THE ANATOMY OF THE BLUE DRAGON: CORRELATIONS BETWEEN LAVA FLOW MORPHOLOGY AND PHYSICAL PROPERTIES. A. Sehlke[1], S.E. Kobs Nawotniak[2], S.S. Hughes[2], D.W. Sears[1,3], M.T. Downs[4], A.G. Whittington[5], D.S.S. Lim[1,3], J.L. Heldmann[1] and the FINESSE Team. [1]NASA Ames Research Center Moffett Field, CA (alexander.sehlke@nasa.gov), [2]Idaho State University, Pocatello, ID, [3]Bay Area Environmental Research Institute, Petaluma, CA, [4]NASA Kennedy Space Center, Titusville, FL, [5]University of Missouri, Columbia, MO.

Introduction: Lava terrains on other planets and moons are abundant, with morphologies similar to those found on Earth, such as flat and smooth pāhoehoe, which can transition to rough, jagged \`a\`ā terrains based on the viscosity – strain rate relationship of the lava [1]. Therefore, the morphology of lava flows is governed by eruptive conditions such as effusion rate, underlying slope, and the fundamental themo-physical properties of the lava, including temperature (T), composition (X), viscosity (η), the volume fractions of entrained crystals (ϕ_c) and vesicles (ϕ_b), as well as bulk density (ϱ). These textural and rheological changes were previously studied and quantified for Hawaiian lava through field and laboratory work [2,3]. In this case, the lava flow started as channelized pāhoehoe and transitioned into a rough \`a\`ā flow, demonstrating a systematic trend in $T, X, \eta, \phi_c, \phi_b$, and ϱ.

NASA's FINESSE (Field Investigations to Enable Solar System Science and Exploration) focuses on Science and Exploration through analogue research. One of the field sites is Craters of the Moon (COTM) National Monument and Preserve, Idaho, a dominantly basaltic volcanic system erupted ~2000 years ago, exposing a variety of well-preserved volcanic features. In this study, we present field work done at a ~3.0 km long open channel lava flow belonging to the Blue Dragon (BD) lavas erupted from a chain of spatter cones, which then coalesced into channelized flows.

Methods: We acquired Unmanned Aerial Vehicle (UAV) imagery along the entire length of the lava flow, and generated a high resolution Digital Terrain Model (DTM) of ~5 cm per pixel (Fig. 1), from which we derived height profiles and surface roughness values [4,5]. Field work included traversing the flow from vent to toe, mapping the change in surface morphology while samples were collected approximately every 150 meters from the channel interior and the levees. In the laboratory, we measured ϕ_c, ϕ_b, and ϱ for all these samples. Viscosity measurements were carried out by concentric cylinder viscometry at subliquidus temperatures between 1310ºC to 1160ºC to study the rheology of the lava, enabling us to relate changes in flow behavior to temperature and crystallinity.

Results: Our results are consistent with observations made for Hawaiian lava. In particular, we observe an increase in bulk density towards the flow terminus, while porosity changes from connected to isolated pore space. Crystallinity increases downflow, and the transition from pāhoehoe to \`a\`ā is prompted by nucleation and growth of plagioclase microcrystals, strongly increasing the viscosity of the lava several orders of magnitude. The transition of the lava from pāhoehoe to \`a\`ā occurs in a temperature interval from 1230ºC to 1150ºC, based on rheology experiments.

Conclusions: The results of this study allows us to correlate $T, X, \eta, \phi_c, \phi_b$, and ϱ to the lava flow morphology expressed as surface roughness, which can then be used as a tool to infer these physical properties of the rocks for open channel lava flows on on the Moon, Mars, and Mercury based on Digital Terrain Models.

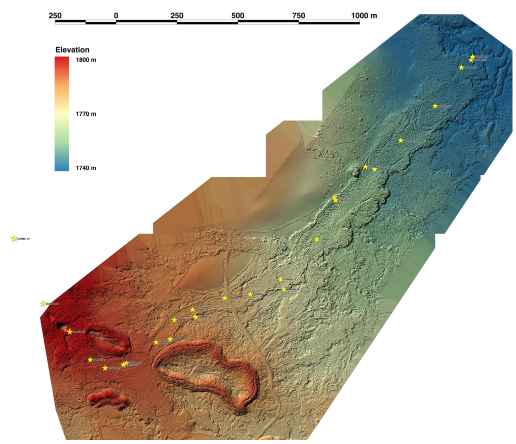

Fig 1: High-resolution (5 cm per pixel) Digital Terrain Model (DTM) of the studied Blue Dragon lava flow at the Craters of the Moon National Monument and Preserve, Idaho, generated by UAV imagery. Star symbols represent sample locations along the flow.

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