FIELD OBSERVATIONS OF ROOTLESS VENTS OVER THE PŌHUE BAY LAVA TUBE, HAWAI'I: COMPARISONS WITH OLYMPUS MONS LAVA FANS, MARS.

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Introduction: Olympus Mons lava fans are features originally identified in *Viking* images, which were described as positive topographic lava flow source points [1]. Originally suggested to be rootless breakouts over lava tubes, these features are also suggested to be primary vents along deep concentric faults [2], or radial dikes possibly indicating rift zone activity [3]. The different possible formation scenarios (primary or rootless vents) have unique implications for the development of Olympus Mons, primarily the existence of rift zones. The objective of this project was to compare Olympus Mons lava fan morphologies with continued field observations of Hawaiian rootless vent features [4] that are associated with lava tubes in order to provide insight into their formation mechanisms on Mars as a means of identifying which vents, if any, might be indicative of rift zone activity.

Background & Approach: A HRSC-based morphologic map of a north-south transect over Olympus Mons showed that ~ 80% of lava fans were associated with lave-tube fed flows [5]. Continued mapping of these features is discussed by *Richardson et al.* in these conference proceedings. Lava fans display a range of surface textures including smooth, mottled, channeled, and sometimes containing small collapsed lava tubes. While a basic spatial relationship with lava tubes suggests a tube-related method of formation, it is nearly impossible to exclusively determine that these features are not younger primary vents related to the evolution of the volcano, as is seen in the later stages of Hawaiian shield development [6]. The flanks of Hawaiian volcanoes display eruption points related to rootless processes from overflow of lava tubes and littoral development related to encounters of lava with ocean water, and primary processes related to rift zone activity and the ascension of independent magma bodies during the alkalic capping phase [6,7].

Our field work was conducted on 8-25-08 over the Pōhue Bay lava flow [7,8], located south of the Hawaiian Ranchos and Hawaiian Ocean View Estates and west of the eastern limb of the 1907 Mauna Loa flow [9]. Here, a flow emplaced ~1300 years ago developed a primary lava channel and tube system that delivered lava to Pōhue Bay and produced littoral cones [7,8]. The channel and tube system that supplied the distal fronts with lava experienced multiple overflow events some of which are possibly related to a younger flow that used the older tube system [7,8]. We present Differential GPS data (Trimble R8, vertical accuracy 2 to 4 cm, horizontal accuracy 1 to 2 cm) collected over one rootless vent within this flow field for comparison with martian lava fans.

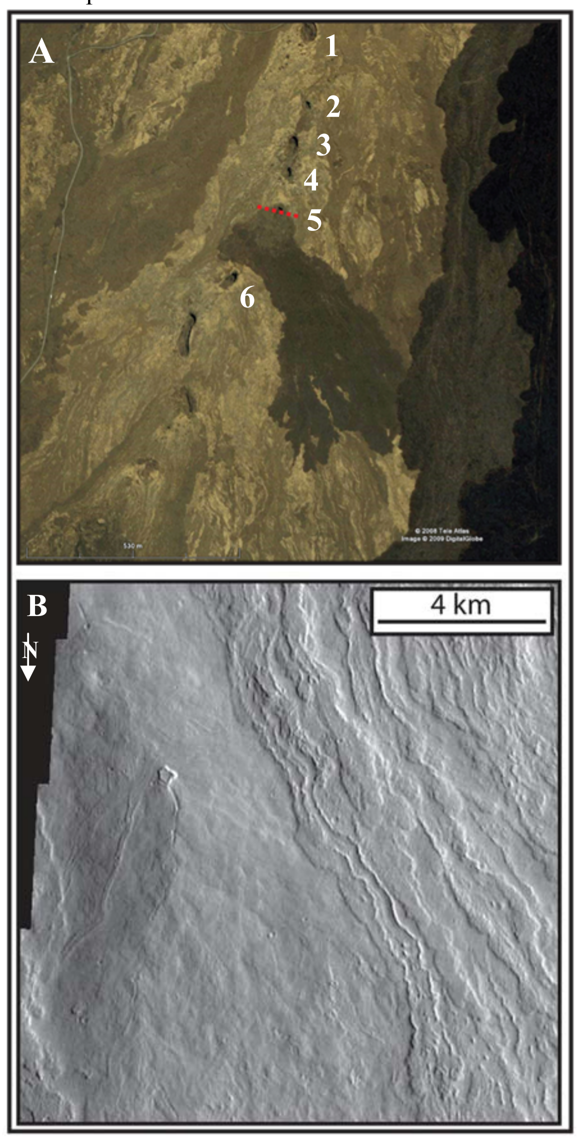

Figure 1. A) Landsat image (credit Google) showing the 6 skylights of the Pōhue Bay lava flow discussed in the text. B) Themis VIS image showing on Olympus Mons lava fan with raised rim pit similar to pit 5.

Results: Analysis of Landsat images shows that pit 5 (Figure 1) is the source for a ~ 750 m long lava flow.

This feature was our primary target of interest, with the intent of comparing it with the other depressions. We explored 8 lava tube roof collapse/skylights, including pits 1-5 (Figure 1). The main flow surface in our study area is composed of two textural units, including 1) rubbly pāhoehoe that is similar to ‘a‘ā, but lacks the true ‘a‘ā spiny texture, and 2) smooth pāhoehoe.

Pits 1-4, each served as the source area for at least one, and sometimes multiple episodes of smooth pāhoehoe overflow. These overflow units are clearly superposed over the rubbly and smooth pāhoehoe that make up the main flow field. The overflow units are composed of thin (~ 1-5 cm thick) layers. The insides of the pits often display a bench at several meters depth below the rim. Above this the pit wall is composed of the thin overflow layers while beneath the bench the layering is much thicker (> 1 meter) where identifiable. At some pits, an even younger layer of lava was emplaced on the smooth overflow pāhoehoe unit. This unit is rougher in texture, described by Rowland et al. [10] as toothpaste lava. During tube overflow at pit 1 a large field of lava balls was emplaced. The lava balls are composed of multiple layers of several centimeter thick smooth pāhoehoe.

Lava overflow at each pit, likely involving multiple episodes, created a slightly raised ridge along the flow length. Pits 5 and 6 developed more significant raised rims around the pits, both rising several meters above the surrounding surface. Unlike the other pits which emplaced thin, smooth pāhoehoe flows, pit 5 was the source of an extensive ‘a‘ā flow. This flow is younger than the adjacent pit overflows and its flow direction was partly controlled by the positive topography of pit 6, directing the flow to the southeast (Figure 1). DGPS measurements show that the pit 5 flow is ~ 60 cm thick along the east and west sides of the pit, and the rim rises ~ 4 m above the pre-overflow surface (Figure 2). Two depressed locations along the rim mark the source for overflowing lavas that formed poorly developed channels within the flow field. Pit 5 is between 13 and 16 m deep. This vent area with a raised rim and associated lava flows is comparable in morphology to many fans on Olympus Mons that display positive topographic relief and sometimes raised-rim pits as the source for channel-fed flow fields (Figure 1).

Discussion & Conclusions: Our observations are consistent with published observations indicating that a tube-fed flow field can produce a raised ridge built from channel and tube overflow episodes. Significant tube overflow through skylights can also lead to the development of a rootless vent or shield that serves as the source for significant surface flows. Current vents at Kīlauea are originating from primary vents along the eastern rift zone, and rootless shields along the well established Thanksgiving Eve Breakout (TEB) tube [11]. Similar surface outbreaks occurred along the Prince Kuhio Kalaniana’ole (PKK) and Campout tubes prior to the TEB event [4,12]. While it is difficult to determine whether a vent is primary or rootless from remote sensing data alone [7], field work on past and current Hawaiian lava flows shows that rootless vents can commonly form over lava tubes. These observations support the interpretation of Olympus Mons fans as lava tube outbreaks, particularly when combined with a spatial relationship with tubes. Identifying which fans are rootless will enable focused studies on features of questionable origin that might be indicative of rift zone processes on Olympus Mons.

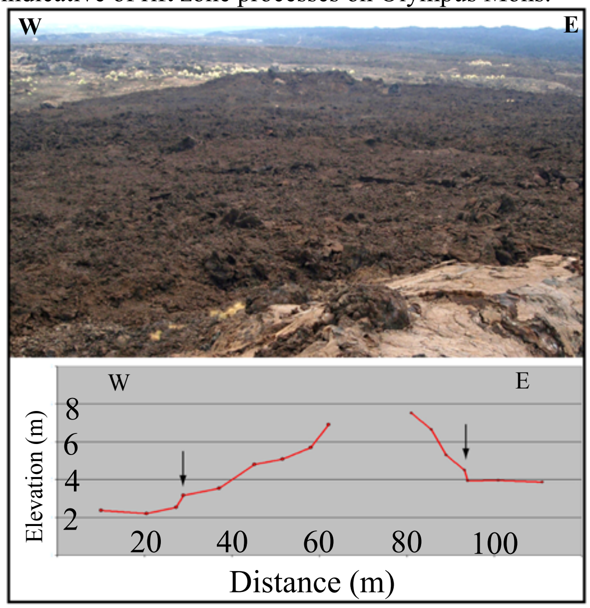

Figure 2. Image looking north towards pit 5 from the northern rim of pit 6. DGPS data collected along an west-to-east transect across the raised rim of pit 5 is shown in red, matching the red dashed line in Figure 1. In the image the smooth pāhoehoe rim of pit 6 is visible at the bottom of the image in contrast to the darker ‘a‘ā flow from pit 5. Arrows mark the extent of the ‘a‘ā flow.

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References: [1] Carr et al. (1977) *JGR*, **82**, 3985. [2] Morris and Tanaka (1994) *USGS Misc. Inv. Series Map I2327*. [3] Mouginis-Mark and Christensen (2005) *JGRE*, doi:10.1029/2005JE002421. [4] Bleacher (2007) LPSC, abstract 1886. [5] Bleacher et al. (2008) JGRE doi:10.1029/2006JE002826. [6] Wolfe et al. (1997) USGS Prof. Paper, 1557. [7] Jurado-Chichay et al. (1996) PEPI, 97, 269. [8] Jurado-Chichay & Rowland (1995) Bul. Vol. doi:10.1007/s004450050083. [9] Zimbelman et al. (2008) JVGR, doi:10.1016/j.jvolgeores.2008.01.042. [10] Rowland & Walker (1987) Bul. Vol. doi:10.1007/BF01079968. [11] Poland et al. (2008) EOS Trans. 89, 5. [12] http://hvo.wr.usgs.gov/kilauea/timeline/.