

INFLATION PROCESSES AT THE McCARTYS LAVA FLOW FIELD, NEW MEXICO, WITH APPLICATION TO IDENTIFYING INFLATED LAVA FLOWS ON PLANETARY SURFACES. J. R. Zimbelman¹, W. B. Garry², J. E. Bleacher², L. S. Crumpler³, S. Self⁴, J. C. Aubele³, S. M. Baloga⁵, L. S. Glaze², R. A. Schultz⁶, ¹CEPS/NASM MRC 315, Smithsonian Institution, Washington, DC 20013-7012; zimbelmanj@si.edu, ²Planetary Geodynamics Laboratory, Code 698, NASA Goddard Space Flight Center, Greenbelt, MD 20771, ³New Mexico Museum of Natural History and Science, 1801 Mountain Rd NW, Albuquerque, NM 87104, ⁴Department of Earth and Environmental Science, The Open University, Walton Hall, UK, and Nuclear Regulatory Commission, Rockville, MD 20852, ⁵Proxemy Research Inc., 20528 Farcroft Lane, Gaithersburg, MD 20882, ⁶ConocoPhillips, 600 North Dairy Ashford, PR-2010, Houston, TX 77079.

Introduction: Inflation has been recognized as a significant process during the emplacement of basaltic lava flows on shallow regional slopes [1-4]. As part of NASA PGG grant NNX09AD88G, we have been studying inflation features and flow textures on the McCarty's lava flow located near Grants, NM, a well-preserved compound flow field that extends ~47 km from the vent (Fig. 1) [5-7], and which is ~3000 yr old [8]. The McCarty's flow is an excellent analog to planetary flows (e.g., on Mars) for four reasons: the pre-existing surface was extremely flat, the areal extent of the flow field is large, the relief generated by inflation is large and ubiquitous, and flow supply likely persisted for months to perhaps years.

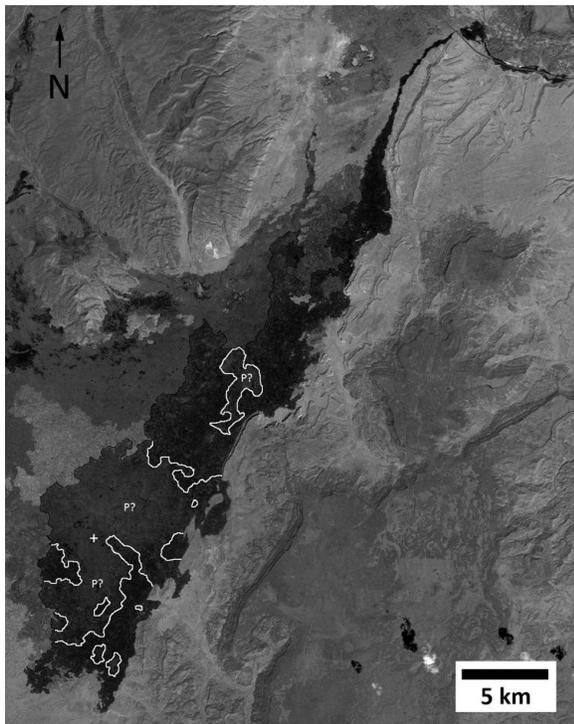


Figure 1. Portion of Landsat Thematic Mapper image L71034036, band 4 (4/14/00). The McCarty's lava flow field is superposed on earlier Zuni-Bandera lavas. White lines indicate probable inflation plateaus (see text); white cross indicates the vent for the flow field.

Results: We have made significant progress in unraveling the history of the McCarty's lava flow field.

Inflation plateaus. Precision topography, obtained from Differential GPS surveys [9], show that inflation plateaus [1] within the flow field have remarkably uniform heights on their upper surfaces. Contact relations between inflation components reveals that individual plateaus can have very complex planforms (Fig. 2).

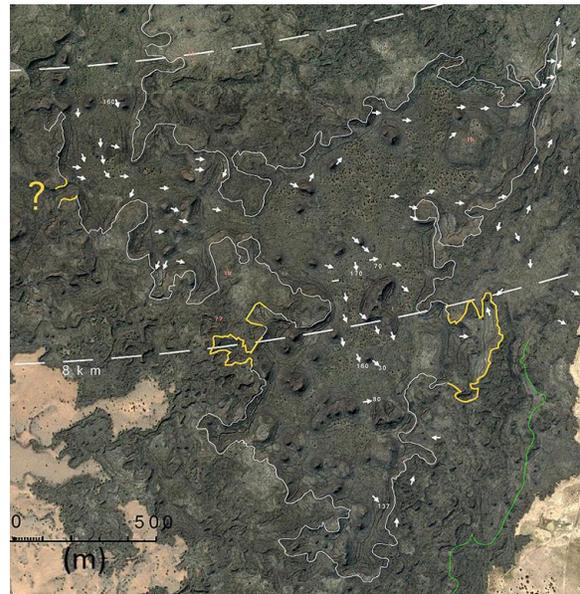


Figure 2. 2011 version of Lava Falls plateau map, the southernmost plateau in Fig. 1. White line: confident contact. Yellow line: inferred contact. Green line: contact between emplacement zones. Arrows: initial flow direction measured on lobe surfaces (preceding inflation). Compiled on Google Earth base by LSC.

We have fully mapped only the southernmost plateau, but the lighter grey-scale reflectance of known plateau areas (in satellite imaging) suggests that large areas near the vent likely include extensive inflation plateaus ('P?' in Fig. 1). Lava-rise pits [1] are common on the upper surface of the inflated plateaus, and blades of squeeze-out lava from the molten interior of inflated components are present in the walls of some pits and

marginal cracks. Fractured tumuli, surrounded by small lobes, are common adjacent to inflated plateaus, comprising a texture distinct from the plateau surfaces [10]. Contact mapping requires close examination in the field, due to the presence of numerous flow lobes and toes surrounding the inflated plateaus.

Terraced margins. DGPS profiles across several margins at McCartys reveal topographic terracing resulting from effusion from break-out fractures in the margin of adjacent inflated lobes, or toes from the terrace itself (Fig. 3) [11]. Terracing may be a helpful indicator of inflated flows on other planets.

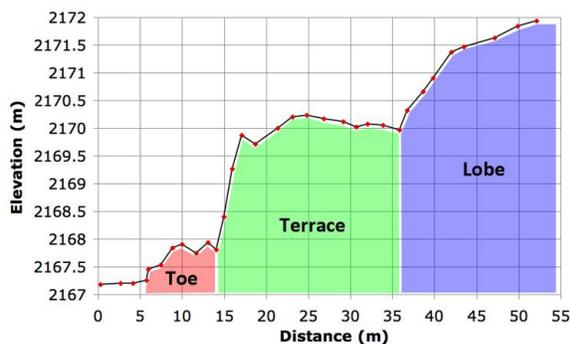


Figure 3. DGPS profile (3/30/11) of a McCartys margin displaying terracing, generated by sequenced emplacement followed by inflation, first from lobe to terrace, then from terrace to toe.

Flow textures. Many distinctive textures are present on the surface of inflated flow components, and some textures give good indications of flow direction for 'pioneer' lobes emplaced prior to inflation [12]. Textures and the topography of the flow indicate that continuous fluid pathways existed to the distal reaches of the flow field; our conclusion is that fluid pressure governed the emplacement dynamics, as opposed to solely gravity-driven forces, a mechanism that relates closely to pahoehoe toe emplacement [13-15].

Low-altitude aerial photography. Weight-shifting ultralights have proven to be an excellent platform from which to obtain low-altitude oblique and vertical photography of inflated features on the McCartys flow field (Fig. 4). Low-altitude vertical photography provides stereo that highlights sub-meter relief [17].

Discussion: Lessons learned from studies at the McCartys flow field were crucial to the interpretation of inflated lava features on the Moon [10], and should prove useful for on-going assessments of inflated lava flows on Mars [e.g., 16], as well as other planetary bodies. Continued analysis of mapped textures on the surface of inflated flows and modeling of inflation mechanisms will improve our ability to interpret inflation features that are identified on other planets.



Figure 4. Oblique low altitude photo of margin of a McCartys inflated plateau. Lava-rise pit in plateau surface is at center left. Margin relief, ~8 m. JRZ, 4/28/12.

Future Plans: A follow-up proposal is currently under review with NASA PGG, which would include additional field studies at the McCartys flow, as well as field investigation of the large inflation plateaus present on the distal portion of the Carey lava flow, in the Craters of the Moon region in central Idaho. We intend to submit one or more manuscripts to summarize the results derived from our work at the McCartys flow field, which should provide a basis for future field and modeling investigations of lava flow inflation.

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