Surface Roughness Analysis of the Holuhraun Lava Flow-Field: A Lunar Analogue

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Abstract. Radar and optical remote sensing data are used in planetary science research and exploration to understand the roughness of lava flows and their emplacement processes[1]. On Earth, ground-truthing can confirm remote sensing interpretations, however, on other planetary bodies where in-situ data is limited or non-existent, remote sensing data is our only source of information[2]. Remote sensing data from instruments such as the Arecibo Observatory (P-band and S-band radar) and Lunar Reconnaissance Orbiter (LRO) Narrow-Angle Camera (NAC) obtain roughness information at different scales (e.g., cm vs m). Depending on the scale, lava flows can appear smoother or rougher, making it harder to distinguish lava flow types on other planetary bodies. By studying and comparing lava flows at multiple roughness scales, we can establish better comparisons between terrestrial and planetary lava flows. In this study, we conduct a detailed analysis of the surface roughness of the 2014-15 Holuhraun lava flow-field at the cm and dm-scale. Holuhraun was selected for this study because it exhibits analogous flow morphologies and roughness to lunar lava flows. Up to five lava flow types are present at Holuhraun, each with a unique surface roughness characteristic: spiny, rubbly, pāhoehoe-like, `a`ā-like and shelly.

To compare dm and cm-scale roughness, we quantified circular polarization ratio (CPR) data from the JPL operated UAVSAR L-Band (24 cm) platform and compared it to roughness statistics (RMS slope (Cs) and Hurst exponent (H)) calculated from LiDAR digital elevation models (DEMs, 5 cm/pixel). Unlike dm-scale roughness, cm-scale roughness is not as widely available in planetary data systems. By seeking a correlation between the dm and cm-scale roughness, we can infer the cm-scale roughness properties of lava flows on the Moon with analogous dm-scale roughness. We compare Cs to CPR and Cs to two H scales (0.05-0.25m, 0.25-2m) to determine if any correlation exists.

[1] Neish et al., *Icarus*, 281, 73-89 (2017)
[2] Tolometti et al., *Planetary and Space Science*, 190, 104991 (2020)