**Our Deepwater Backyard: Exploring Atlantic Canyons and Seamounts 2014**

**EX1404 Leg 3 Cruise Summary**

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***Overview***

From September 16-October 7, the NOAA Ship *Okeanos Explorer* and ROV *Deep Discoverer* (D2) explored deep canyons and seamounts off the Northeast United States on leg III of the “Our Deepwater Backyard: Exploring Atlantic Canyons and Seamounts 2014” expedition. D2 completed 13 dives to depths ranging from 1100 to 4693 m at sites along the continental slope of the northeast US and offshore along the New England Seamounts chain; an additional 6 planned dives had to be cancelled due to weather or sea state conditions. Six ROV dives were conducted in canyons cutting into the continental slope, one each in Phoenix, Hendrickson, McMaster, Ryan and Nantucket Canyons, and an unnamed minor canyon east of Veatch Canyon; and 7 dives on offshore seamounts, including Physalia and Retriever in the US EEZ, and Atlantis II, Gosnold, Kelvin, Asterias (this dive was aborted at ≈2200 meters, before the D2 reached bottom, due to deteriorating weather conditions), and a deep unnamed star-shaped seamount east of Asterias Seamount. The latter was D2’s deepest dive to date. In the offshore region weather and strength of the Gulf Stream current required in some cases that primary dive targets be moved from one seamount to an alternate location. Nonetheless, most D2 dives were the first ever explorations of the visited areas.

**Canyons**

***Geological Setting***

The canyon dives all consisted of an initial transit over a soft-sediment floor before proceeding to the nearby canyon wall. The majority of each dive was spent ascending a hard or lightly-sedimented surface, broken occasionally by intermediate terraces with higher sediment accumulation. The canyon floors were blanketed in a thick layer of silty-sand, punctuated by isolated blocks of lithified material that had tumbled from the walls above. On all of the dives the dominant canyon wall lithology was a form of calcareous mudstone, with carbonate content high enough to give the walls a chalky texture. This unit is likely the Late Cretaceous to Early Eocene chalk observed during previous expeditions (e.g. CANEX-EX1304). At Hendrickson Canyon and the unnamed canyon east of Veatch Canyon, we did observe a contact between the underlying calcareous unit and an overlying red-brown siliciclastic mudstone layer at about 1465 m and 1385 m respectively. This lack of consistency in depth and occurrence suggests the mudstone layer may not be laterally continuous along the US Atlantic margin. At the greatest depths in Nantucket Canyon (1825 m) we encountered an underlying sandy mudstone not observed on any of the other dives. A variety of failure features were observed throughout the canyons, including debris aprons, talus slopes, micro- and macro-scale fractures often eroded out as slide chutes, and evidence of sharp break-off planes resulting in rock falls. Almost all the canyons showed evidence of major and minor brittle failure, except for Ryan Canyon, which was heavily sedimented and seemingly undisturbed in recent times. A geologic highlight of the canyon exploration was the discovery of an extensive series of deeply-eroded caves holed out above a more resistant chalk layer in an unnamed canyon east of Veatch Canyon; these features were referred to by biologists as the “Octopus Grotto” as many caves were inhabited by octopi (both *Graneledone verucossa* and *Muusoctopus* sp.). In Nantucket Canyon a glacial dropstone was observed, with a manganese veneer thin enough to confirm a granitic texture.

***Biological Setting***

Biological communities in the canyons were diverse. The canyon walls were characterized by a patchy distribution of sessile fauna, likely related to stability of the walls and local current dynamics. Heavily sedimented areas (canyon thalweg or gentle sloping walls) were populated by characteristic deep-sea soft bottom benthos such as sea cucumbers [Holothuroidea], brittle stars [Ophiuroidea], and various decapods. The floor of Ryan Canyon (≈1500 m) was highly bioturbated and thousands of very small elasipodid holothurians (?*Amperima*) were scattered across the soft sediments, and many were also seen swimming. Fish were seen sporadically throughout the canyons, with a minimum estimate of at least 20 species in total; several observations were made of parasites on deep-water fish. Dominant fishes included cutthroat eels (Synaphobranchidae), grenadiers (Macrouridae), hakes (Moridae), skates (Rajiidae)*,* and witch flounder (*Glyptocephalus cynoglossus).*

A common association we observed at overhangs and below ledges comprised of dense aggregations of *Desmophyllum* cup corals, often arranged in linear fashion across the wall, with occasional colonies of the scleractinian coral *Solenosmilla*, the octocoral *Acanthogorgia*, and limid bivalves (*Acesta*) among them, along with a variety of associated smaller animals (ophiuroids, crinoids, anemones, brisingid asteroids, crinoids, and hydroids); this community type has also been observed in canyons in the eastern North Atlantic.

Several invertebrate species werefrequently observed during most canyon dives, particularly octocorals (at least 19 species), black corals (3 spp.) echinoderms (sea cucumbers [Holothuroidea], brittle stars [Ophiuroidea], crinoids [Crinoidea], and seastars [Asteroidea]), *Hygrosoma* sea urchins, including some with a juvenile Cusk Eel (*Barathrites*) tucked among the spines, *Graneledone verrucosa* octopi, including individuals sitting on eggs tucked under overhangs or in crevices, king crabs (*Neolithodes*) and red crabs (*Chaceon*), pycnogonid sea spiders, cerianthid tube anemones, glass sponges (Hexactinellida), and xenophyophores. In some places on canyon walls *Keratoisis* bamboo corals were particularly abundant.

Other notable sightings include *Muusoctous johnsonianus* (including brooding female), benthic “dandelion” siphonophores (?*Thermopalia*), and at least 4 species of squid (*Illex illecebrosus*, *Mastigoteuthis magna*, *Brachioteuthis beanii*, *Teuthowenia megalops*).

**Seamounts**

***Geological Setting***

Dives on the flanks and summits of the New England seamounts revealed a diversity of lava flow morphologies and great variability in sediment cover. Those seamounts located close to the continental margin (Physalia, Retriever) were typically blanketed in a layer of hemipelagic sediment and provided only sparsely-spaced hard rock outcrops for exploration. Lavas were more extensively exposed on those seamounts beyond the EEZ, which were draped with thinner layers of fine pelagic sediments. Rough measurements of sediment thickness yielded values of > 50 cm for Retriever Seamount compared to 5-35 cm for the seamounts further offshore. Flow types observed on the dives included sheet, lobate and pillowed flows, with lobate being the most common morphology. A deep dive on the outer rift arm of an unnamed star-shaped seamount revealed large (50 cm to > 1 m), bulbous pillow lavas and only minimal sediment dusting. This environment was very different from that observed on the upper flanks of the other seamounts. We observed volcaniclastic breccias at only one seamount (Physalia), where they were the dominant lithology throughout the dive. At two of the seamounts (Atlantis II and Physalia) we observed inter-flow carbonate intervals several meters thick, perhaps indicating a hiatus in lava emplacement. All hard rock surfaces on the seamounts were covered in a layer of manganese crust displaying various crust surface morphologies. Crust thickness could not be measured, but was sufficient to prevent identification of the underlying rock type. During the seamount dives we observed several isolated cobbles that were likely glacial dropstones, but we could not confirm rock type due to complete manganese crust covering.

***Biological Setting***

Biological diversity of large observable fauna was strongly associated with the degree of sediment cover on seamounts. As in the canyons, corals and associated fauna were very patchily distributed and more diverse in areas that were relatively sediment free. An exception was the deepest dive (4550-4693 m); although the slopes of the unnamed seamount were only lightly coated with sediments, there were very few sessile fauna observed (both in terms of density and species richness) compared to shallower seamount dives, likely a result of very low food input at this depth. No fish were observed throughout the deepest dive track, however, many hexactinellid (glass) and cladorhizid (carnivorous) sponges and a stoloniferous octocoral (Cornulariidae) were common. The ribbon-like colonies of the Cornulariidae were seen encrusting the seafloor throughout the deep dive, and in places their linear ribbons were relatively abundant crossing the high points of pillow lobes.

Where exposed hard substrates were available the community could be diverse. Near the summit of Kelvin seamount we observed a high diversity of octocorals and associated invertebrates, including *Candidella*, *Calyptrophora ?microdentata* and *C.* ?*antilla*, *Lepidisis, Acanella, Isidella, Chrysogorgia*, *Iridogorgia* *magnispiralis and I. splendens* (at least some with shrimp ?*Bathypalaemonella serratipalma*), *Metallogorgia melanotrichos* (with ophiuroid associate *Ophiocreas oedipus*), *Clavularia*, *Cornularia*-like stoloniferan octocoral, *Paragorgia*, *Paramuricea* sp. (with ophiuroid *Asteroschema*), *Swiftia, Corallium ?niobe,*  and black corals *Stauropathes* and *Parantipathes*. On the northern flank of Gosnold Seamount thickets of a bramble-like bamboo coral (*Keratoisis* sp.) formed dense patches of fine intertwining coral branches across extensive areas of the slope. These thickets were home to a host of invertebrates, including hydroids, barnacles, galatheoid crabs, sea urchins and glass sponges (Hexactinellida), the latter of several morphs and colors (yellow-green, purple, white). On Atlantis II we passed through a glass sponge (Hexactinellida) “zone” of high abundance and diversity beginning around 2692 m depth.

Sea urchins (*Echinus* like), brittle stars (Ophiuroidea) and globose xenophyophores (Syringamminidae?) were abundant on gentler, sediment-coated slopes. In addition to the many live urchins, we observed many empty tests in some locations, suggesting significant predation.

Fish diversity and abundance was relatively low in comparison to the canyon dives, with 12 species distinguished (though not specifically identified), and appeared mostly to be a subset of the species observed in the canyons. On the other hand, octocorals (at least 23 species) and black corals (at least 4 spp.) showed greater diversity on the seamounts.

**Other notable highlights**

On this leg of the expedition we developed a simple tool to measure sediment thickness. Dubbed the “SePoke,” the flexible plastic rod was marked with lines at 5 cm-intervals. It could be grasped by the D2 manipulator arm and thrust into the sediment until significant resistance was met in order to get an estimate of the amount of sediment overlying the hard bottom. The SePoke was successfully deployed on 5 occasions, in both canyons (Hendrickson and unnamed east of Veatch) and seamounts (Retriever, Gosnold and Kelvin).

Input from various participating experts revealed several notable observations, including the northernmost record of purple comatulid crinoids of the genus *Xenometra* (on Kelvin Seamount) and several rare observations of asteroid seastars. The dives provided an opportunity to witness interesting behavioral interactions that are rarely documented on video. One highlight for several scientists was a pycnogonid sea spider carrying an egg mass; it is well-documented that males carry eggs but this had not observed in the deep sea. We recorded several predation events, such as a hydroid colony being preyed upon by aeolid nudibranchs, seastar *Evoplosoma* feeding on a bamboo coral, a neolithoidid crab feeding on a *Hygrosoma* sea urchin, and an unprecedented observation of a large pycnogonid sea spider (Colossendeidae) feeding on a corymorphid hydroid (giant solitary hydroid). It appeared the proboscis was specifically directed at the gonophores, suggesting feeding on reproductive tissue.

Partial taxon list of corals and fish (preliminary IDs requiring further analysis)

**Corals**

Canyons: *Anthothela*, *Acanthogorgia*, bamboo corals (*Isidella* , *Eknomisis,* *Lepidisis*, *Keratoisis* spp., *Acanella*), *Thouarella* ?*grasshoffi*, *Swiftia*, *Paragorgia ?*j*ohnsoni*, *Paramuricea*, stoloniferan *Clavularia*, and *Anthomastus*. chrysogorgiid whips (*Radicipes gracilis*), sea pens (?*Anthoptilum, ?Distichoptilum, Umbellula, Pennatula*)

black corals (*Bathypathes*, *Parantipathes*, *Telopathes*)

Seamounts: octocorals *Anthomastus, Anthoptilum* sp., *Pennatula,* *Candidella*, *Calyptrophora ?microdentata* and *C.* ?*antilla*, *Chrysogorgia*, *Iridogorgia* *magnispiralis and I. splendens*, *Metallogorgia melanotrichos*, *Clavularia*, *Cornularia*-like stoloniferan octocoral, *Paragorgia*, *Paramuricea* sp., *Swiftia, Corallium ?niobe, Corallium ?bathyrubrum*, bamboo corals *Lepidisis, Acanella, Isidella* (at least 2 species)*, Jasonisis,* black corals *Telopathes, Bathypathes*, *Stauropathes, Parantipathes,* and stony corals *Caryophyllia*,

**Fish**

Canyons: witch flounder (*Glyptocephalus*), blue hake (*Antimora rostrata*), long-finned hake (*Urophycis chesteri*), cutthroat eels (*Synaphobranchus* sp.), Duck-billed Eel (Nettastoma sp.), Ophidiid cusk eels (*Luciobrotula, Barathrites, Dicrolene*), Halosaur (*Aldrovandia* sp.), roundnose grenadier (*Coryphaenoides*) and marlinspike grenadiers (*Nezumia*), cusk eels (Ophidiidae), fathead (*Cottunculus*), False boarfish (*Neocyttus helgae*), Blackspot seasnail (*Paraliparis copei*), Rockling (?*Gaidropsarus*), black dogfish (*Centroscyllium fabricii*), ghost cat shark (*Apristurus*?), Chimaera (*Hydrolagus* sp), skates (*Bathyraja* sp.), and dragonfish (Stomiidae).

Seamounts: Blue hake (*Antimora rostrata*), hatchetfish, ?synaphobranchid eel, Halsosaur (*Aldrovandia* sp), Grenadier 1 (*Coryphaenoides armatus*?), Grenadier 2 (*Malacocephalus*?), Cusk eels (*Brotulataenia* or *Diplocanthopoma*? and other), Anglerfish [sea toad] (*Bathychaunax roseus*); Snailfish (Liparidae), Bristlemouth (*Gonostoma* sp), Chimaera (*Hydrolagus affinis*),

***Mapping and Other Operations***

[to be added by Lindsay or some other responsible person…].