LUNAR VOLCANIC HISTORY FROM IN-SITU MORPHOLOGICAL ANALYSES. E. R. Rader[1,2] and J. L. Heldmann[1], FINESSE team. [1]NASA Ames Research Center Moffett Field, CA, , [2]NASA Postdoctoral Program, USRA (Erika.rader@nasa.gov).

Introduction: Nearly all analyses revealing the thermal and geochemical history of volcanoes on Earth require large volumes of material to be retrieved, prepared, and analyzed in a laboratory setting. To obtain the same level of information for lunar volcanoes, new techniques that require little to no sample collection must be developed. The presented project has expanded a method to determine emplacement temperature and accumulation rate of volcanic deposits, which only requires measurements of outcrops [1] to be applicable to lunar conditions. Thermal constraints for volcanic eruptions on the Moon will allow for better understanding of the thermal evolution of the lunar crust and mantle, as well as the loss of gasses from the lunar mantle [2].

Methods: The empirical relationship between measurable characteristics (clast shape, connections and voids between clasts, and vesicularity) of volcanic deposits and thermal conditions during emplacement were developed by making experimental spatter piles at the Syracuse Lava Project (Fig. 1), tracking the thermal evolution of each clast, and then measuring morphological characteristics, such as the amount of connection and void space between clasts, and the vesicularity, shape, and size of each clast. The relationship was tested using a 1-D numerical model, and then applied to natural spatter clasts at Craters of the Moon in Idaho, a lunar analogue studied extensively by the FINESSE project [3].

Results: The morphology of volcanic spatter correlates to eruption temperature and time spent above 700ºC, which is approximately the glass transition temperature for experimental basalt at the Syracuse Lava Project. Higher temperatures and longer times correlate to more connections and fewer void spaces between clasts. Furthermore, lower interior vesicularity and more oblate clasts were formed at higher temperatures and longer durations above the glass transition temperature. The range of conditions in which spatter forms include emplacement temperatures of 840ºC-950ºC and sintering times of 25-90 minutes. Numerical modeling can be used to match these emplacement temperatures and cooling trends and estimate accumulation rates, which range from 2-6 m/hr for experimental clasts.

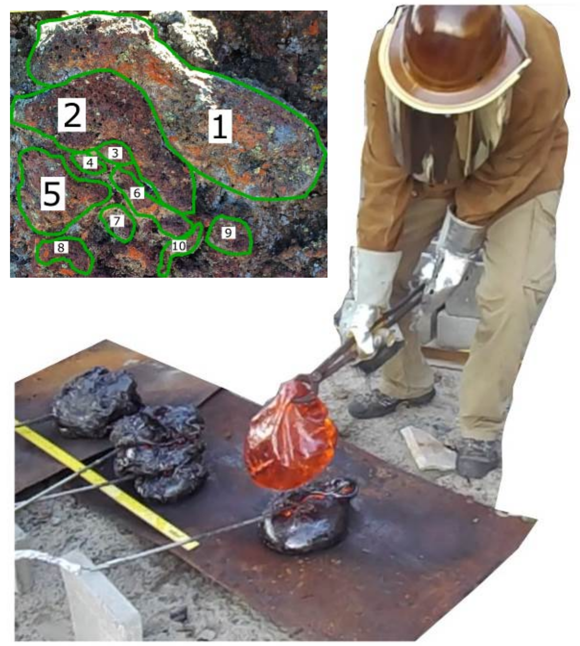

Figure 1. Experimental spatter bombs are shown being stacked with thermocouples between each clast, the cooled product mimicked the appearance of natural spatter clasts (insert) from Craters of the Moon National Monument, Idaho.

Implications: We present a new method requiring no sample collection to asses the thermal evolution of lunar volcanic deposits, providing key information on eruptive history of volcanic areas on the Moon. There is currently no way to remotely sense these data from satellite imagery, therefore, landing on the Moon is critical to gain more understanding of the eruptive processes that shaped our nearest neighbor. With the correct measurements, the eruption duration, explosivity, and eruptive column height can be garnered from outcrops of scoria or spatter clasts. This type of material has been hypothesized to exist in several locations on the Moon, including the Marius Hills [4].

References: [1] Rader E. L. and Geist D. (2015) *JVGR, 304,* 287–293. [2] Wilson L. and Head J. W. (1981) *JGR*, *86*, 2971-3001. [3] Heldmann J. L. et al. (2015) *AGU Fall Meeting*, Abstract # P53C-2145. [4] Lawrence S. J. et al. (2013) *JGR, 118,* 615-634.

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