Oceanography
VOL. 30, NO. 1, SUPPLEMENT
MARCH 2017

New Frontiers in Ocean Exploration

The E/V *Nautilus*, NOAA Ship *Okeanos Explorer*, and R/V *Falkor* 2016 Field Season

GUEST EDITORS | KATHERINE L.C. BELL, JOANNE FLANDERS,
AMY BOWMAN, AND NICOLE A. RAINEAULT

Mapping and Exploration Within and Surrounding the Channel Islands National Marine Sanctuary

By Dwight Coleman, Peter Etnoyer, Chris Caldow, Julie Bursek, Leigh Marsh, Will Sautter, Ryan Freedman, and Renato Kane

During July 2016, E/V *Nautilus* and the Corps of Exploration conducted a major research and exploration program within and surrounding the Channel Islands National Marine Sanctuary (CINMS) offshore southern California. The sanctuary was designated in 1980 to protect the natural and cultural resources around the five northern Channel Islands: Anacapa, Santa Cruz, Santa Rosa, San Miguel, and Santa Barbara. To carry out its mandate to manage these nationally significant regions, NOAA collects new data to help inform decision-making. This cruise included a large-scale multibeam sonar mapping effort to collect detailed bathymetric, acoustic backscatter, and video data, as well as samples both within CINMS and in regions outside of the sanctuary boundaries that are being considered by the public for designation as a new sanctuary and/or are of particular oceanographic interest.

While seafloor maps are a critical component of decisions ranging from navigational safety and disaster response to resource management and conservation, nearly 90% of the seafloor off southern California remains largely unmapped. Within the sanctuary, this number is nearly 50%. During cruise NA074, approximately 286 nm^2 (981 km^2) was mapped within CINMS, providing bathymetric data covering over one-third of the remaining gap within the sanctuary; an additional 420 nm^2 (1,441 km^2) was mapped outside the sanctuary (Figure 1). These data will provide an understanding of the geological structures and biological habitats associated with the local living marine resources, as well as aid in planning future oceanographic studies and informing management.

The team also completed 10 ROV dives to ground truth newly mapped terrain, revisit key locations where cold-water coral ecosystems thrive, and collect geological and biological samples, as well as high-definition underwater video and still imagery (Figure 1). The dives were planned in collaboration with many Scientists Ashore who helped identify locations of specific scientific interest and who participated virtually through telepresence during the dives to help collect more than 100 samples. Many samples were distributed to our shore-based partners for detailed analyses.

The first ROV dive was on a knoll west of Santa Barbara Island—the first ever ROV investigation within this unexplored part of the sanctuary. During the dive, we came across a region loaded with interesting and perplexing geological formations and a rich and diverse benthic ecosystem. At ~150 m depth near the top of the knoll, we saw large mudstone boulders, some of which were nearly perfectly spherical, or large, smooth, and oblate; some had the shape of saucers, others the shape of cupcakes (Figure 2). This type of rock formation commonly forms along high-energy coastal environments such as rocky headlands adjacent to beaches. When seafloor at this depth was exposed during lower sea level stands, the sediment that makes up the mudstone remineralized to form a hard core that is more resistant to weathering than the

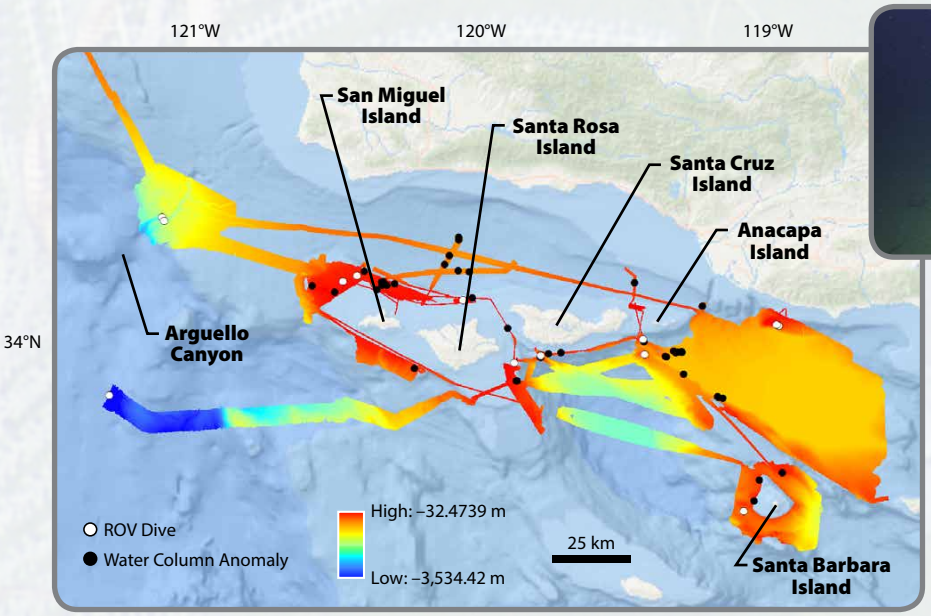

Figure 1. Figure depicting E/V *Nautilus* multibeam mapping coverage and depth, water column anomalies, and ROV dive sites. *Service layer credits: Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors*

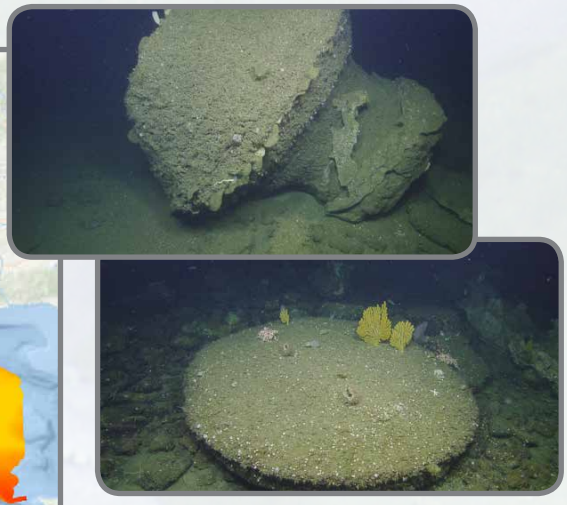

Figure 2. Mudstone concretions were discovered off Santa Barbara Island at depths ranging from ~150 m to 275 m. They were likely formed by ancient coastal sedimentary depositional processes associated with paleoshorelines.

Figure 3. The community around cold-water corals on Footprint Reef includes rockfish and purple sea fans.

substrate in which it sits. The rock formations were exposed at an ancient shoreline for long periods of time, leaving the mudstone boulders behind as the sediment substrate eroded away. The boulders became submerged due to rising sea level and tectonic subsidence, depositing them in their current location and configuration.

Two dives surveyed low relief, rocky ridge features north of Santa Rosa Island and west of San Miguel Island, contributing to an ongoing characterization of the Channel Islands shelf habitat. The dives encountered hundreds of orange and purple sea fan corals (*Adelogorgia* and *Eugorgia*), with attendant schools of colorful rockfish (Figure 3). Many live samples were collected and shipped to cold-water aquaria for further study. The surveys will support conservation and management of these sanctuary areas, which lie outside of adjacent marine protected areas.

We conducted two dives in and around a selected deep-water portion of Arguello Canyon. Shore-based scientists suggested conducting an ROV dive where the axis of the submarine canyon is offset by active fault splays associated with the San Andreas Fault system. Sonar mapping of the region revealed canyon walls with formations that were likely exposed by faulting and scoured by turbidity currents, exposing bedrock and creating habitat for benthic fauna. These dives were the first look at this dramatic undersea feature, which has been proposed to NOAA as a new national marine sanctuary.

The two dives in Arguello Canyon made a series of five wall climbs from 1,800 m to 1,500 m depth, three on the steep southern wall and two on the gentle northern slope. There were many deep-sea corals on the steep southern wall, but they were sparse until the top of the wall, where thousands of red, yellow, and white sea fan corals were observed. Many of the colonies were 1–2 m across and included bubblegum and bamboo corals (Figure 4a). More than a dozen Grenelodone octopuses were seen (Figure 4b). On the gentle northern slope of Arguello Canyon, the ROV encountered a very different but equally diverse assemblage, including large crabs, corallimorph anemones, *Acesta* clams, a whelk nursery (Figure 4c), and a mysterious "purple orb" (see page 16).

Figure 4. (a) The top of the south wall in Arguello Canyon was composed of a deep-sea "coral garden" with many large bubblegum corals (bright red), bamboo corals (orange and white), and Plexauridae sea fans (yellow). (b) A Graneledone octopus approaches a pair of tall Primnoidae sea fan corals with ophiuroid brittlestars attached at 1,650 m depth. (c) A whelk nursery was observed along the west levee.

During this cruise, we experimented with innovative sampling techniques and technologies. Working with a team from Harvard University, the ROV *Hercules* manipulator was equipped with a new set of "squishy fingers," soft robotic grippers for collecting delicate benthic animal samples (see page 12). The bulk of the preserved samples were deep-sea corals, which are common at these depths and important to research. We collected live specimens of coral that were immediately delivered ashore and kept alive in the laboratory (see page 17); they continue to grow and are monitored and studied at the NOAA Center for Coastal Environmental Health and Biomolecular Research. While all samples collected are of scientific interest, the mysterious purple orb was an international phenomenon (see page 16).