Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

SVC050-16 Room:302 Time:May 23 12:30-12:45

Steady deformation pattern and the magma storage system of Kilauea volcano

Yo Fukushima[1]*

[1]DPRI, Kyoto Univ.

1. Introduction

At Kilauea volcano, Hawaii, it has been known from GPS and other data sets that, at least after 1983, the summit and rift zones are subsiding and that the southern flank is displacing at up to ~8cm/year. This deformation pattern is usually explained by a superposition of the effects of opening of a vertical rift reservoir and slip of a subhorizontal decollement located at ~9km depth connected to the base of the rift reservoir (Owen et al., 2000). In the summit area, signals of subsidence and tilt change toward the summit have been observed, which has been interpreted by the activities of magma reservoirs located at depths of 3.5km and 0.5km (Cervelli and Miklius, 2003, USGS prof. paper).

The rift zones are bent especially at the summit where the east and southwest rift zones meet. Therefore, if the rift reservoir opens, strain is expected to accumulate around the bending points. Such effects of realistic rift reservoir geometry has not been fully studied by previous works. This study investigates such effects by assuming realistic structures of the rift reservoir and subhorizontal decollement and modeling the surface deformation pattern using the 3D mixed boundary element method (Cayol and Cornet, 1997).

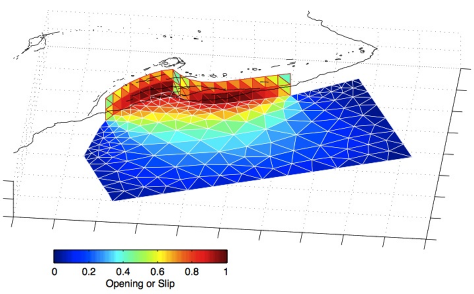
2. Model setting

The rift reservoir and decollement are modeled by dislocations. The rift reservoir is vertical and has its upper and lower limits at 3km beneath the surface and 8km below sea level (9km beneath the summit), respectively. The horizontal location of the rift reservoir is assumed to coincide with the micro-seismicity which is considered to well characterize the tip of the reservoir. Furthermore, the subhorizontal decollement is assumed to be connected to the rift reservoir. Displacements on the ground surface are solved under boundary conditions of 1) uniform overpressure on the rift reservoir surface, 2) null shear stress change and normal displacements on the surface of the decollement. Under such conditions, the rift reservoir opens and the decollement slips in response to the overpressure of the rift reservoir.

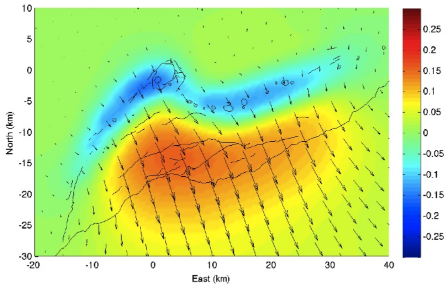
3. Results

As shown in the figure, the considered model well explains 1) the sudsidence of the rift zones, 2) the localized subsidence at the summit, and 3) the seaward displacements and uplift of the southern flank. Especially, the localized subsidence at the summit questions the presence of a summit reservoir at ~3.5km depth. The deformation pattern after 2007 has changed; the same patten on the southern flank but a higher subsidence rate along the rift zone. The obtained results indicate that this kind of pattern can not be explained unless developed shallow reservoirs are considered beneath the rift zones.

Acknowledgements
I thank the Hawaiian Volcano Observatory for providing GPS data and Dan Sinnett of Stanford University for data preparation.



(a) Opening distribution on the rift reservoir surface and slip distribution of the decollement. These displacements are created by over-pressurizing the rift reservoir.



(b) Surface displacements. Color shows the vertical and arrows show horizontal displacements, respectively.

Keywords: Kilauea volcano, Magma storage system, Crustal deformation, GPS, Boundary Element Method