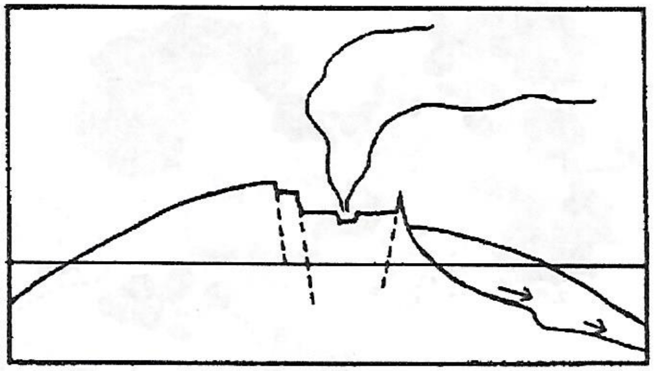
SUBMARINE LANDSLIDES IN THE HAWAIIAN ISLANDS

`Ōhi`a Project Insert



Illustrated at left is the giant landslide stage of a Hawaiian volcano. Refer to the Grade 4 `Ōhi`a Project activity titled "Volcanoes on Stage," and to p. 35 of the Grades 7-8 guidebook for an illustration of nine other stages in the "life cycle" of a Hawaiian volcano. Insert the giant landslide stage after the shield building stage. Also use this article to supplement teacher background information for the Grade 3 activity titled, "The Case of the Disappearing Island."

New Discoveries in Geology

Until a few years ago it was believed that erosion from rain and wave action was the primary destructive force in the aging of our Hawaiian volcanoes. Recent discoveries from sonar views of the sea floor around our islands have shed some fascinating new light on our volcanic past.

An early geologist with the Wilkes Expedition in the 1840s speculated that O`ahu's Ko`olau Pali was a scarp—the result of the land to the East (Waimānalo to Waikāne) having dropped. While we now know that the whole *pali*, and more, is the result of erosion (rain, for the most part, and marine in some areas) a great landslide did play a part. Recent sonar "pictures" have revealed vast talus (broken rock) deposits off shore of most of the high sea cliffs in the Hawaiian chain. These deposits, frequently at 18,000 ft. depth in the trenches that parallel the island chain, are the result of great slides that carried away up to a third of the above-sea-level mass of some of our shield volcanoes. Most of these slides probably occurred early in the final stages of the shield's building and, in some cases, capping phase. The talus debris from O`ahu's Ko`olau is actually merged with similar and later material from Molokai's great Wailau shield.

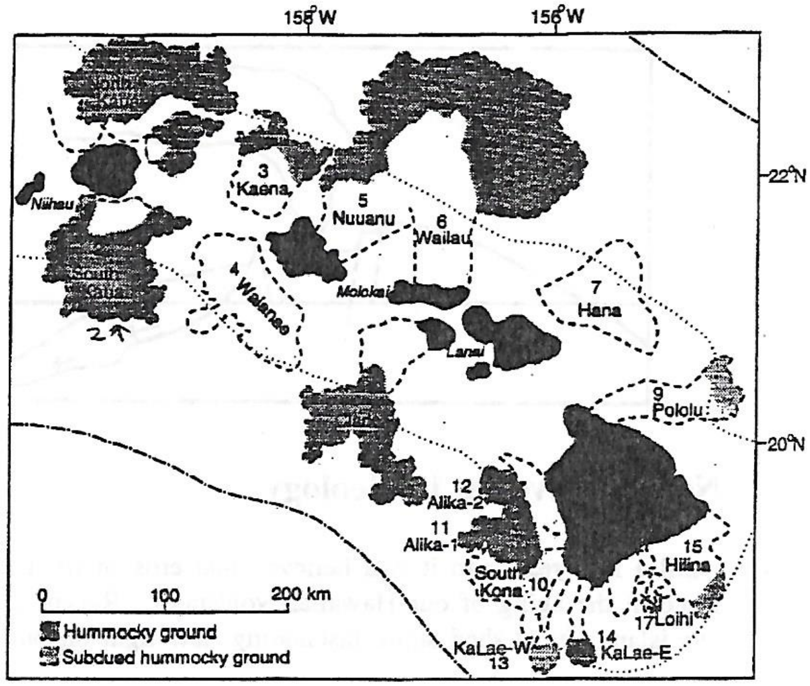
What created the Ko`olau Pali?

So how did the Ko`olau slide play a role in the formation of the Ko`olau Pali? Turn back about one and a half million years to near the end of the Ko`olau shield's building phase (it never "capped") and here is this great mass reaching about 5,000 ft. above sea level, newly built on the thin crust of the Pacific Plate. Magma has been drawn from the chambers in the crust and piled as lava on that crust; magma is probably still rising in the rift zones; the crust (ocean floor) has been depressed by this great bulk; the young volcano is "settling in." It is during this period of instability that most of our slides seem to occur. Draw an imaginary line from the cliffs of Kualoa to those behind Sea Life Park; the scarp occurred somewhat east of this line—probably in a series of "rapid" drops that left an inland cliff 2,000-3,000 feet high. Then the rains falling on that 5,000 ft. high remnant, at right angles to the trade winds, would have fed countless waterfalls down the face of the new cliff. Taking advantage of cooling cracks in the shield's flank flows, the rain eroded the Ko`olau Pali from the scarp back to where it is today. Realize that during this one and a half million year period (the "settling in," the slide, subsequent erosion) the Ko`olau volcano subsided (sank) about 1,000 ft. while loosing another 1,000 ft. to erosion. So today we have a summit of about

3,000 ft. elevation and possibly a third of the volcano's original mass slumped down the submarine flank to rest in the trench at 18,000 ft. depth. The result is the world's most beautiful *pali* formed of the merged heads of former amphitheater-headed valleys eroding back from the great scarp.

Other Great Slides in the Hawaiian Chain

Sonar mapping shows that virtually all the islands of the Hawaiian chain experienced one or more submarine slides. The accompanying diagram by Steve Mattox shows those that have been detected on the main islands.



Map of submarine landslides of the southeastern Hawaiian Ridge. Major slides bounded by heavy dashed lines. Axis of the Hawaiian deep is marked by light dashed line. Crest of Hawaiian Arch marked by dash-dotted line. Modifed from Moore and others by Mattox (1994).

The South Kaua`i slide (#2) is a seaward extension of the Makaweli slump that is visible between Hanapēpē and Waimea. This scarp deflected westward flowing streams southward, cutting the Waimea Canyon.

The Wai`anae slide (#4) may be responsible for the relatively rapid erosion of the Lualualei, probably in less than 60,000 years. Note: Before the Wai`anae volcano subsided, its summit was about 6,000 ft. above sea level. At that time, the Ko`olau volcano was still small so the Wai`anae volcano received the full brunt of trade wind borne rains.

The Wailau slide (#6), whose materials merge with the Nu`uanu (Ko`olau) slide probably, according to Robin Holcomb, rotated backward by 10 degrees as it slumped, leaving the upper portion of the slide above sea level. Subsequent erosion by the waves of the upper portion has resulted in the headlands and sea stacks whose strata dip "backwards."

A slide on the west side of the Big Island (possibly #10, South Kona) is thought by James Moore to be responsible for the giant tsunami that cast coral fragments at least 1,200 ft. above sea level on the southeast side of the island of Lāna`i! Such action is evidence that these submarine slides were sometimes cataclysmic—not gentle settlings.

For the content of this article, the author, Lorin Gill, relied on the mana`o *of Robin Holcomb, James Moore, Stephen Mattox and John Sinton.*

For further reading (note that the 3rd and 4th articles listed below are highly technical):

Mattox, Stephen R., A Teacher's Guide to the Geology of Hawaii Volcanoes National Park, Hawai`i Natural History Association, June 1994. See pp. 67-73.

"The Fragile Volcano," by Noreen Parks, *Earth*, Vol. 2, No. 6, pp. 42-49 (November 1993).

"Prodigious Submarine Landslides on the Hawaiian Ridge," by J.G. Moore, D.A. Clague, R.T. Holcomb, P.W. Lipman, W.R. Normark, and M.E. Torresan, *Journal of Geophysical Research*, Vol. 94, No. B12, pp. 17,465-17,484 (December 10, 1989).

"Giant Hawaiian Underwater Landslides," by James G. Moore, William R. Normark and Robin T. Holcomb, *Science*, Vol. 264, pp. 46-47, (April 1, 1994).