TERRACED MARGINS ON THE INFLATED MCCARTYS BASALT LAVA FLOW, NEW MEXICO: CONSTRAINTS ON EMPLACEMENT MECHANISMS.

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Introduction: Inflation is now recognized as a common occurrence when basaltic lava flows are emplaced on relatively shallow regional slopes [1-4]. Margins of inflated basaltic flows often display discrete terraces (Fig. 1), stepping down from the thickness represented by the central portion of the inflated sheet lobe. Differential Global Positioning System (DGPS) surveys of terraced margins at the McCartys lava flow in central New Mexico [5] provide precise topographic data for the margin terraces, which will be useful for evaluating mechanisms for the emplacement of these features. This work was supported by NASA PGG grant NNX09AD88G.

Figure 1. Terrace level visible along the southeastern margin of the McCartys lava flow. Red arrows show the levels of the top of the terrace (lower arrow) and the top of the inflated sheet lobe (upper arrow). Sheet lobe is ~4.2 m thick here (see Fig. 5). JRZ, 3/28/11.

DGPS surveys of terraced margins: Initial DGPS studies at the McCartys flow revealed the presence of distinct terraces at one-half of the margin locations examined in 2000-1(Table 1 of [5]). The current grant included support to carry out new DGPS surveys at some of the best terrace locations, in order to obtain detailed topography across these features. In November, 2009, surveys were made at several terraced margin locations, one of which is shown in Figure 2. An inflated sheet lobe represents the thickest portion of the flow (C), which was the source for a terrace (B) adjacent to the sheet lobe, and the terrace margin became the source for a toe breakout (A). DGPS data (Fig. 3) show the relief across all three sections of the flow; a distinct depression is present between the sheet lobe and the terrace, and the depth of a prominent crack near the margin of the sheet lobe ends essentially at the elevation of the terrace upper surface. The ratio of the terrace thickness to the sheet lobe thickness is 1/2.28; the ratio of the toe thickness to the terrace thickness is 0.34/1. The terrace in Fig.1 was traced to its source, which was a large fracture in the sheet lobe (Fig. 4). DGPS of this terrace shows a depression between the sheet lobe and the terrace (Fig. 5), comparable to a similar depression seen in Fig. 3. The ratio of the terrace thickness to the sheet lobe thickness in Fig. 5 is 1/1.97. A terrace to sheet lobe thickness ratio of 1/2 is representative of the results for the data in Figs. 3 and 5, as well as surveyed margins of inflated flows in Idaho and Hawaii [6], and also for previous point thickness measurements [5]. The ratio of toe to terrace thickness is also close to 1/2 (Fig. 3), but previous point thickness results [5] suggest this ratio may range between 1/3 and 1/2. These results suggest the following sequence of events for how either single or multi-

Figure 2. Oblique view of a terrace on the southeastern margin of the McCartys flow. Letters correspond to features in DGPS profile (see Fig. 3). JRZ, 11/4/09.

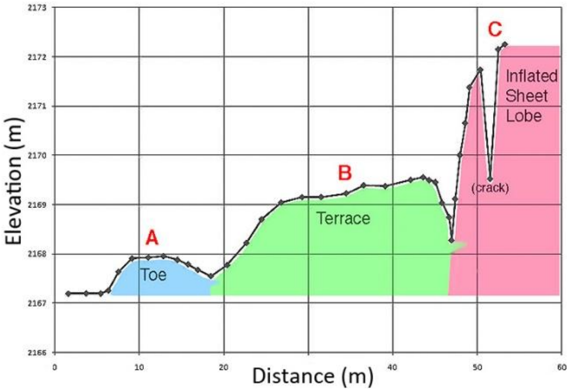

Figure 3. DGPS survey across the features shown in Fig. 2. The toe emanates from the terrace margin, and the terrace emanates from the inflated sheet lobe.

Figure 4. Geologist is standing in the source fracture for a terrace on the southeastern margin of the McCartys flow. See Fig. 5 for DGPS data. JRZ, 3/30/11.

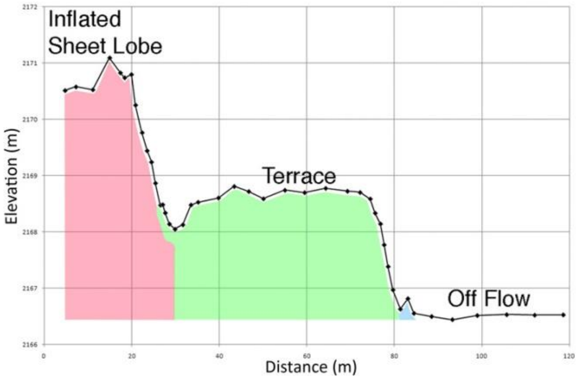

Figure 5. DGPS profile across the terrace shown in Fig. 4. A (small) toe emanates from the terrace margin, and the terrace emanates from the inflated sheet lobe.

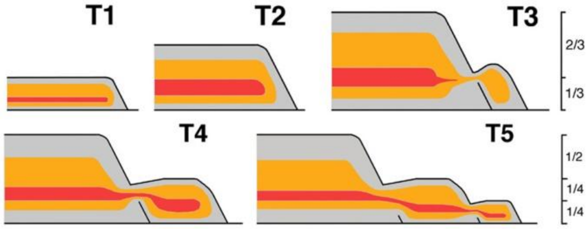

Figure 6. Model for terrace formation at the margin of an inflating lava flow. Times T1 to T5 are arbitrary.

ple terraces may have been emplaced (Fig. 6): an inflating sheet lobe (times T1 and T2) reaches the point where stresses on the margin cause a breakout of molten lava from within the inflated core of the flow, most likely from a point ~1/3 of the total thickness of the sheet lobe (T3). Continued supply of molten lava to the sheet lobe inflates the newly created terrace to a height that is roughly 1/2 of the sheet lobe thickness (T4). In some cases, the terrace margin may breach and feed a toe or secondary terrace, which will rise to a level that may reach ~1/2 of the terrace thickness (T5). This general scenario will be used to evaluate hydraulic and/or mechanical models [6] that may be a consequence of continued inflation of the flow field.

Implications for planetary flows: This work is in support of a larger project that is intended to provide tools for assessing whether some planetary lava flows have undergone inflation. Terraced margins hold promise as a surface feature that can provide support to an interpretation that a planetary flow may have undergone inflation (e.g., Fig. 7). We are continuing to look for additional physical attributes of inflated lava flows on Earth that may be detectable with currently available remote sensing data for lava flows imaged on other planetary surfaces.

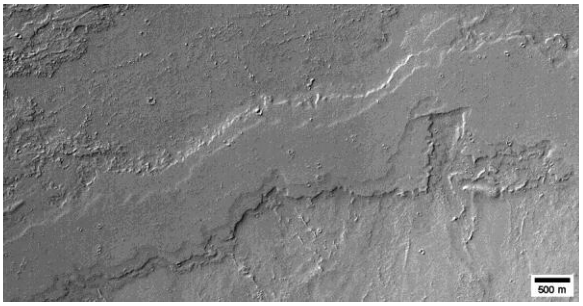

Figure 7. A lava flow on Mars that is interpreted to have undergone inflation; there is no apparent central leveed channel, the flow top is remarkably uniform in texture, and both sides of the flow have features that may be terraces similar to the McCartys terraced margins. Portion of CTX frame P21_009237_1800, near 0.1° S, 253.7° E.

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