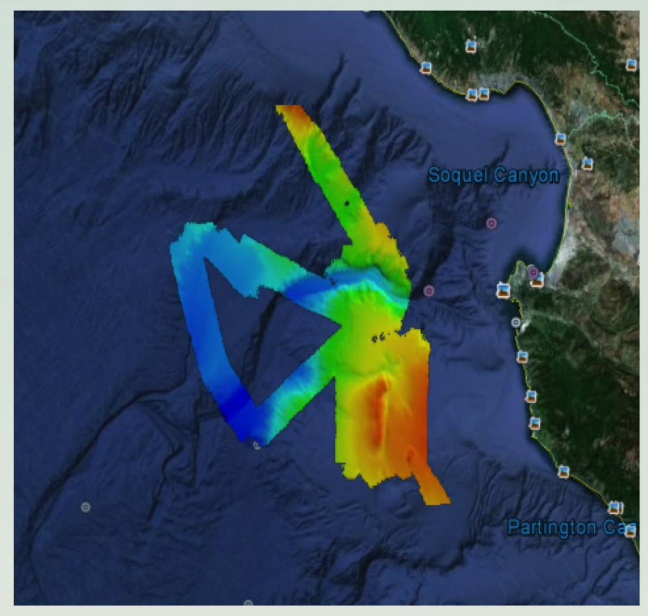


Figure 1. The Monterey Canyon, off the coast of central California (36º36'09.33"N, 122º23'59.91"W)

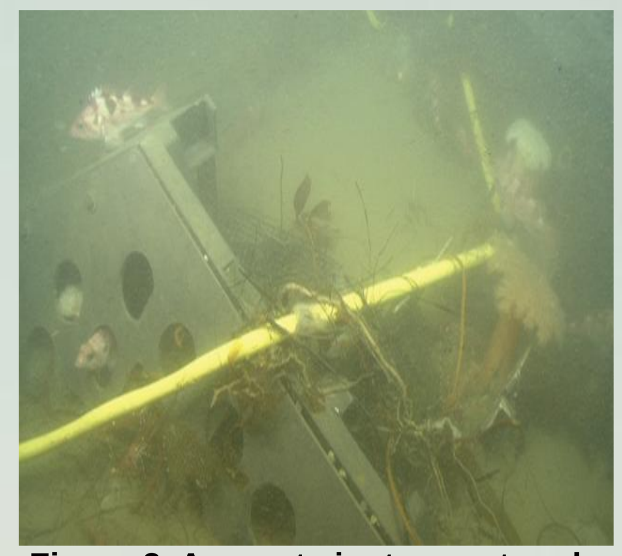


Figure 2. A remote instrument node (RIN) laying in the Upper Monterey Canyon after being damaged by a turbidity current.

What

- **During the data collection process over the past few years, several scientific instruments have been caught in turbidity currents and were severely damaged.**
- **Figure 2 illustrates the extent of the forces applied by the currents, which can be enough to bury instruments and leave them in piles of debris.**
- **In 1994, one current damaged a pressure sensor and totally occluded an optical water-clarity sensor located 100 m above the bed (Martini, 2004).**

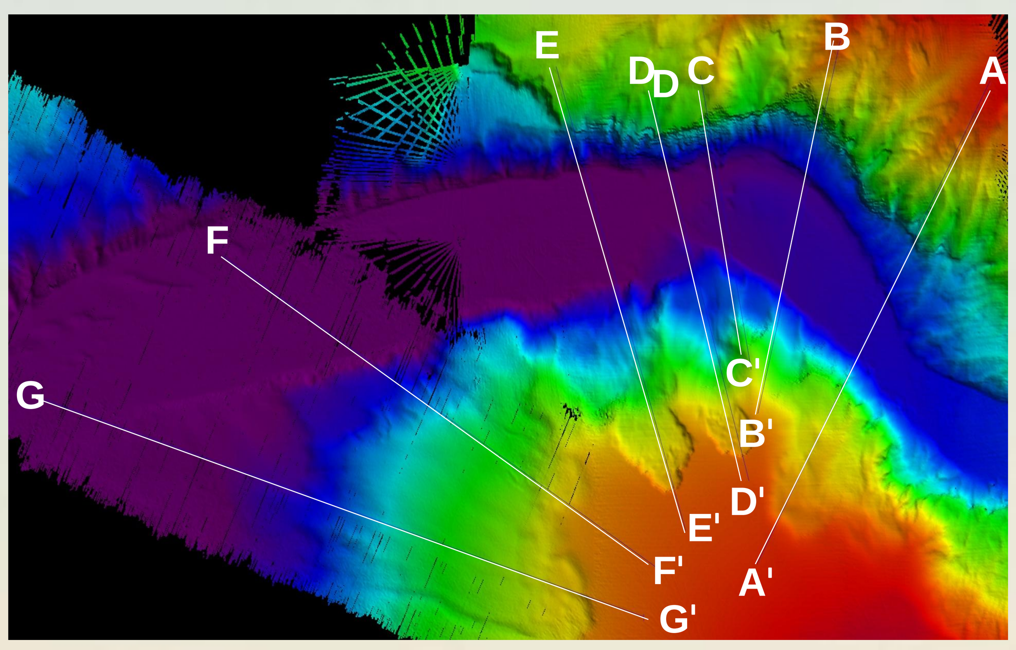
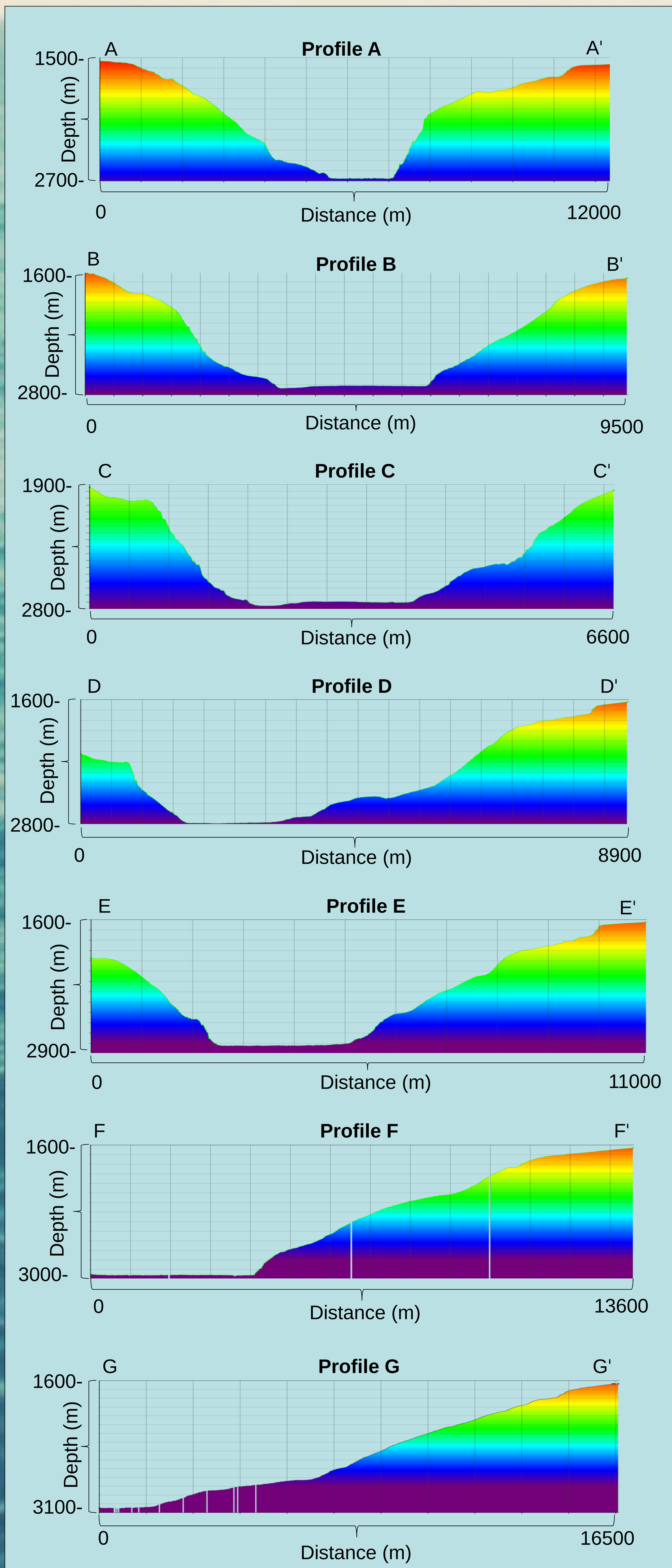


Figure 3. 2D view of canyon profile locations, A - G (above), depicted below. For each profile, the South Wall of the canyon is on the right.



Why

- **Monterey Ocean Observing System (MOOS) is beginning to use fiber-optic cables to power and communicate with solar panels, wind turbines, and satellites from the deep sea (MBARI, 2005).**
- **These instruments and their installation are time-consuming and expensive. To increase the life-time and use of these instruments, bathymetric maps and backscatter data can help identify locations less prone to turbidity currents, reducing the risk of damage or loss.**

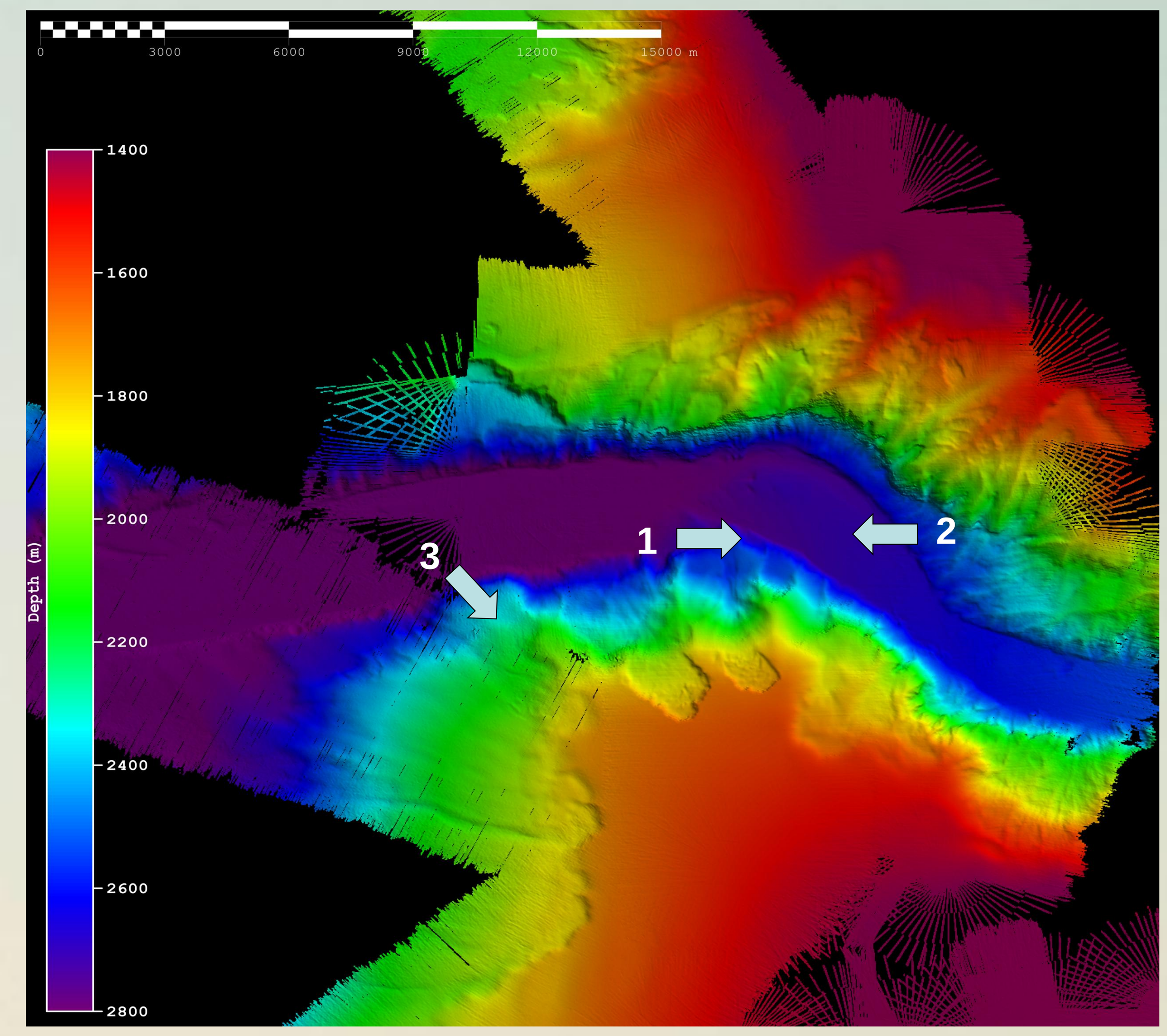


Figure 4. 2D BASE surface of the Northern and Southern canyon walls including the locations of 3D visualizations 1 (Fig. 5), 2 (Fig. 6), and 3 (Fig. 7). Arrows indicate the 3D view directions.

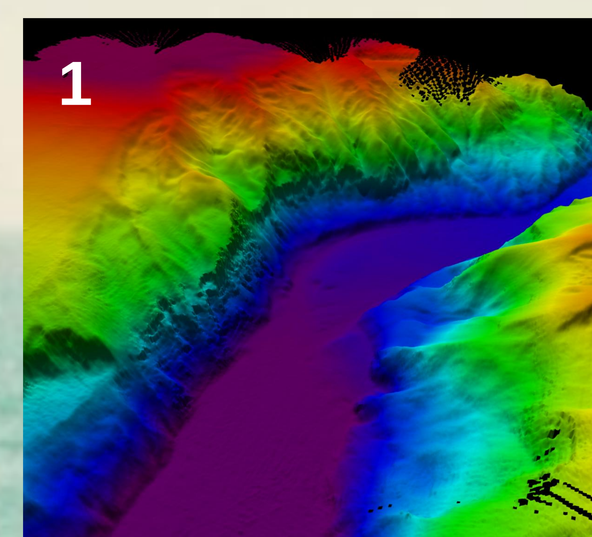


Figure 5. 3D visual of the Northern Canyon wall, viewed looking upstream (east) at VE=1.8x.

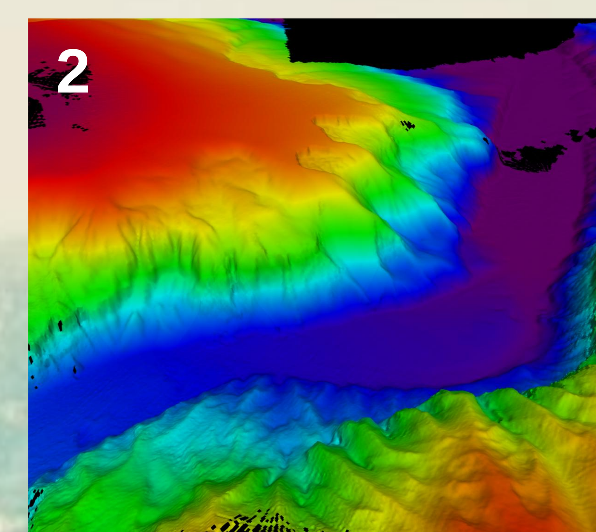


Figure 6. 3D visual of the Southern Canyon wall, looking downstream (west) at VE=1.8x.

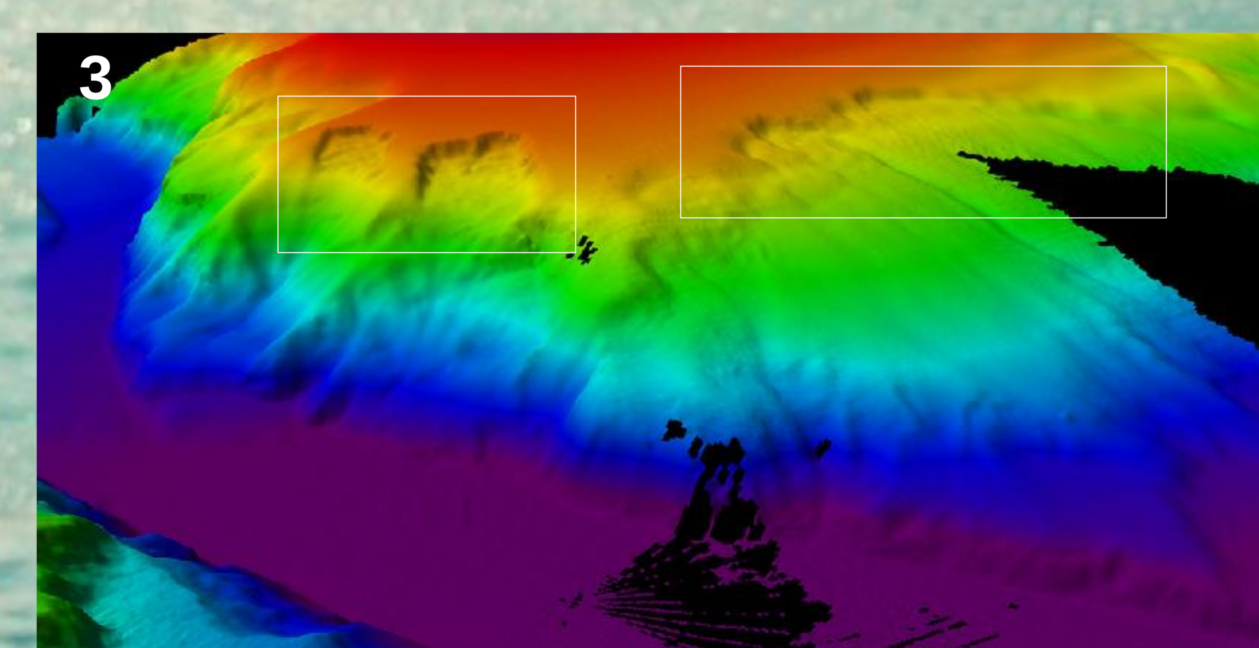


Figure 7. 3D visual of the Southern Canyon wall, viewed from the North (VE=1.8x). Note the scarp remnants on the top of the of the wall (white boxes). Black areas have no bathymetric data.

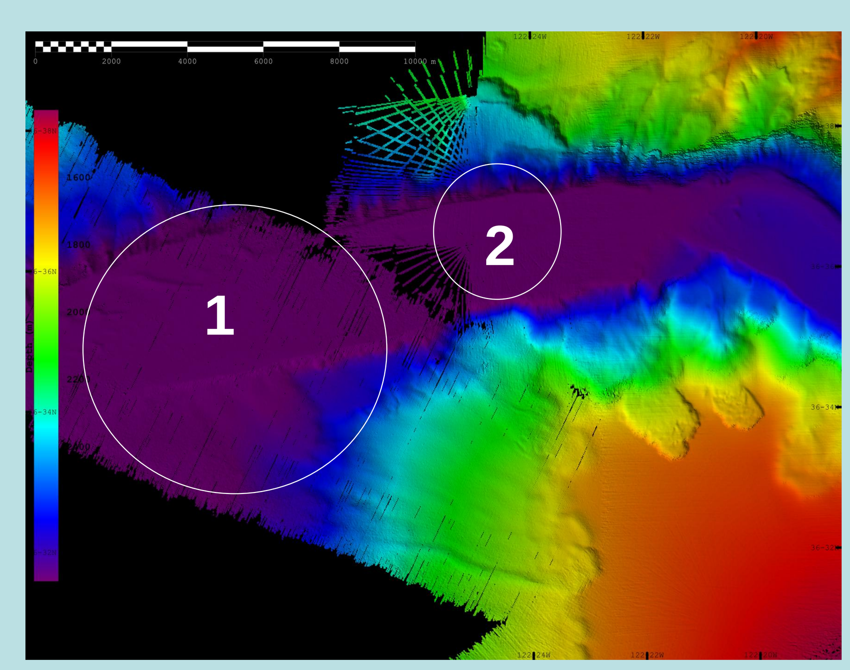
Methods

- **March 2011 NOAA Ship *Okeanos Explorer* acquired multibeam data of the Monterey Canyon seafloor using a Kongsberg EM302 multibeam sonar.**
- **Bathymetric data were processed using CARIS HIPS & SIPS 7.1 post-processing software.**
- **A CUBE 20 m resolution BASE Surface was then generated to create a bathymetric map of the seafloor (Fig. 1).**

Table 1. Gradient (slope=rise/run) for both North and South Walls of Monterey Canyon, generated from Profiles A-G (Fig. 3). Profiles of significant gradient and vulnerability to slumping are highlighted in red.

Northern Wall	Southern Wall
Profile A 1150m/5500m = 21˚	Profile A' 900m/2000m= 45˚ Possible Break Point
Profile B 1200m/3400m= 35˚ Possible Break Point	Profile B' 1 120m/3400m= 33˚
Profile C 800m/1350m= 59˚ Possible Break Point	Profile C' 850m/2500m= 34˚
Profile D 600m/950m= 63˚ Possible Break Point	Profile D' 1150m/5600m= 21˚
Profile E 870m/2500m= 35˚	Profile E' 1180m/6000m= 20˚
Profile F NA	Profile F' 1300m/9400m= 14˚
Profile G NA	Profile G' 1400m/15100m= 9˚

Discussion



Monterey Canyon, one of the largest submarine canyons in the world, offers an unprecedented environment to study turbidity currents and sediment transport. Submarine canyons are often referred to as "carbon highways," delivering as much as 85% of yearly inorganic and organic carbon deposits in just one event (MBARI, 2005). In 2005 Dr. Charlie Paull, along with the Monterey Bay Aquarium Research Institute, began using the canyon as a natural laboratory for exploring canyon dynamics. Due to its size and frequent activity, the knowledge they obtain here can be taken and applied to submarine canyons worldwide. To avoid unnecessary damage that may be inflicted on instruments deployed for the study, two "safe zones" have been designated as seen in the figure above. These safe zones were determined using the data generated (Table 1), by selecting the areas where the canyon wall gradient was less than 20˚. Placing instruments in either zone will lessen the chance of malfunction or destruction from turbidity current debris flows and sediment cascading down the canyon walls. In the future, backscatter data and sediment type analysis might be used to supplement the bathymetric data that currently exist.

Works Cited

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Martini, Marinna. "USGS Instruments Record Turbidity Flows in Monterey Canyon, California." *Sound Waves* (Feb. 2004): n. pag. USGS. Web. 12 Mar. 2013. <http://soundwaves.usgs.gov/2004/02/>.

MBARI. "A History Lesson from Monterey Canyon." *Monterey Bay Aquarium*. Monterey Bay Aquarium Research Institute, n.d. Web. 10 Mar. 2013. <http://www.mbari.org/news/publications/ar/chapters/05_canyondynamics.pdf>.

Acknowledgements

A special thanks to Josh Mode at Caris for his time and effort in running the software workshop as well as his continued technical support; to SC Sea Grant, the CofC School of Science and Mathematics, College of Charleston Geology and Environmental Geosciences Department for their generous contributions for travel support; to the crew of the NOAA Ship *Okeanos Explorer* who gathered the data; and to fellow Beam Team members for their support and feedback.