GEOMORPHOLOGY OF POTENTIAL DEEP-SEA HABITAT ALONG KARIN SEAMOUNT RANGE, CENTRAL PACIFIC

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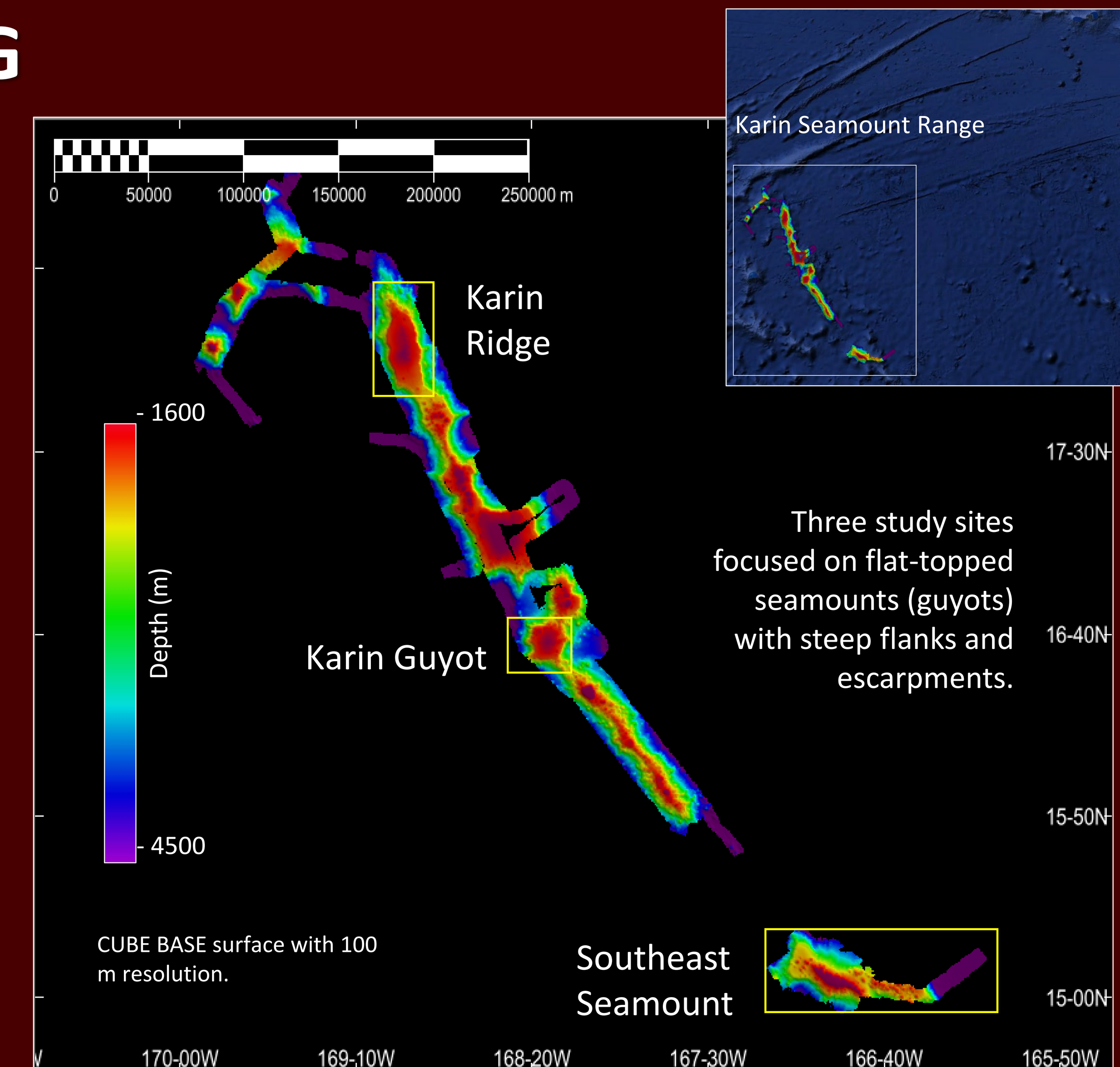
#2762

BACKGROUND

Coral reefs are submerged biogenic structures that alter sediment deposition and provide complex structural habitat. Deep-sea corals, unlike shallow-water tropical corals, can be found at higher latitudes in deeper and colder waters. They are most commonly located on topographic areas of high slope with currents that are thought to concentrate food supply (Davies et al. 2008). During the NOAA Ship *Okeanos Explorer* Expedition, *Hohonu Moana: Exploring Deep Waters off Hawaii* (expedition EX1504), researchers evaluated Karin Seamount Range off the southwest coast of Hawaii (Fig. 1) in search of deep-sea coral and sponge communities.

Karin Seamount Range is defined as a linear chain of seamounts consisting of guyots, or flat-topped seamounts, with steep embankments. Guyots first form volcanically as seamounts on the seafloor but then grow large enough to become exposed to the sea surface. Wave energy at the water's surface erodes the seamount, creating a flat top. Finding guyots on the seafloor indicates that at one point, these features were exposed to the sea surface and have since subsided to their current depths.

Corals found in deep-sea environments are ecologically important, providing food and shelter for a diversity of life (Etnoyer 2010). This biodiversity provides support for numerous examples of environmental adaptations as humans utilize extremophile organism mechanisms in the development of anthropogenic products (NOAA OER 2015a). Deep-sea corals thrive on seamounts due to an abundance of hard substrate, increased productivity and water flow (Etnoyer 2010). In 2015, NOAA launched the Campaign to Address Pacific monument Science, Technology and Ocean NEeds (CAPSTONE) in response to an expanding desire for exploration in the Pacific exclusive economic zone. The goal of the CAPSTONE project was to improve understanding of the diversity of life on the seafloor and their resilience to change (Kennedy et al. 2020). The purpose of this study is to evaluate deep-sea coral communities by identifying characteristic geomorphological features of their habitats and then generalize these findings to identify potential locations of deep-sea corals.




NOAA Ship *Okeanos Explorer*

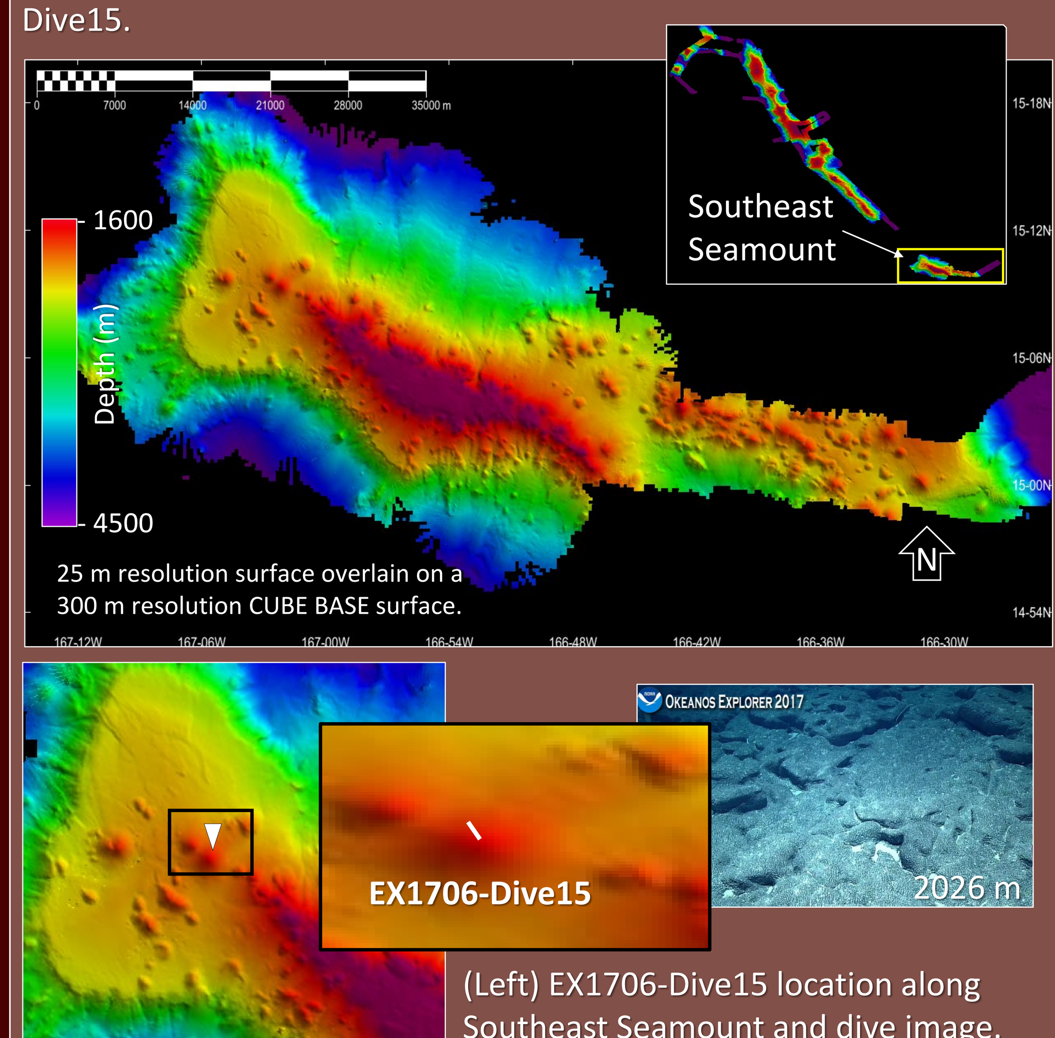

ROV *Deep Discoverer*

METHODS

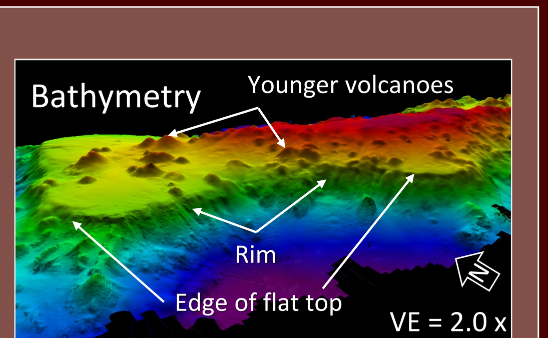
- Raw multibeam sonar data were used from surveys conducted during the 2015 NOAA expedition *Hohonu Moana: Exploring Deep Waters off Hawaii* (EX1504L1, EX1504L4). Multibeam sonar data was also used from the 2017 NOAA Expedition *Laulima O Ka Moana: Exploring Deep Monument Waters Around Johnston Atoll* (EX1706).
- The NOAA Ship *Okeanos Explorer* served as a sonar platform using Kongsberg EM302 multibeam system. Sonar data were processed using Caris HIPS and SIPS 11.3.
- Generated products included 2D and 3D surfaces illustrating bathymetry, slope and classified backscatter intensity. Profiles were analyzed to compare slope and general shape of seamount flanks.
- ROV dives were analyzed using HD video footage generated by the ROV *Deep Discoverer*. Ground-truth data were collected from three expeditions: EX1504L4-Dive10, EX1504L4-Dive13 and EX1706-Dive15.

Figure 2. Southeast Seamount

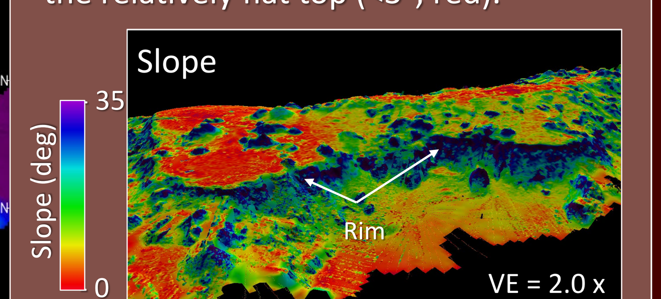
Southeast Seamount is a guyot characterized by a relatively flat top with steep flanks (20°). The flat area also has conical-shaped volcanoes, one of which was further explored during ROV EX1706-Dive15.

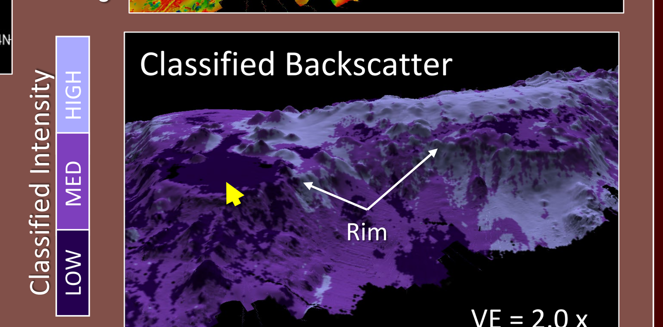


(Left) EX1706-Dive15 location along Southeast Seamount and dive image.



3D slope surface (below) note high slopes (20°; dark blue) that distinctly outline the volcanic rim surrounding the relatively flat top (<3°; red).

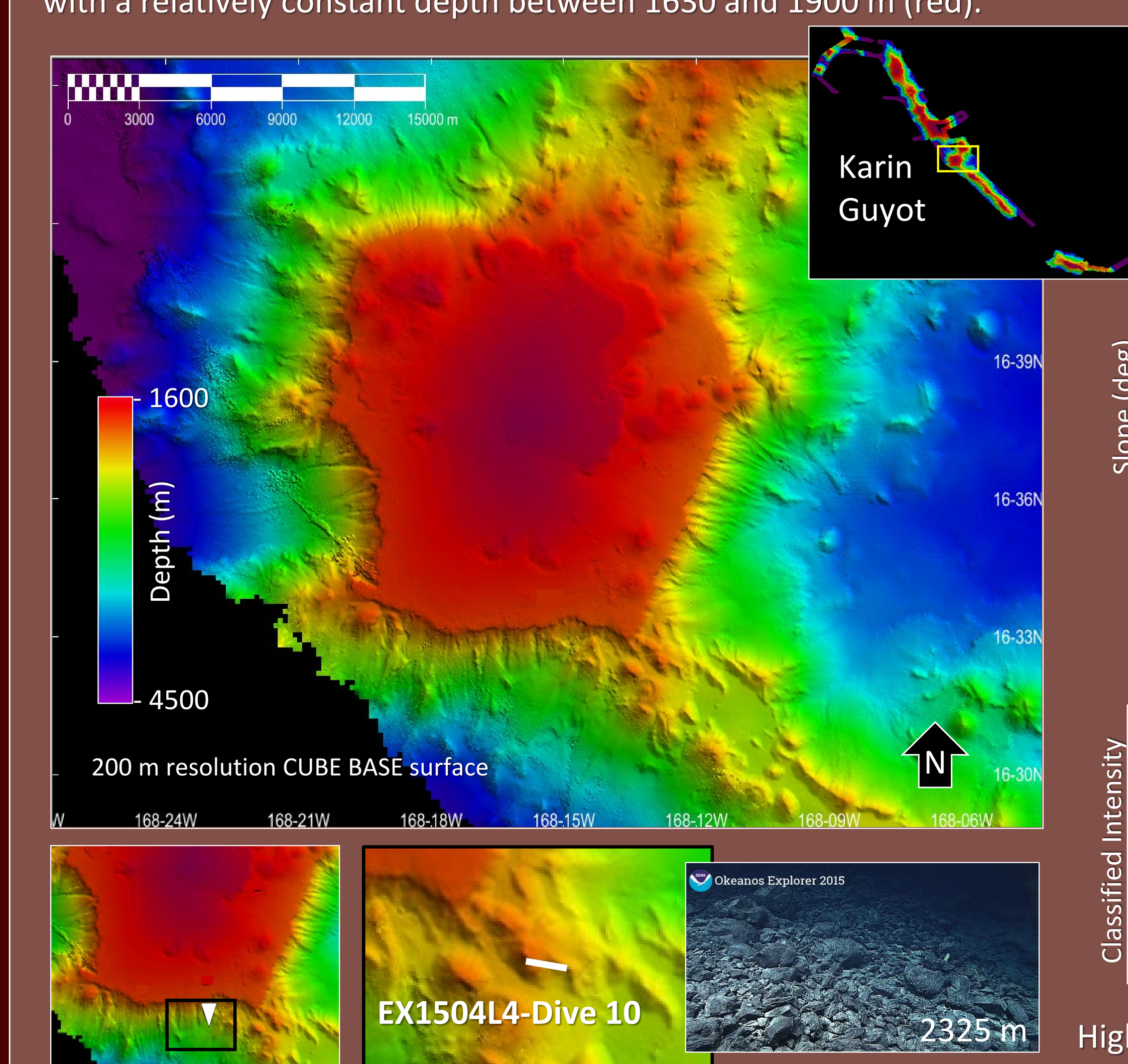




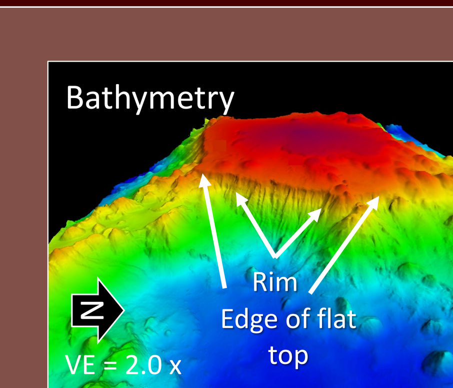
Classified backscatter intensity (above) highlights areas of high intensity (light purple). Note the low intensity area of portions of the flat top (yellow arrow).

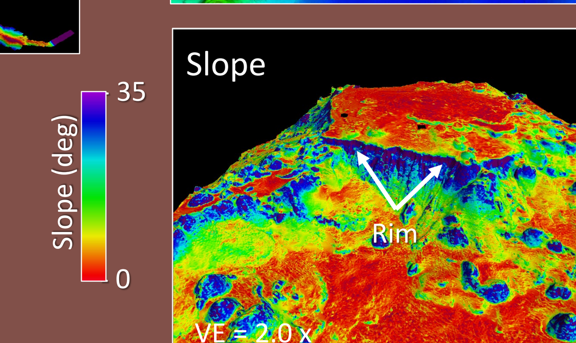
Figure 3. Karin Guyot

Bathymetric surfaces (below) emphasize the seamount's flat top with a relatively constant depth between 1630 and 1900 m (red).

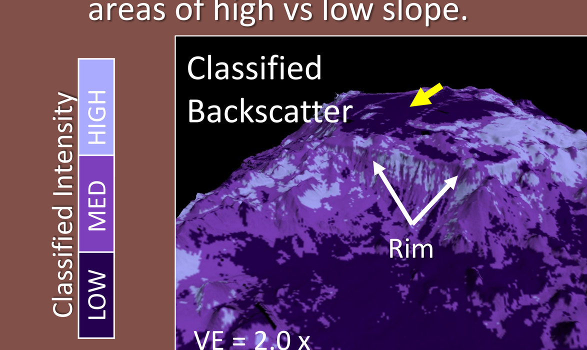


(Above) Map of EX1504L4-Dive 10 along the south end of Karin Guyot and selected dive image.





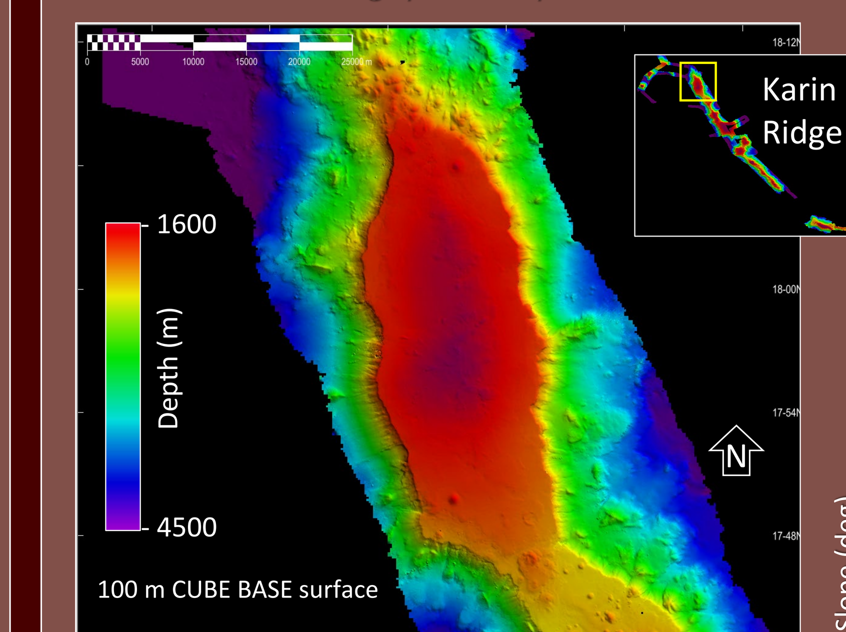
3D slope surface (above) indicates areas of high vs low slope.

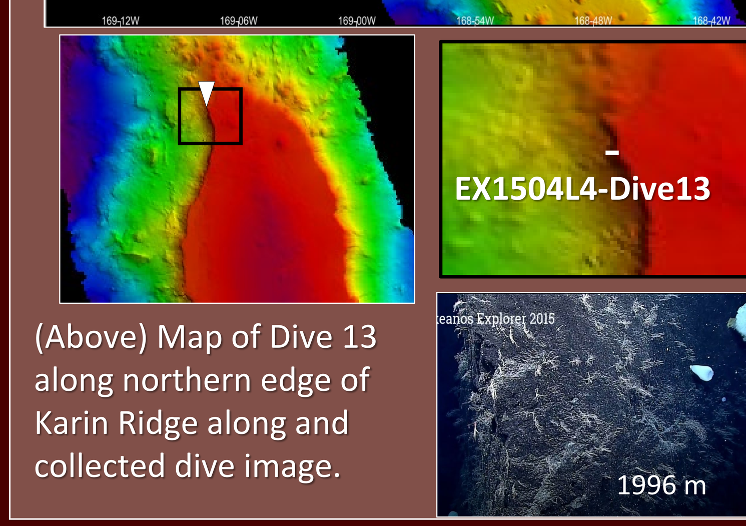


High intensity backscatter (above, light purple) occurs primarily along areas with high slope, whereas the guyot's flat stop has low intensity (yellow).

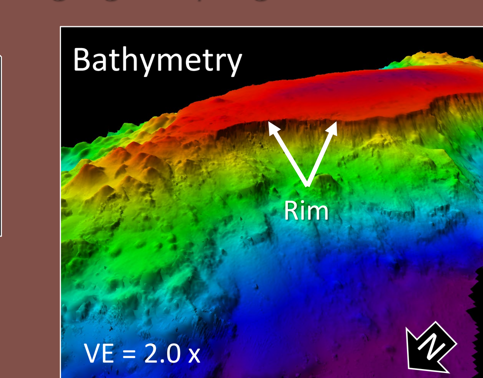
Figure 4. Karin Ridge

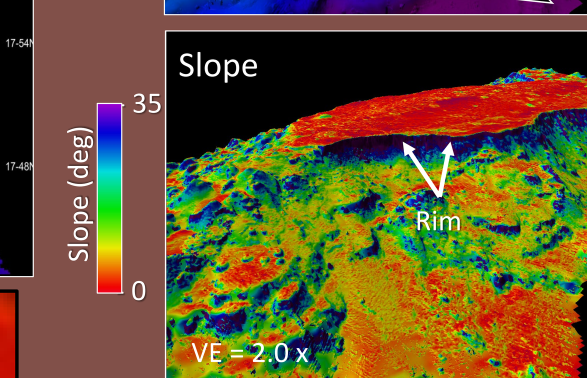
Karin Ridge is an elongate guyot with steep embankments with a max slope of 25°. Depth is relatively constant between 1630 and 1900 m (red) along the flat top. Bathymetric surfaces emphasize the flat-topped characteristic of this guyot. Bathymetric color bands also highlight depth gradient.



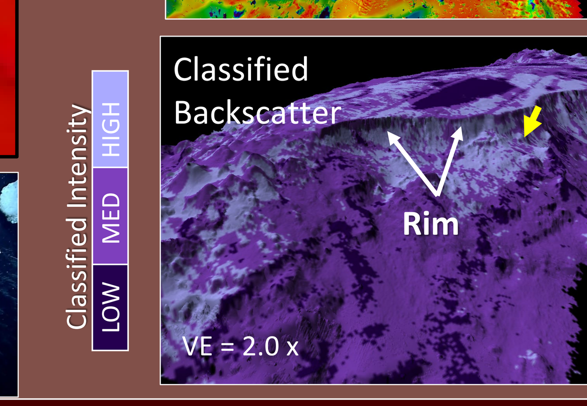


(Above) Map of Dive 13 along northern edge of Karin Ridge along and collected dive image.





3D slope surfaces (left) distinctly outline the high-sloped rim (23°) compared to the low-sloped flat top (1°).



Highly sloped areas found along the rim are clearly areas of high backscatter intensity. Low intensity occurs along the flat top (yellow arrow).

DATA ANALYSIS

Similar geomorphologies occur across the three study sites, including a flat top with slope <5° and steep flanks with slopes >15°. Karin Ridge has the steepest slope along its flanks (23.8°) and the lowest slope along the flat-top (1.7°). Southeast Seamount has the largest flat-top area (525 km^2), although it includes varying slope between 2.8° and 9.6° at its crest before reaching the steep rim (20.8°). This difference in the guyot top's geomorphology is the result of younger volcanoes along the flat top. Karin Ridge and Karin Guyot are the most similar in shape with broad flat-top areas (458 and 235 km^2, respectively) followed by steep flanks (23.9° and 17.2°, respectively). Karin Guyot has the greatest vertical relief (2,650 m) compared to the other study sites with vertical reliefs between 2,125 and 2,345 m.

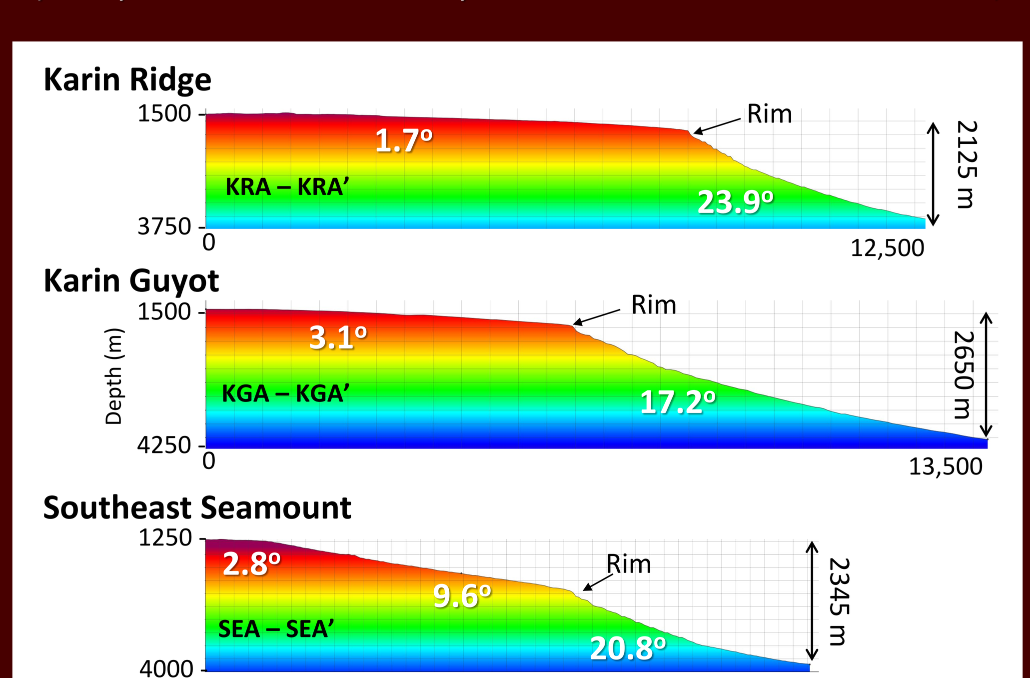
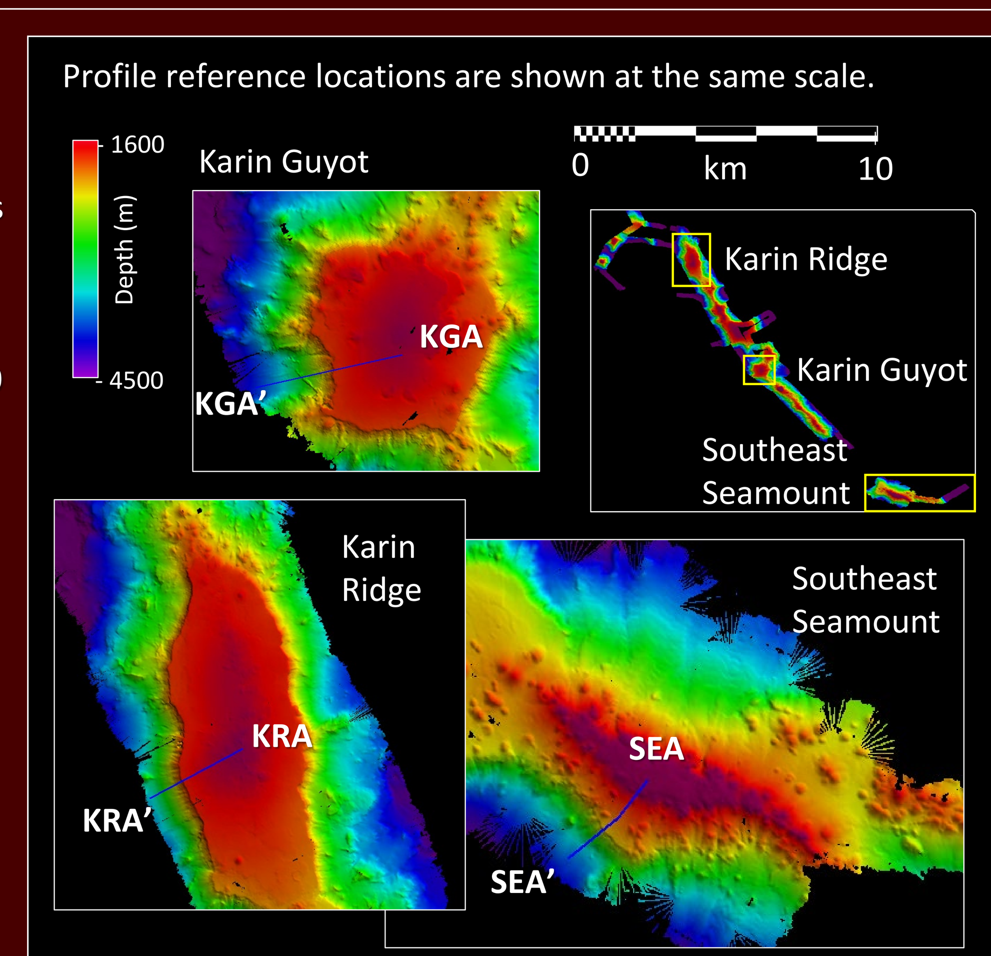


Figure 5. Profile Comparisons

Profiles of Karin Ridge, Karin Guyot and Southeast Seamount were analyzed to compare seamount shape and slope. All profiles are shown to the same scale, with no vertical exaggeration (VE = 1x).

Profile reference locations are shown at the same scale.

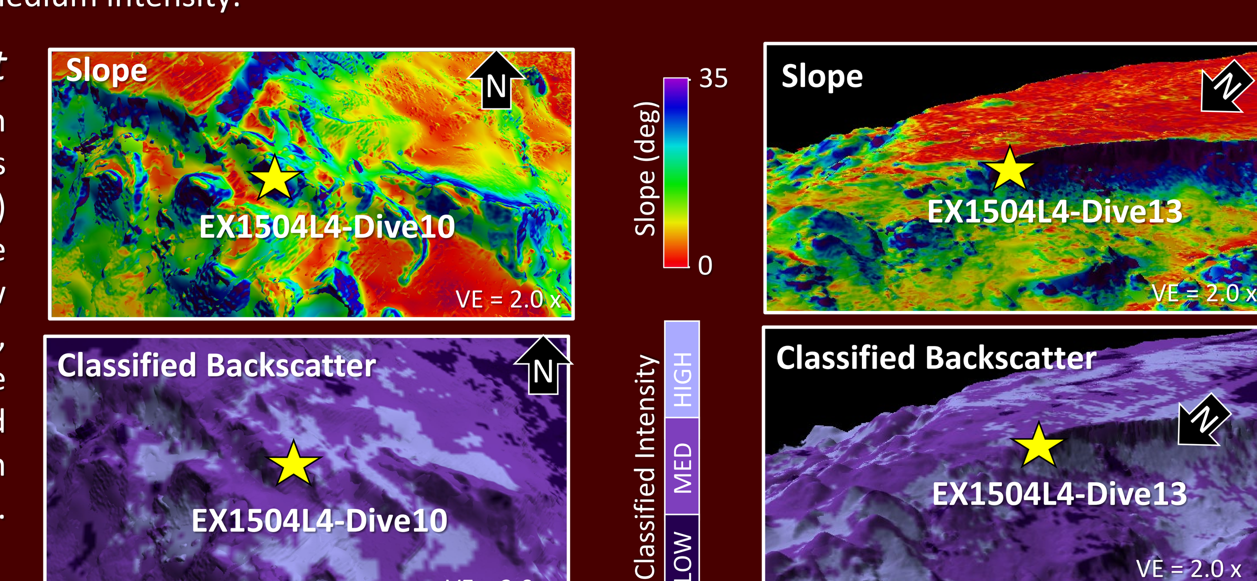


DISCUSSION and CONCLUSIONS

Since these study sites exhibit similar geomorphologies, conclusions on the location of corals on one seamount can be generalized to the other seamounts. Assessment of dive videos emphasized similar substrate across all study sites with consolidated sediments and manganese precipitates. High diversities of coral and sponge species were identified on all dives. Based on ROV dive tracks overlain on slope and backscatter intensity surfaces, preferred coral habitat exist along steep escarpments where backscatter is medium intensity.

Karin Guyot

ROV dive data indicated a high diversity of coral communities along areas of high slope (>17°) where relatively moderate backscatter intensity occurs (yellow star on slope and intensity surfaces, at right). These areas were characterized by consolidated substrate encrusted with manganese precipitates.



Karin Ridge

Compared to Karin Guyot, Karin Ridge showed a weak correlation (R^2 = 0.2345) with a less organized distribution of data. ROV dive video showed the presence of deep-sea coral on steeply sloped substrate exceeding 23° (below) with medium backscatter intensity (below).

Deep-sea corals would be located along areas of high slope and medium backscatter intensity.

ACKNOWLEDGEMENTS

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