Investigators Spotlight

A Seafloor Geodetic Experiment to Monitor Deformation on the Slope of Kilauea Volcano, Hawaii

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Seafloor geodesy represents an exciting new field in marine geophysics. In geodesy, the size and shape of Earth's surface can be mapped through a network of accurately surveyed points of geographic position using longitude, latitude and elevation, while taking into account the curvature of the earth through precise mathematical calculations.

Developments over the last several decades in satellite-enabled GPS (Global Positioning Systems) and InSAR (Interferometric Synthetic Aperture Radar) systems have provided the ability to make geodetic measurements with sub-centimeter accuracy on the continents. These remote sensing techniques have led to unprecedented discoveries in fault behavior and earthquake mechanics on land.

In comparison, seafloor geodesy is in its infancy; and, to date, only a few scattered geodetic measurements have been made in the ocean basins.

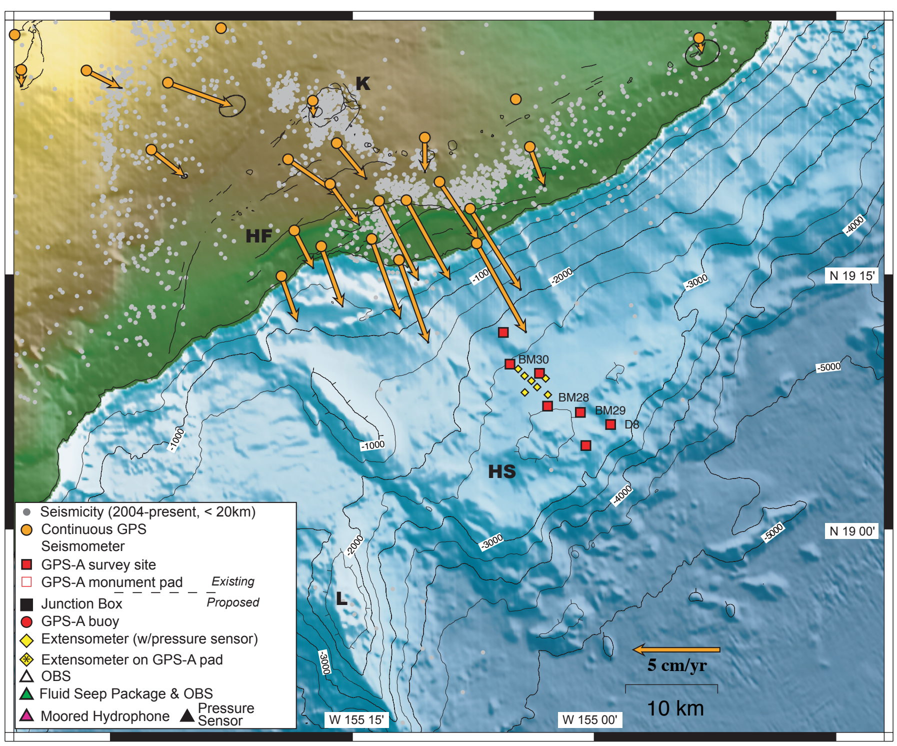
This DOEI-funded project, 'AHOLO, employs geodetic techniques to study undersea earthquakes and landslides in Hawaii. ('AHOLO stands for **A** **H**awaiian **O**cean **L**andslide **O**bservatory – *'Aholo* being the Hawaiian word for landslide.)

Massive slope failure and debris avalanches on the flanks of oceanic volcanoes have been linked to tsunami generation in the Pacific and Atlantic Oceans. However, the process by which the flanks of active volcanoes deform remains poorly understood. One of the best-studied active volcanic landslides is the Hilina slump on the southeast flank of Kilauea volcano, Hawaii. Geodetic measurements and field observations on land show that the Hilina slump breaks away along a system of seaward-dipping faults that transport material to the southeast at rates of approximately ten centimeters per year (see figure).

Two competing theories explain the movement of the Hilina slump. One posits that this extension may represent merely the upper-flank expression of a more massive slump sliding coherently seaward. Alternatively, several recent studies have proposed that volcanic spreading associated with magma injection at the summit of Kilauea causes the upper flanks to extend while simultaneously generating compression and thrust faulting in the lower submarine flanks. If correct, this second model implies a more stable flank configuration, with less potential for massive landslides and tsunami genesis. Distinguishing between these models for the Hilina slump has been difficult, because much of the deformation appears to be accommodated aseismically; and, prior to this project, no submarine geodetic measurements had resolved horizontal motions on the flank.

Project 'AHOLO involves a six-month deployment of a new acoustic extensometer system developed at WHOI to monitor deformation in Kilauea's submarine flank. Extensometers measure small increments of deformation. When many are used in a network, a continuous time series can be obtained, showing incremental changes in land formation. The continuous time series obtained by the extensometer network can be compared to onshore continuous GPS data to look for correlations between transient periods of deformation.

In addition to explaining the movement of the Hilina slump, the



Map of the 'AHOLO project located at the Hawaiian volcano Kilauea, showing the location of WHOI's newly developed extensometer network (yellow diamonds). Extensometers are devices that measure small increments of movement or deformation in Earth's surface. K = Kilauea Caldera; HF = Hilina Faults; HS = Hilina Slump; L = Loihi Seamount.