Geomorphic Analysis of Deep Coral Habitat in the Kaiwi Channel, Hawaiian Islands

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ABSTRACT

The Kaiwi Channel is located between the Hawaiian Islands of O'ahu and Moloka'i. In 2014, the University of Hawaii ALOHA Program surveyed the channel and the area to its north off the southeastern coast of O'ahu. Sonar data were acquired aboard the R/V *Falkor* with Kongsberg EM302 and EM710 multibeam echosounders, and bathymetry and backscatter data were post-processed using CARIS HIPS and SIPS 9.0 software. The Kaiwi Channel is 42 km wide with a maximum depth of 700 m. Its western margin exhibits a steep slope, whereas the eastern margin's more gradual slope contains an array of small submarine canyons with relief as much as 500 m. Using backscatter, hard substrate areas were found in a large area of the channel's eastern floor extending 2.0 km along the channel axis at depths between 300 and 500 m. Overlays of backscatter intensity with bathymetry and slope maps provide a means to estimate the area's seafloor character and identify possible deep coral and other benthic habitats.

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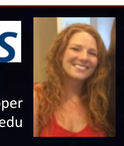


The Kaiwi Channel

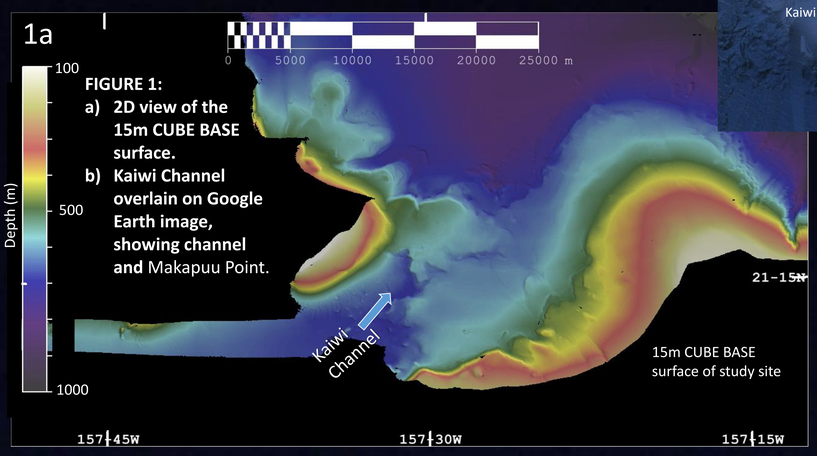


FIGURE 1:
a) 2D view of the 15m CUBE BASE surface.
b) Kaiwi Channel overlain on Google Earth image, showing channel and Makapuu Point.

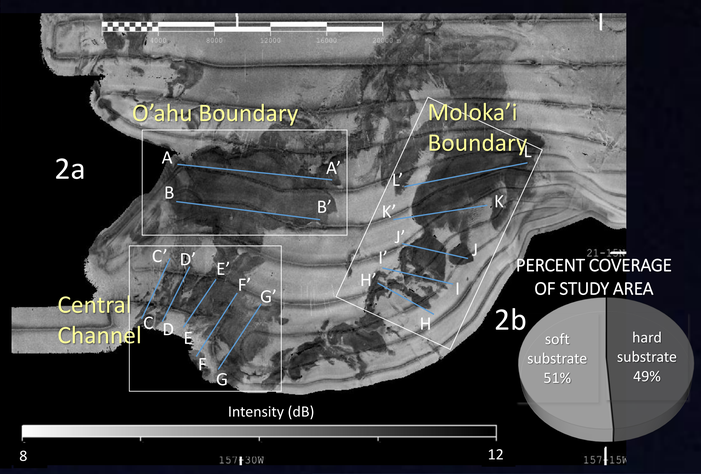


FIGURE 2 (right):
a) 15m backscatter mosaic with profile transects made in each study area (Figs. 4, 5, 6).
b) Percent coverage between relatively softer (8-11 dB) and harder substrate (11-12 dB) found in the total study area.

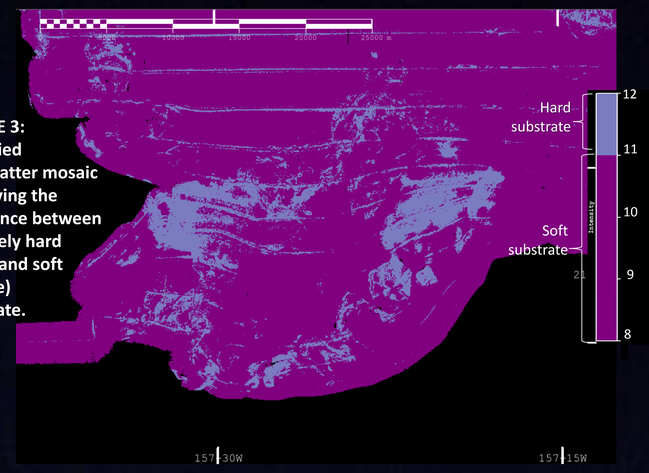


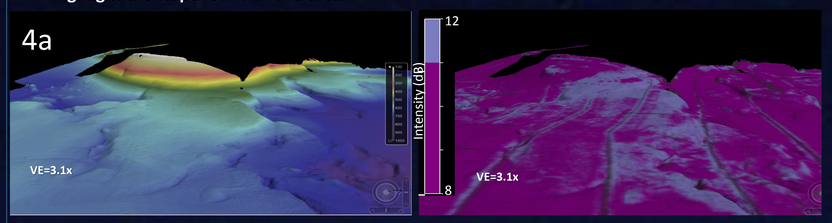
FIGURE 3: Classified backscatter mosaic displaying the difference between relatively hard (blue) and soft (purple) substrate.

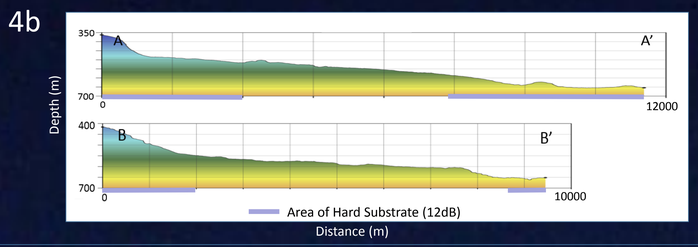
O'ahu Boundary

FIGURE 4
a) 3D view of BASE Surface and classified backscatter mosaic viewed looking from mid-channel to the west towards O'ahu.
b) A-A' and B-B' profiles (see Fig. 2a), and Table 1 highlight the slope found in this area.

Table 1. O'ahu Boundary Profiles

Profiles	Change in Depth (m)	Change in Distance (m)	Slope
A-A'	290	10500	0.028
B-B'	235	9000	0.026



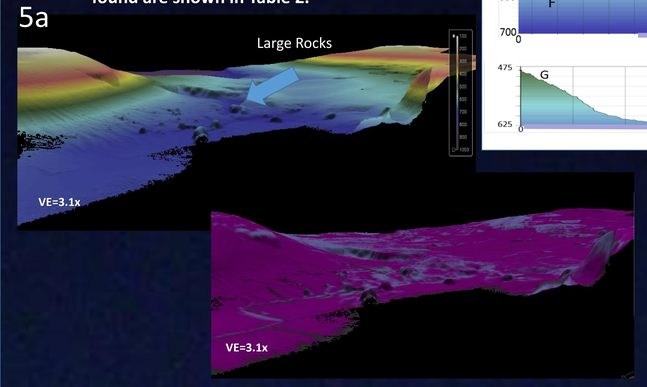


BACKGROUND

The Kaiwi Channel is a popularly traversed channel, known for its intense winds and currents. Kaiwi in Hawaiian means "bone" and is named after the extreme conditions. The focus area in this 42 km channel is the section east of the southeastern coast of O'ahu (Fig. 1). Characteristics in the area include small submarine canyons and large rock formations. Within the depth range of 250 to 700 m significant slopes occur throughout the edges of the channel, suggesting possible deep coral inhabitants. These slopes provide sediment transport activity and gradual reliefs that is favored by coral (Guinotte and Davies, 2014). After producing the backscatter map, areas with high substrate intensity were seen overlaying the sea bottom. Areas with higher intensity have a greater chance to be a location for deep coral (Baker et al., 2012). The CUBE BASE surface was divided into three areas with the emphasis of slope and sea bottom intensity (Fig. 2a). Features are examined in detail using profiles and backscatter with deep corals characteristics acknowledged.

Central Channel

FIGURE 5
a) 3D bathymetry and classified backscatter views toward the northeast of the Central Channel.
b) Profiles C through G (see Fig. 2a) from the north region of area study. C-C' displays large rock formations within profile. Slopes found are shown in Table 2.



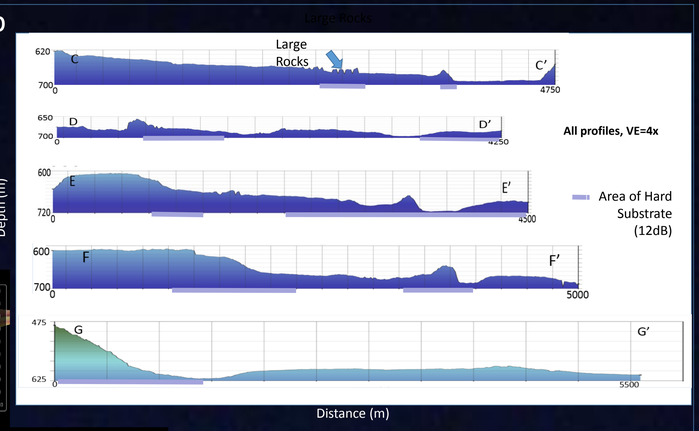


Table 2. Central Channel Profiles

Profiles	Change in Depth (m)	Change in Distance (m)	Slope
C-C'	70	3750	0.019
D-D'	37	1600	0.023
E-E'	92	2250	0.041
F-F'	70	1850	0.038
G-G'	135	1500	0.090

METHODS

- Multibeam sonar survey data collected by the R/V *Falkor* in June 2014.
- Kongsberg EM302 and EM710 multibeam systems used.
- The cruise was led by the University of Hawaii ALOHA Program with Chief Scientist, Dr. Erica Goetze.
- 15 m CUBE BASE surface and 15 m mosaic backscatter created using CARIS HIPS and SIPS 9.0.

RESULTS

- 49% hard substrate coverage in total study area (Fig. 2b).
- Profiles A-A' and B-B' in the O'ahu Boundary study area were made showing hard substrate areas (11-12 dB intensity) and had an average slope approximately 0.027 (Table 1).
- Profiles in Central Channel study area had a range in slopes between 0.019-0.090 (Table 2). G-G' started from a intensity of 12 to 10 dB (Fig. 2a) and displays the greatest slope of 0.090 (Table 2).
- The Moloka'i Boundary study area exhibits the most significant difference in backscatter intensity, ranging from 9 to 12 dB (Fig. 2a), reflected in the profiles (Fig. 6b). I-I' and J-J' display areas of soft substrate where there is little to no slope on the profile (Fig. 6b).

Moloka'i Boundary

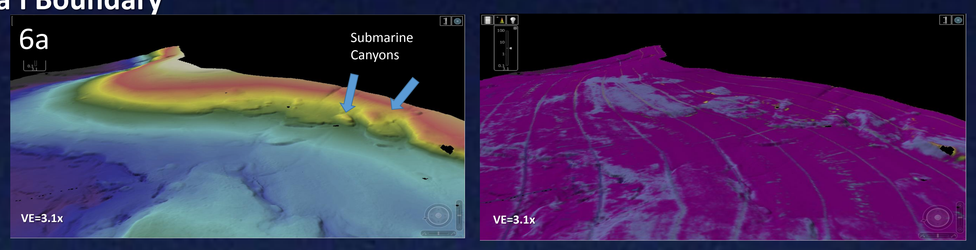
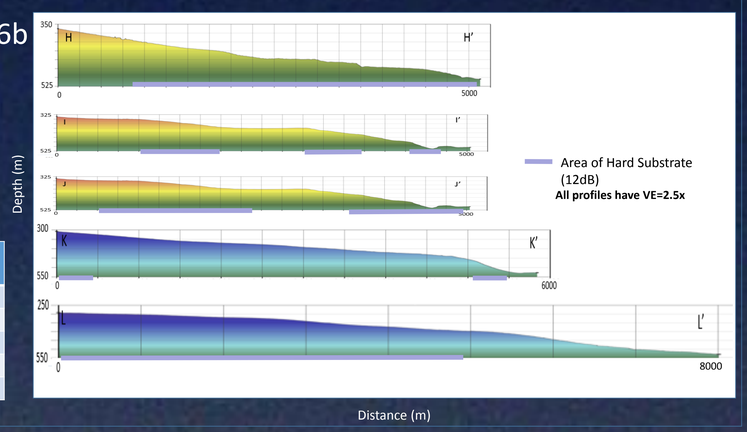


FIGURE 6
a) 3D view of BASE surface and classified backscatter mosaic towards the southeast highlighting the Moloka'i Boundary.
b) Profiles H through L (see Fig. 2a) measured in the 15 km area featuring multiple small submarine canyons. Table 3 exhibits slopes measured in each profile.

Table 3. Moloka'i Boundary Profiles

Profiles	Change in Depth (m)	Change in Distance (m)	Slope
H-H'	135	4750	0.028
I-I'	170	4600	0.037
J-J'	190	4600	0.041
K-K'	225	8000	0.028
L-L'	225	5800	0.039



DISCUSSION

When combining observations made in results and previous research, the Kaiwi Channel has a strong possibility for housing deep corals. The data collected by the R/V *Falkor*, 2D backscatter mosaic (Fig. 2a) and 3D classified backscatter (Fig. 3) unveiled hard substrate occurring mainly in areas with greater slope. In the channel, slopes ranged from 0.019 to 0.090 which reveals the seafloor's variance (Table 1, 2, 3), and exhibits high backscatter intensity indicating hard substrate along particular slopes (Profiles A-A' through L-'L). Deep coral habitats have been found in depths occurring 50 m around the poles to 4000 m near the equator (Roberts et al., 2006). Their distribution depends highly on temperature, substrate, and slope (Baker et al, 2012). The volcanic Hawaiian Islands, located less than 30 degrees north of the equator, are known for their steep sloping walls and ample amounts of hard substrate that are favored by deep coral (Parrish et al., 2007). Deep coral species such as *Gorgonia* sp. and *Corallium* sp. have been found at 300 to 500 m depths in the Makapuu coral bed off O'ahu, only a few kilometers from the study area (Fig. 1b) (Parrish et al., 2007). This information should stimulate future studies within the Kaiwi Channel, focusing mainly on areas highlighted in Figure 7 (below) for deep coral research.

Another variable that affects deep coral growth besides substrate and slope is the level of organic carbon found in an environment (Guinotte and Davies, 2014). Further studies could examine carbon levels in the area providing more data to where deep corals might not only occur but also flourish.

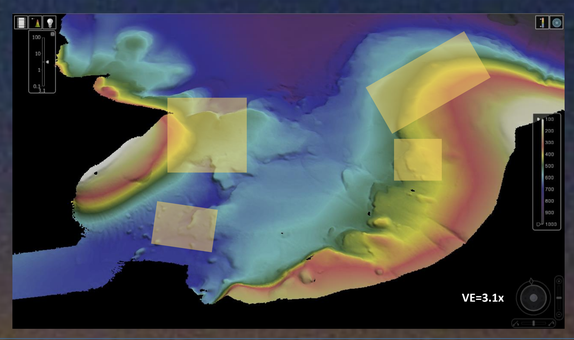


FIGURE 7
Highlighted boxes show areas likely to house deep coral. Future studies should focus on these regions within the Kaiwi Channel.

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