STUDYING LUNAR LAVA FLOW EMPLACEMENT BY QUANITFYING THE SURFACE ROUGHNESS OF THE HOLUHRAUN LAVA FLOW-FIELD G. D. Tolometti[1], C. D. Neish[1], G. R. Osinski[1], A. Kukko[2], J. R. C. Voigt[3], C.W. Hamilton[3]. [1]University of Western Ontario, London, ON (gtolomet@uwo.ca), [2]Centre of Excellence in Laser Scanning Research, Finnish Geospatial Research Institute, [3]Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ.

Introduction: The 2014–15 Holuhraun lava flow-field in Iceland serves as an analogue for lava flows on other planetary bodies, including the Moon. Measuring surface roughness at different scales (e.g., cm vs. m) ultimately provides information about the processes involved in volcanic eruptions, which is vital for inferring the emplacement styles of lava flows on other planetary bodies [1]. Using UAVSAR L-Band (λ = 24 cm) quad-pol radar data and Akhka-R4DW, a backpack kinematic LiDAR system [2], we analyze the surface roughness of the diverse types of lava flows at Holuhraun. From this data, we seek to make more refined interpretations about the emplacement of lava flows on the Moon, since Holuhraun exhibits analogous flow morphologies and roughness to lunar lava flows and impact melt flows [3].

Data and Methods: To compare dm and cm-scale roughness, we correlate the circular polarization ratio (CPR) from the UAVSAR data (dm-scale) with roughness statistics from LiDAR Digital Elevation Models (DEMs) (cm-scale) (Fig. 1). CPR was calculated at a spatial resolution of 8 m/pixel and incidence angles ranging from 50° to 53°. CPR of each lava flow type was extracted using the zonal statistics tool in ArcGIS.

The roughness statistics – RMS slope (Cs) and Hurst exponent (H) – were calculated from the DEMs using techniques detailed in [3]. The Cs is the standard deviation of slope points along a defined profile length. It provides information about the roughness of surfaces because the greater the slope points along the profiles, the more irregular the surface. H tells how roughness changes with scale. If H approaches 0, it indicates that the surface becomes smoother or rougher as the scale increases. If H approaches 1, the surface maintains its roughness despite a change in scale.

Lunar Analogue: The cm-scale of lava flows on the Moon is difficult to analyze using available remote sensing data due to regolith cover and impact gardening [4]. Radar however, can penetrate through the regolith and scatter off buried lava flow surfaces at dm-scale [5]. By establishing correlations between dm-scale and cm-scale surface roughness of the Holuhraun lava flow types, we can interpret the cm-scale roughness of lunar lava flows with analogous dm-scale features, which will provide more information about the emplacement styles of lunar lava flows. Other applications for this study include enhancing hazard terrain maps for robotic and human missions in volcanic regions on the Moon. Combination of different roughness scales can ensure the safety of missions with the goal to sample volcanic material on the Moon.

Conclusion: The surface roughness of lava flows types at the Holuhraun lava flows-field exhibit morphologies and roughness analogous to lunar lava flows and impact melt flows. Using dm and cm-scale roughness, we seek to interpret the emplacement styles of lunar lava flows by studying analogous lava flow types at the Holuhraun lava flow-field.

References: [1] Zanetti et al. (2018) *LPSC, XLIX, Abstract #2361*. [2] Kukko et al. (2020) ISPRS Annals, Acc. [3] Neish et al. (2017) *Icarus*, 281, 73-89. [4] Carter et al. (2011) *IEEE, 99(5), 770-782* [5] Campbell et al. (2007) *IEEE Geo. Remote Sensing*, 45(12), 4032-4042.

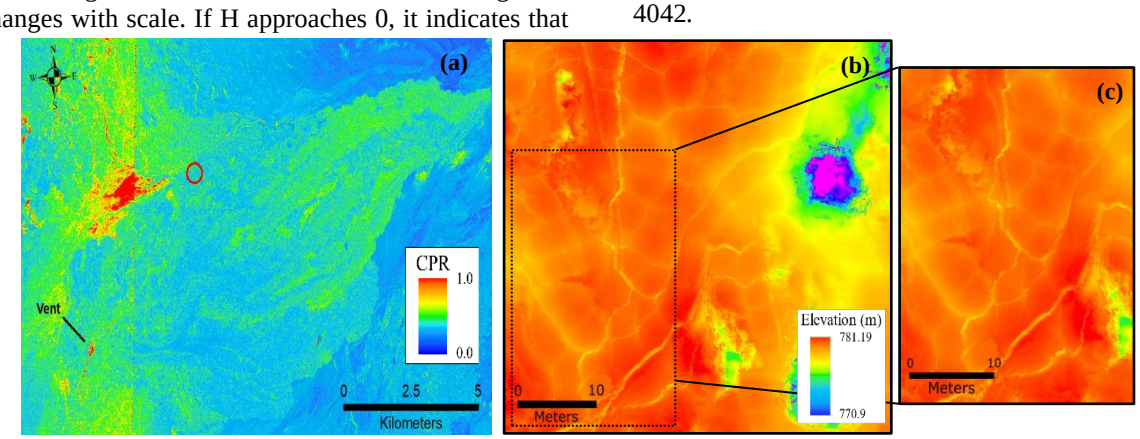

Figure 1. (a) CPR datasets calculated from two UAVSAR flights in May 2015. (b) Section of a LiDAR DEM of a spiny lava flow with polygonal plates. The entire LiDAR DEM covers an 80 × 80 m grid with a resolution of 5 cm/pixel. The margins of the plates and their rift zones are easily distinguishable in the data (zoomed in image, (c)).