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THE ANATOMY OF THE BLUE DRAGON: CHANGES IN LAVA FLOW MORPHOLOGY AND PHYSICAL PROPERTIES OBSERVED IN AN OPEN CHANNEL LAVA FLOW AS A PLANETARY ANALOGUE (Invited Presentation)

SEHLKE, Alexander[1], KOBS NAWOTNIAK, Shannon[2], HUGHES, Scott[2], SEARS, Derek[3], DOWNS, Michael[4], WHITTINGTON, Alan G.[5], LIM, Darlene S.S.[6] and HELDMANN, Jennifer[7], (1)Ames Research Center, NASA, Moffett Field, CA 94035, (2)Idaho State University, Pocatello, ID 83209, (3)Space Science and Astrobiology Division, NASA Ames Research Center, MS 245-3, Moffett Field, Mountain View, CA 94035, (4)NASA Kennedy Space Center, Merritt Island, FL 32899, (5)Department of Geological Sciences, University of Missouri, Columbia, MO 65211, (6)BAER Institute, NASA Ames Research Center, Moffett Field, CA, (7)NASA Ames Research Center, Moffett Field, CA, alexander.sehlke@nasa.gov

Lava terrains on other planets and moons exhibit morphologies similar to those found on Earth, such as smooth pāhoehoe transitioning to rough \`a\`ā terrains based on the viscosity – strain rate relationship of the lava. Therefore, the morphology of lava flows is governed by eruptive conditions such as effusion rate, underlying slope, and the fundamental thermo-physical properties of the lava, including temperature (T), composition (X), viscosity (η), fraction of crystals (φ_c) and vesicles (φ_b), as well as bulk density (ρ). These textural and rheological changes were previously studied for Hawaiian lava, where the lava flow started as channelized pāhoehoe and transitioned into \`a\`ā, demonstrating a systematic trend in $T, X, \eta, \varphi_c, \varphi_b$, and ρ.

NASA's FINESSE focuses on Science and Exploration through analogue research. One of the field sites is Craters of the Moon, Idaho. We present field work done at a ~3.0 km long lava flow belonging to the Blue Dragon lavas erupted from a chain of spatter cones, which then coalesced into channelized flows. We acquired UAV imagery along the entire length of the flow, and generated a high resolution DTM of ~5 cm/pixel, from which we derived height profiles and surface roughness values. Field work included mapping the change in surface morphology and sample collection every ~150 meters. In the laboratory, we measured φ_c, φ_b, and ρ for all collected 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 T and φ_c.

Our results are consistent with observations made for Hawaiian lava, including increasing bulk density downflow, and porosity changing from connected to isolated pore space. Crystallinity increases downflow, and the transition from pāhoehoe to \`a\`ā occurs between 1230ºC to 1150ºC, which is prompted by nucleation and growth of plagioclase microcrystals, strongly increasing the viscosity of the lava several orders of magnitude.

The results of this study allows us to correlate $T, X, \eta, \varphi_c, \varphi_b$, 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 DTMs.

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