FIELD INVESTIGATION OF INFLATED PAHOEHOE BASALT LAVA FLOWS, WITH APPLICATION TO LAVA FLOWS ON OTHER PLANETS. J. R. Zimbelman[1], W. B. Garry[1], L. S. Crumpler[2], J. E. Bleacher[3], and S. Self[4], [1]CEPS/NASM MRC 315, Smithsonian Institution, Washington, DC 20013-7012; zimbelmanj@si.edu; [2]NM Museum of Natural History and Science, 1801 Mountain Rd NW, Albuquerque, NM 87104-1375; [3]Planetary Geodynamics Laboratory, Code 698, NASA GSFC, Greenbelt, MD, 20771; [4]Dept. of Earth and Environmental Sciences, The Open University, Walton Hall, MK7 6AA, UK.

Introduction: We conducted field studies of the distal pahoehoe portion of the 1859 Mauna Loa basalt flow field in Hawai'i (Feb. 25 – Mar. 2, 2009) and of the McCartys basalt flow field in New Mexico (Nov. 3 – 7, 2009), both of which display impressive attributes of inflated lava flows. Here we present our preliminary results regarding distinctive aspects of the emplacement of the inflated portions of both flows, and their implications for the detection of inflated lava flow fields on other planets.

1859 Mauna Loa flow, HI: The 1859 eruption of Mauna Loa volcano produced the longest historic lava flow in Hawai'i (51 km), and it is a prime example of a 'paired' lava flow where both ‘a‘ā and pāhoehoe comprise distinct portions of the flow [1]. The 1859 eruption produced ‘a‘ā from Jan. 23 - Feb. 7, followed by tube-fed pahohoe until the eruption stopped in November [1-3]. Walker's [4] classic description of inflation features documents tumuli, lava rises and pits (produced by inflation) on the distal end of the 1859 flow. We conducted Differential Global Positioning System (DGPS) surveys on the distal pāhoehoe (Fig. 1), obtaining precise topo graphy for individual tumuli,

Figure 1. Location of DGPS surveys on distal end of pahoehoe portion of 1859 Mauna Loa basalt flow. Screen shot from Google Earth, 2009.

lava rises, and rise pits. We also documented surface textures (Fig. 2) during each survey, in order to relate field observations to the DGPS data.

Figure 2. Swales on top on an inflated lava rise, 1859 flow, Hawai'i. Compare to Fig. 5.

McCartys flow, NM: The McCartys flow is a well-preserved compound flow field extending 47 km from vent to the most distal end [5]. Cosmogenic and radiocarbon methods both give an age of ~3000 yr [6]. McCartys was the site for the classic description of tumuli on basalt flows [7], as well as documentation of the topography of inflated lava rise plateaus [8]. We collected additional DGPS data during the recent field work, but we were more focused on assessing the distribution and variability of inflated features, particularly at the southern end of the the flow (Fig. 3). We documented a complex pattern of inflated lava rise plateaus, suggesting interconnection of some of the rises during emplacement. Elevation data from the Shuttle Radar Topograhy Mission (SRTM) [9] provide a good perspective of the long profile of the flow field, from

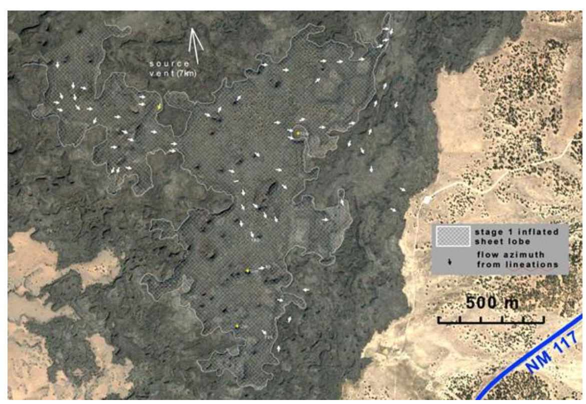

Figure 3. Preliminary map of inflated lava rises (sheet lobes) which comprise much of the southern end of the McCartys basalt flow. Small arrows indicate flow direction inferred from various surface textures.

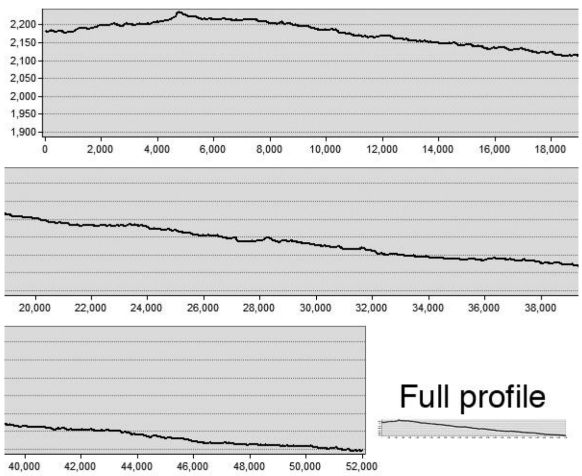

Figure 4. Profile along the McCartys flow field, from vent (5000 m dist.) to distal end (52000 m dist.), using SRTM [9] topography. Inset shows full profile.

the vent area to the most distal end (Fig. 4). The flow follows a fairly consistent topographic drop of ~350 m over 47 km, indicating an average downflow slope of 0.4º. We are in the process of integrating results from both Hawai'i and New Mexico studies; we observed and documented similar inflation-induced features at both locations.

Discussion: We are confident that the results from our field studies in both Hawai'i and New Mexico will have applicability to evaluating whether inflation has taken place in lava flows on planetary surfaces. The DGPS results will provide precise topographic attributes for several inflation features which can be compared to data obtained from other planets. The documentation of several specific surface textures, observed on both flows, also provides valuable information for comparison to detailed images of planetary flows. To illustrate the potential for such comparisons, we noted a distinctive 'swale' pattern on the top of several of the inflated lava rises that we examined, giving the visual impression of a collection of very shallow (concave down) plates, joining at linear fractures that define the angularly shaped plates (Fig. 2). Recent High Resolution Imaging Science Experiment (HiRISE) [10] images reveal a very similar swale pattern on the upper surface of some lava flows on Mars (Fig. 5). The example in Fig. 5 is from a series of lava flows in the Cerberus-Athabasca region of Mars, interpreted to represent very fluid basaltic lavas that have followed large water floods onto the surface of Mars [11]. We are certain that the continuing analyses of our data from the two inflated terrestrial flows will provide the community with a series of specific attributes for evaluating whether particular planetary lava flows may have undergone inflation.

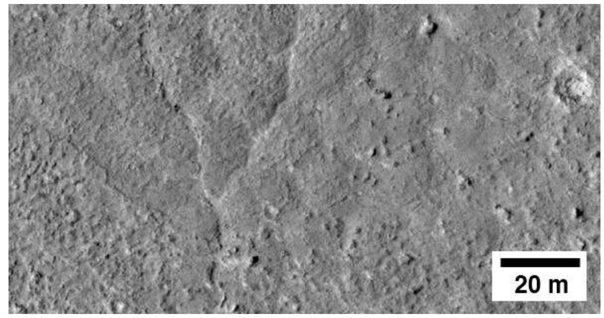

Figure 5. Swales on surface of lava flow in the Cerberus region of Mars. Portion of HiRISE PSP_010480_1910, 10.7ºN, 155.8ºE, 25 cm/p. Compare to similar features in Fig. 2. NASA/JPL/U of A.

References: [1] Rowland, S. K., and G. P. L. Walker (1990) Bull. Volc. 52, 615-628. [2] Haskell, R. C. (1859) Am. J. Sci. 78, 66-71. [3] Barnard, W. M. (2002) Mauna Loa: A source Book, SUNY-Fredonia, 139-154. [4] Walker, G. P. L. (1991) Bull. Volc. 53, 546-558. [5] Crumpler, L. S., et al. (2007) The Geology of Mars (M. Chapman, Ed.), Cambridge Univ. Press, 95-125. [6] Laughlin, A. W., et al. (1994) Geology 22, 135-138. [7] Nichols, R. L. (1946) Geol. Soc. Am. Bull. 57(11), 1049-1086. [8] Zimbelman, J. R., and A. K. Johnston (2002) New Mexico Geological Society Guidebook, 53rd Field Conf., 121-127. [9] SRTM site: srtm.usgs.gov. [10] McEwen, A. S., et al. (2007) J. Geophys. Res. 112, E05S02, 10.1029/2005JE002605. [11] Jaeger, W. L., et al. (2007) Science 317, no. 5845, 1709-1711, 10.1126/science.1143315.

Acknowledgements: This work was supported by research grants from the Scholarly Studies Program of the Smithsonian Institution and a new NASA Planetary Geology and Geophysics grant (NNX09AD88G).