

From 1998-2007 the mobile south flank of Kilauea volcano, Hawaii has been the site of at least 7 slow slip events (SSE) recorded principally with continuous GPS data from the network operated jointly by the USGS-Hawaii Volcano Observatory, Stanford University, and the University of Hawaii. The Kilauea SSEs are an important example of the SSE phenomena, occurring in a very different tectonic setting from SSEs in subduction zones. Although the precise depth and mechanism of the Kilauea SSEs is still debated, they certainly occur more shallowly than ~ 10km in oceanic crust. Additionally it is possible that these aseismic slip transients locate largely offshore, updip of the zone where major south flank earthquakes nucleate, unlike the downdip SSEs at subduction zones.

Here, we demonstrate by using a surface displacement event correlation filter, that the Kilauea events can be clearly divided into two spatially distinct families. Prior to July, 2007, the “Western” family comprised four events that exhibited a high degree of periodicity (774 +/- 7 days) whereas the “Eastern” family comprised three events with no apparent periodicity. The data are coincident either with SSEs occurring on spatially distinct and neighboring fault planes or occurring on separate slip patches of the same fault plane, such as the regional decollement below Kilauea’s south flank. The spatial association of the displacement fields for the two families with shallow slump structures within the south flank interpreted from submarine seismic reflection surveys suggests a common structural control, and raises the possibility of a longer term kinematic segmentation.

Of particular interest, the Western family events appear to trigger microseismicity, which our waveform cross correlation and high precision relocation analysis demonstrates occurred on distinct fault zones that form streaks aligned with the SSE GPS surface displacements (Wolfe et al., 2007). Due to the unknown effects of velocity heterogeneity and nonideal station coverage, our relocation analyses cannot distinguish whether some of these fault zones occur within the volcanic crust at shallow depths or whether all occur on the decollement.

Additionally we show that the June 17th dike intrusion at Kilauea’s east rift zone apparently triggered an SSE with characteristics very similar to previous Western family events. Inclusion of this event in the overall time series yields SSE repeat times of 798 +/- 50 days, which still maintains these events as more regularly occurring than other well established slow slip locales such as Cascadia or Guerrero, Mexico. We suggest that constant stressing rate due to relatively constant opening of Kilauea’s rift zones since 1998 could explain the regular behavior of the Western family, though this explanation is still not satisfactory for the neighboring Eastern family. Moreover, the correlation of the Western family events with triggered microseismicity allows us to test how long these events have been occurring with their current periodicity by examining the Kilauea earthquake catalog. We conclude that there is no evidence of this periodicity prior to January 1997, suggesting that the periodicity, itself, may be a transient phenomenon.