Pattern to Process: Flood Basalt Emplacement Parameters and their Cross-Sectional Morphologies

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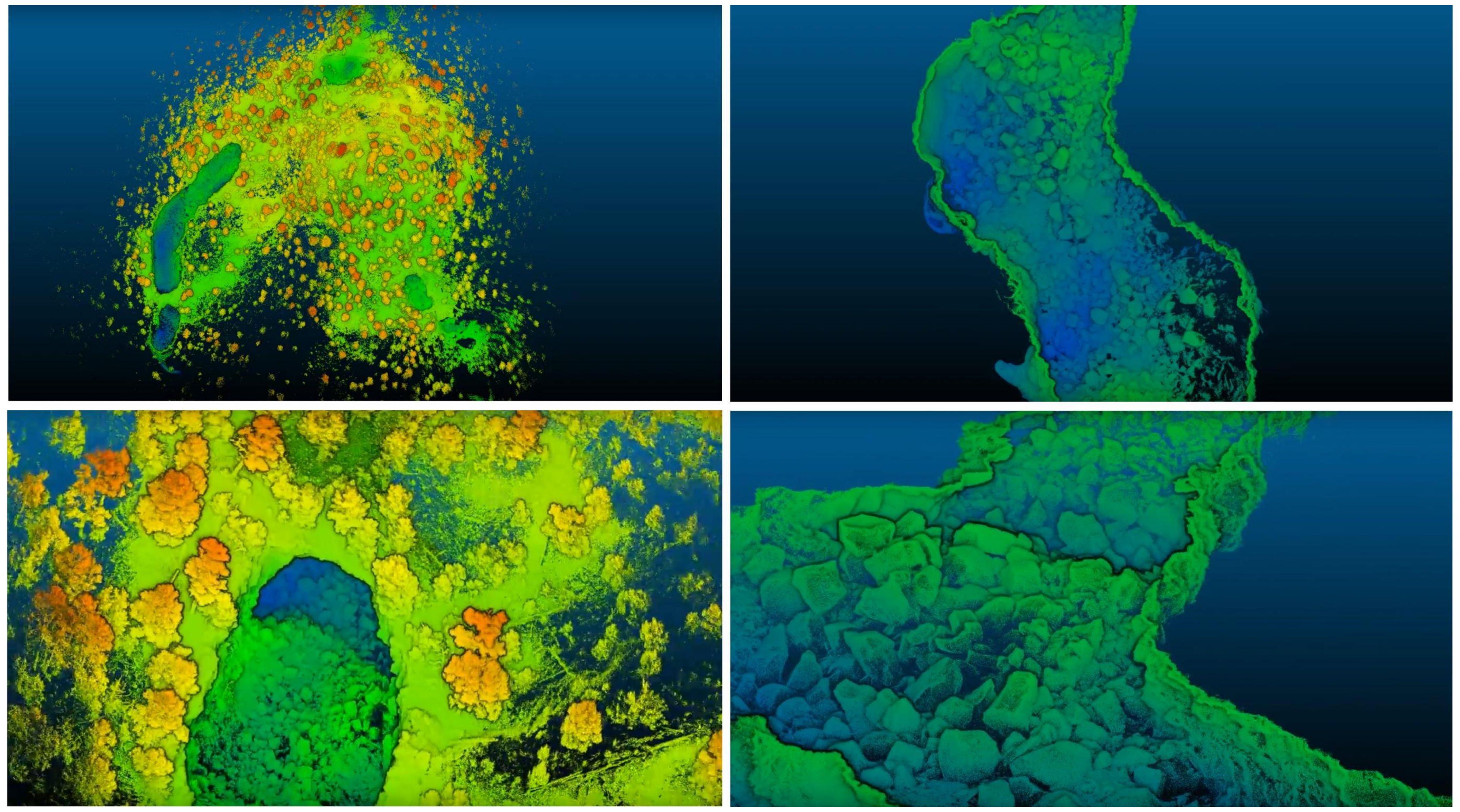
Objectives

This project's objective was to support JPL's Moon Diver Discovery mission concept by obtaining 'ground-truth' observations of terrestrial inflated lava flows in cross-section and developing scientifically novel models for the relationships between lava flow emplacement, inflation, morphology, and chemistry.

By examining a suite of large lava lobes and tubes in cross-section within the Zuni–Bandera Volcanic Field, we characterized the spatial variability in lava chemistry within wide range of lava flows, validated Moon Diver's data acquisition strategy, and improved modern terrestrial models of lava flows.

Approach and Results

Detailed observations of lava flow features within the Zuni–Bandera Volcanic Field were acquired and developed into a manuscript for publication within the Journal of Geophysical Research (JGR): Planets. Professor Hamilton also obtained access to the Martinsville #1 drill core through the Newark Basin's Orange Mountain Basalt (OMB), which (from bottom to top), three lava flow units: OMB 1 (85.5-m-thick), OMB 2 (65.5-m-thick) and OMB 3 (13.8-m-thick). OMB 3 is similar to flow units within the Zuni–Bandera Volcanic Field and comparable to small to medium lava flow units on the Moon, whereas OMB units 1 and 2 are much thicker and comparable to the products of the largest end-member lunar eruptions. In February 2020, new high-resolution (25 cm/pixel) LiDAR data was collected over the Zuni–Bandera Volcanic Field by Fairweather Airborne LiDAR and digital photogrammetry. UA Graduate Student Joana Voigt also submitted a manuscript related to the topographic signatures of lava flow surfaces with applications to LiDAR and radar imaging of planetary surfaces. The manuscript (Voigt et al, 2021) has been accepted for publication within the Bulletin of Volcanology.



Examples of LiDAR point clouds obtained for a lava tube system within the Zuni–Bandera Volcanic Field, generated using a hand-held Simultaneous Localization And Mapping (SLAM) LiDAR system. Left: Perspective views of the exterior of the lava tube system. Please note that the lava tube is about 10 m in width near its opening. Right: Cut-away perspective views of the interior of the lava tube system.

Significance/Benefits to JPL and NASA

Our combined efforts to characterize processes (Hamilton et al., 2020) and surface morphologies (Voigt et al., 2021) associated with basaltic flood basalt eruptions provide new insight into the structures we would expect in association with lunar lava flow cross-sections.

Publications

Christopher W. Hamilton, Stephen P. Scheidt, Michael M. Sori, Andrew P. de Wet, Jacob E. Bleacher, William B. Garry, Patrick L. Whelley, Peter J. Mouginis-Mark, Stephen Self, James R. Zimbelman, and Larry S Crumpler (2021) "Lava-Rise Plateaus and Inflation Pits within the McCartys Flow-Field, New Mexico: An analog for Pāhoehoe-Like Lava Flows on Planetary Surfaces," Journal of Geophysical Research: Planets, 124(7), E2019JE005975 (2020): pp. 1–36.

Joana R. C. Voigt, Christopher W. Hamilton, Gregor Steinbrügge, and Stephen P. Scheidt "Surface Roughness Characterization of the 2014–2015 Holuhraun Lava Flow-Field in Iceland: Implications for Facies Mapping and Remote Sensing," Bulletin of Volcanology, accepted (2021).

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