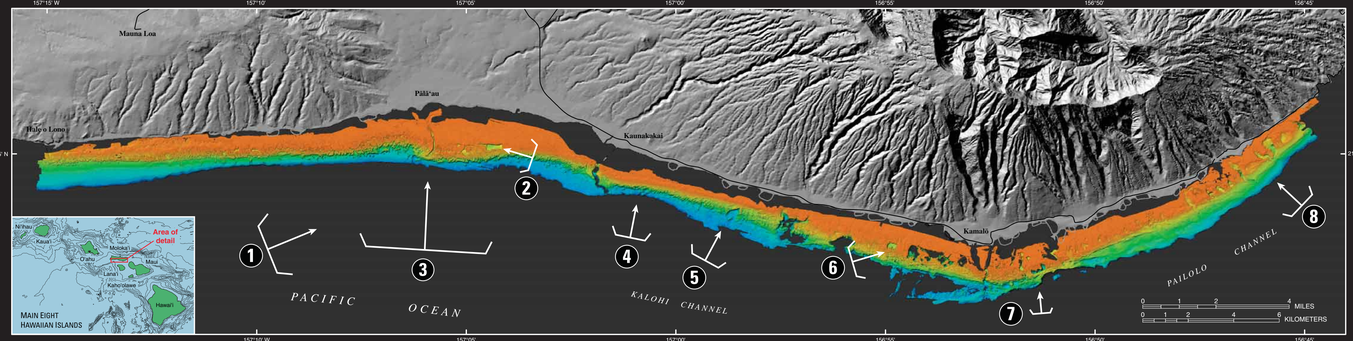
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

SCIENTIFIC INVESTIGATIONS MAP 2886

Perspective Views Using High Resolution Lidar Bathymetry

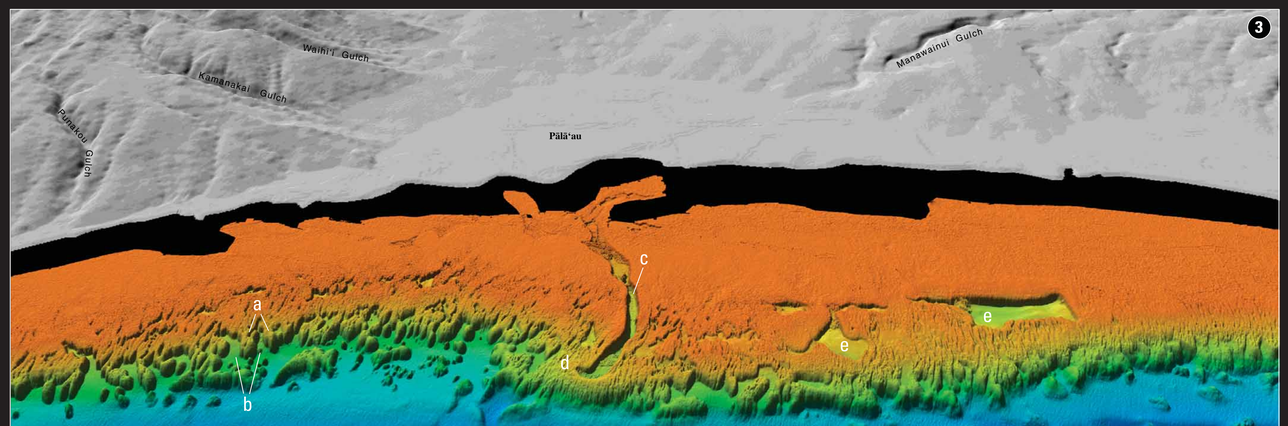
The fringing coral reef along the south side of the island of Moloka'i is one of the most extensive fringing coral reefs in the Hawaiian chain, if not in the entire Pacific. For a distance of about 40 km, from Hale o Lono on the west to Kamalō on the east, live coral coverage is estimated to be 60 to 90 percent, higher than all but the most shielded reefs in Hawaii. The reef is actively accreting in depths between about 6 and 27 m (20 and 90 ft), creating, as these views show, spurs, grooves, knobs, pits, and pinnacles that are home to thousands of marine organisms. Winter waves restrict active reef accretion beyond the sheltered portion of the coast but the old reef surface in those areas is still populated by numerous individual coral colonies, invertebrates, and fish.

These images of the coral reef were created using high-resolution bathymetric data collected in 1999 and 2000 using an airborne laser imaging system called SHOALS (Scanning Hydrographic Operational Airborne Lidar Survey) operated by the U.S. Army Corps of Engineers. The SHOALS system employs laser pulses, or lidar (light detection and ranging) technology to determine water depth at a point roughly every 4 m along the bottom. Over 12 million depth measurements were collected during the Moloka'i surveys, with a vertical accuracy of 15 cm. The maximum depth lidar can measure is dependent on water clarity. During the Moloka'i surveys the maximum depth recorded by the lidar system was typically about 35 to 40 m (115 to 130 ft). Detailed map views of the South Moloka'i reef bathymetry can be found on reverse. For more information on SHOALS, see http://shoals.sam.usace.army.mil/. More information on U.S. Geological Survey studies on coral reefs can be found at http://coralreefs.wr.usgs.gov/.

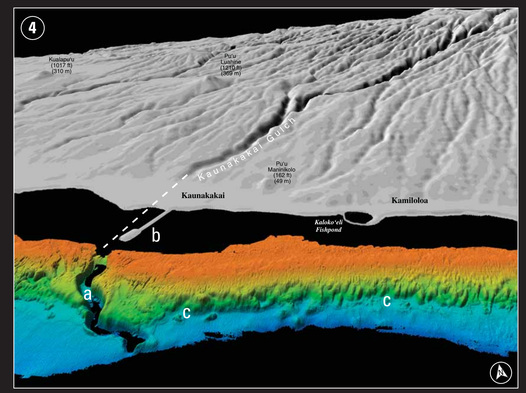


Map of south Moloka'i showing the relief of the island based on a digital elevation model (DEM), and the adjacent coral reef, shown in color, based on airborne bathymetric data (lidar). The reef off south Moloka'i is one of the most extensive and best developed fringing coral reefs in Hawaii. The white arrows show the location and view direction of the perspective views. Unless otherwise noted, the vertical exaggeration of each view is 7X for the reef and 2X for the island.

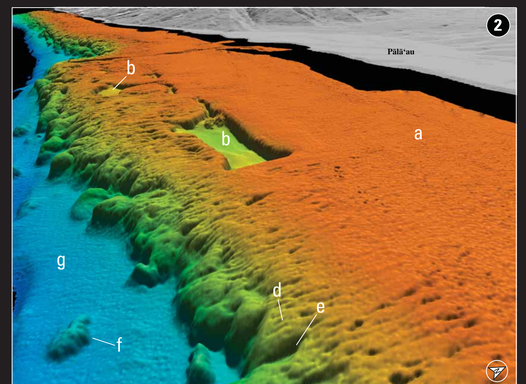
Oblique view of the central and eastern part of Moloka'i constructed from Landsat TM satellite and DEM data. Visible features include the mud flats (a) and reef channel (b) at Pālā'au, the wharf (c) at Kaunakakai, and the wide reef flat (d) that characterizes the Moloka'i reef. The change in coastal orientation at Kamalō (e) results in higher wave energy and decreased coral growth to the east. Vertical exaggeration is 2X, approximate distance across the bottom of the image is 12.4 km (7.7 mi).



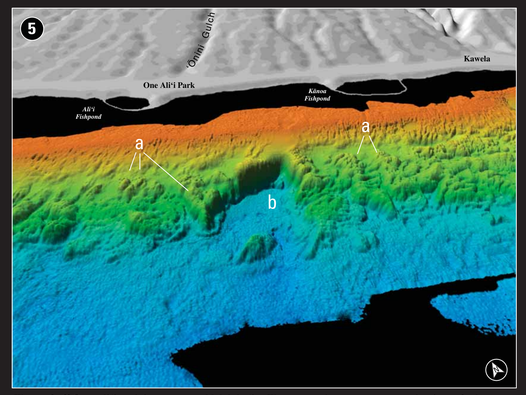
Expanded view of the central portion of the coral reef off south Moloka'i. Distinctive features include its pervasive rhythmic spur (a) and groove (b) formations that characterize many reefs around the world, and the reef channel (c) at Pālā'au, remnant from a stream valley that formed when sea level was lower than present. Note that the channel is encased in framework reef at its terminus (d). Also note the large sediment-filled solution pits (e) east of the channel. Approximate distance across the bottom of the image is 7.5 km (4.7 mi).



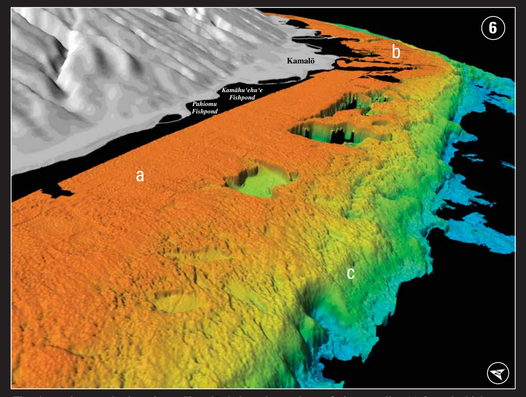
Oblique view of central Moloka'i showing the alignment of Kaunakakai Gulch with the reef channel (a) west and offshore of the wharf (b). The channel was formed by stream water flowing out of the gulch when sea level was much lower and the shoreline was farther south. The base of the actively growing reef (c) lies at about 28 m (about 90 ft). Approximate distance across the bottom of the image is 4.5 km (2.8 mi).



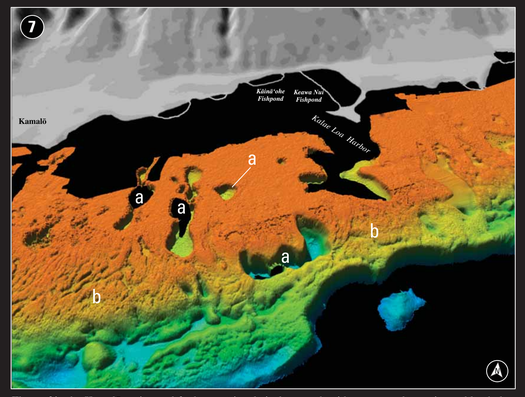
Central Moloka'i reef near Pālā'au. The inner reef is characterized by a wide reef flat (a) and large sediment-filled, or partially filled pits (also known as blue holes) (b). Note the alignment of the inner walls on the pits suggesting a regional control related to shoreline history or reef structure. The outer reef has a pronounced spur (d) and groove (e) structure, grading to isolated reef pinnacles (f) and a sediment-covered platform (g). Approximate distance across the bottom of the image is 850 m (0.5 mi).



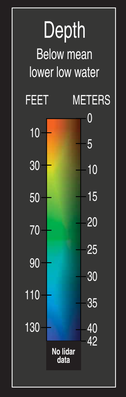
The reef off One Ali'i park in east central Moloka'i. The spur and groove structure, dominant farther west (see views 2 and 3) is not well defined in this area; individual spurs (a) are discontinuous and of variable orientations, indicating that coral growth has not been uniform in this area. The large re-entrant (b) in the reef may have been the site of stream outflow at a lower sea level position. Approximate distance across the bottom of the image is 2 km (1.25 mi).



The change in coastal orientation at Kamalō shelters the southwest facing coastline (a) from the high wave energy that reaches the eastern portions of the island. High wave energy limits the reef growth east of Kamalō (b) (see views 7 and 8). In contrast, the forereef west of Kamalō (c) is well developed and densely covered with live coral to depths of 28 m (about 90 ft), although small isolated coral colonies may be found deeper. Approximate distance across the bottom of the image is 1.3 km (0.8 mi).



The reef in the Kamalō region and farther east is relatively smooth with numerous large pits, or blue holes (a). The blue holes are typically 6 to 24 m (20 to 80 ft) deep, and are likely formed by dissolution of the pre-existing reef. The irregular reef surface (b) marks the transition between the actively accreting reef to the west (see view 6) and the sparsely covered limestone surface to the east (see view 8). Approximate distance across the bottom of the image is 2.7 km (1.7 mi).



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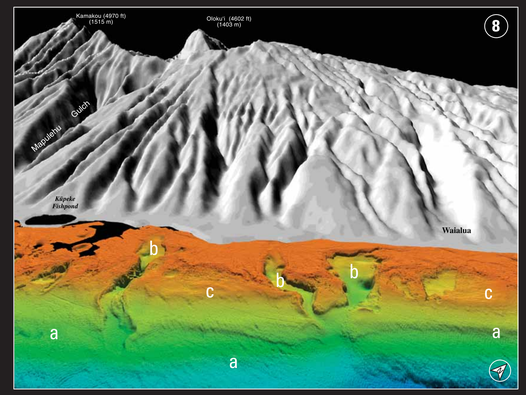

The eastern reef of south Moloka'i is marked by a smooth surface (a) with numerous channels and pits (blue holes). Note the large number of channels dissecting the steep land surface that align with reef channels (b). There is a complete absence of spur and groove formation by coral accretion in this area due to the high wave stresses. Live coral colonies are relatively sparse on the limestone surface (c). Approximate distance across the bottom of the image is 2.8 km (1.7 mi).

Bathymetry and Selected Views of the Fringing Coral Reef, South Moloka'i, Hawaii

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U.S. Geological Survey Coral Reef Project website: http://coralreefs.wr.usgs.gov
U.S. Geological Survey Western Region Coastal and Marine Geology website: http://walrus.wr.usgs.gov

Three detailed map views of the Moloka'i coral reef can be found on the reverse side.

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