

THE GEOLOGY OF INFERNO CHASM, IDAHO: A TERRESTRIAL ANALOG FOR LUNAR RILLES?

W. Brent Garry¹, Scott S. Hughes², Shannon E. Kobs Nawotniak², Catherine D. Neish³, Christopher W. Haberle⁴, Jennifer L. Heldmann⁵, Darlene S. S. Lim⁵, and the FINESSE Team ¹Planetary Geodynamics Laboratory, Code 698, NASA Goddard Space Flight Center, Greenbelt, MD, 20771, ²Dept. of Geosciences, Stop 8072, Idaho State University, Pocatello, ID, 83209, ³Florida Institute of Technology, Melbourne, FL, 32901, ⁴School of Earth and Space Exploration, Arizona State University, Tempe, AZ, 85287, ⁵NASA Ames Research Center, Moffett Field, CA, 94035.

Introduction: Lunar sinuous rilles are thought to have formed by thermal erosion, mechanical erosion, construction, or a combination of these processes via emplacement by lava tubes or lava channels [e.g., 1-4]. The investigation of Hadley Rille by Apollo 15 provided the first field observations of a rille [5], but remote sensing observations remain our primary method for studying these features [6,7]. Terrestrial volcanic features with similar morphologies to lunar rilles can provide insight into their formation on the Moon. While the scale of lunar rilles are much larger than terrestrial analogs, there may be some morphologic comparisons and inferences we can make between the two planetary bodies through field work. Here we compare field observations at a rille-like channel in Idaho (Inferno Chasm) to a rille in Marius Hills on the Moon.

Background: The SSERVI FINESSE team (Field Investigations to Enable Solar System Science and Exploration) [8] conducted field studies at Craters of the Moon National Monument and Preserve (COTM) in Idaho (Fig. 1A) from July 28 – Aug. 8, 2014 to investigate terrestrial analogs for lunar volcanic and impact features. In addition to Inferno Chasm, field sites included Kings Bowl and North Crater Flow – each site exhibiting different volcanic attributes. Kings Bowl erupted along a N-S trending fissure system and formed a series of spatter cones, perched lava ponds, and phreatic blowouts (Fig. 1B). North Crater Flow is a complex pahoehoe flow with a variety of textures that resemble an impact melt flow on Tycho crater [9].

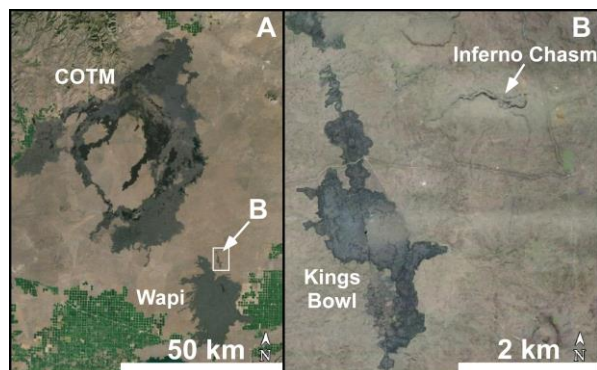


Figure 1. (A) Craters of the Moon (COTM), Idaho. (B) Location of Inferno Chasm and Kings Bowl [Google Earth].

Inferno Chasm (42°58'00"N, 113°11'25"W) is a basaltic low-shield with a vent and sinuous channel (Figs.

1B, 2). The area is overgrown with sage and desert grasses, but it appears that the margins of the low shield have been embayed or buried by subsequent lava flows or loess making it difficult to define the true extent of this volcanic feature.

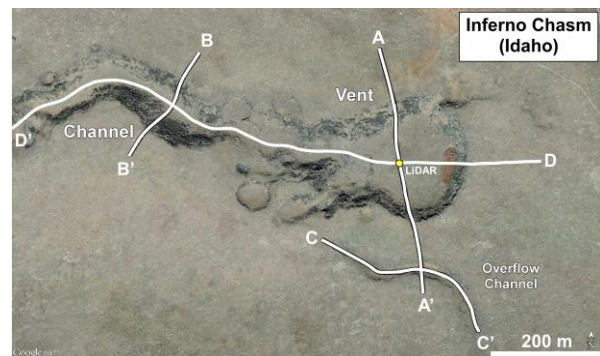


Figure 2. Location of Differential GPS and LiDAR surveys at Inferno Chasm in Idaho [GoogleEarth].

Data Collection. We documented the geology and morphology of Inferno Chasm using Trimble R8 and TopCon Hiper II Differential Global Positioning Systems (DGPS) (Fig. 2), LiDAR, Unmanned Aerial Vehicles (UAV), and sampling.

Field Observations. Inferno Chasm is ~20 m high and 2 km in diameter. The main vent crater is roughly circular with a sinuous channel extending to the west. DGPS survey A-A' shows the vent is ~200 m wide, ~20 m deep and has a small 2.5 m-high mound in the center (Fig. 3). DGPS profile D-D' indicates a channel length of ~1.6 km and a slope of <math><1^\circ</math> along the channel floor (Fig. 2). Several overflow channels are also visible in the remote sensing images, but are much more subtle in the field (DGPS profile C-C'). Outcrops of the vent walls expose prominent massive layers (2-3 m thick) (Fig. 4) overlain by a 1-2 m thick sequence of thinner layers (10s cm thick). Field observations and samples collected for analysis indicate low-shield development typical of the eastern Snake River Plain [10].

Lunar Rille: A rille in Marius Hills (Fig. 5) has a similar morphology to Inferno Chasm. The vent region is ~3 km wide and up to 225 m deep. The channel is 15 km long, 0.9-1 km wide, and ~30-100 m deep. The path of the rille diverts around the base of a mound within Marius Hills and the distal end of the rille may have been buried by subsequent lava flows obscuring

the true extent of the rille. The walls of the rille and vent region reveal layers of lava possibly related to this eruption and boulders.

Discussion: Preliminary observations at Inferno Chasm provide insight into how rille-like channels can form almost entirely via construction. The vent region at Inferno Chasm was apparently constructed by a combination of thick and thin lava layers. Evidence of thermal erosion and/or lava tube collapse along the channel were not identified, but have not been ruled out. Distinct levees were not identified along the channel margin. More field work is planned at COTM in 2015 to study the channel in more detail. Lunar rilles form through a combination of thermal and mechanical erosion [1-7], plus construction [4]. Layers exposed in rille walls could represent sequences of lava layers related to the eruption that formed the rille and not substrate layers that have been thermally eroded by the lava flow. Determining which component of a rille was formed via construction versus thermal erosion is important for modeling eruption parameters.

References: [1] Greeley R. (1971) *Science* 172, 722-725. [2] Gornitz V. (1973) *The Moon*, 6, 337-356. [3] Hulme G. (1973) *Modern Geo.*, 4, 107-117. [4] Spudis P. *et al.* (1988) *LPSC*, 18, 243-254. [5] Swann G.A. *et al.* (1972) *Apollo 15 Prelim. Sci. Rep.*, 289, 5-1 – 5-112. [6] Hurwitz D.M. *et al.* (2012) *JGR Planets*, 117, E00H14, doi:10.1029/2011JE004000. [7] Hurwitz D.M. *et al.* (2013) *Planet. & Space Sci.*, 79-80, 1-38. [8] Heldmann J. L. *et al.* (2013) AGU Fall Mtg. Abstract #P54B-01. [9] Carter L.M. *et al.* (2012) *JGR-Planets*, 117, E00H09, doi:10.1029/2011JE00391. [10] Greeley R. (1982) *JGR-SE*, 87(B4), 2705-2712.

Acknowledgements: This research is supported by a NASA SSERVI research grant provided to NASA Ames Research Center and collaborating institutions.

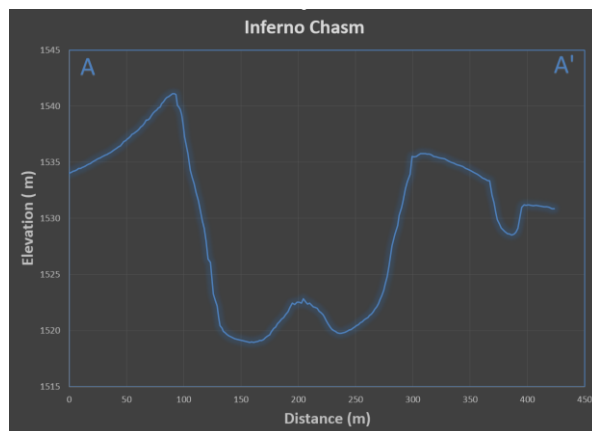


Figure 3. Differential GPS profile A-A' across the vent at Inferno Chasm (see Fig. 2). The vent is ~200 m wide, ~15-20 m deep, and has a 2.5 m high mound near the center.

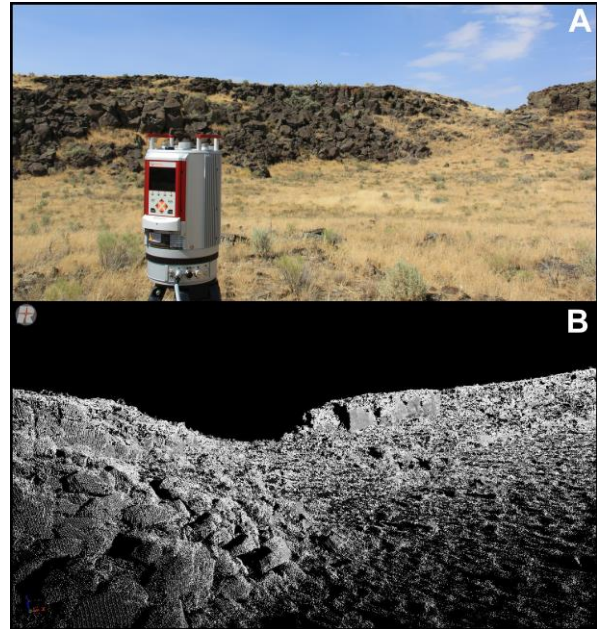


Figure 4. (A) Riegl Vz-400 LiDAR setup within the Inferno Chasm vent (See Fig. 2 for location). (B) LiDAR scan looking to the east along the northern vent wall.

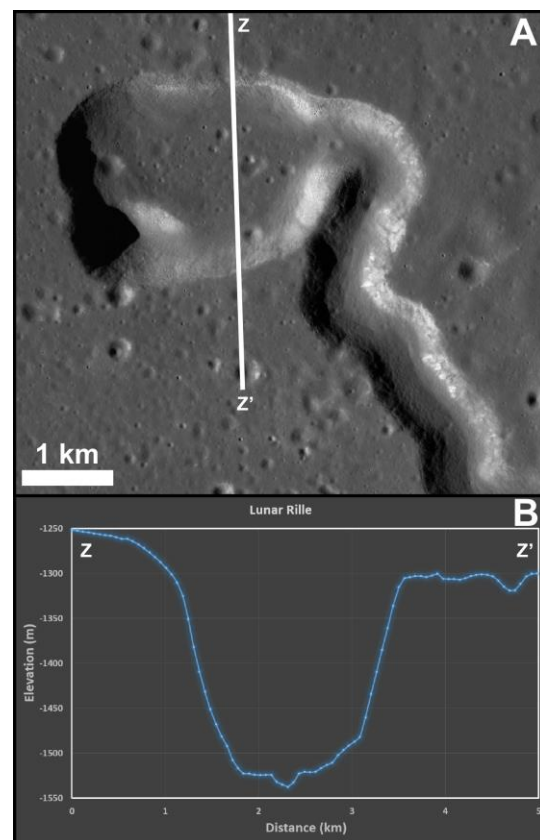


Figure 5. (A) Sinuous rille located within Marius Hills (13.95° N, 49.55° W) LROC NAC image M1096815341LE [NASA/GSFC/ASU]. Resolution (1.25 m/px). Incidence angle (66°). (B) LOLA profile across vent (1024 ppd DEM).