Volcanic Facies and 15m Scale Roughness Throughout Athabasca Valles Outflow System on Mars: A Dynamic Flow Development

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The characterization of surface roughness properties provide context to the nature of geologic terrains, commonly partnered with field-based mapping on Earth and satellite-based photogeologic mapping in planetary sciences. In this study, we combine morphology based facies mapping and perform quantitative roughness analysis and characterization of lava facies for the Athabasca Valles lava flow-field on Mars to identify lava flow features, provide insight into eruption conditions, and link roughness patterns throughout the flow to emplacement conditions. The root-mean-square height (RMS) height and effective slope were acquired at 15m wavelength for 14 unique lava facies using statistically derived components from the Shallow Radar (SHARAD) surface echo strength. Quantitative RMS height surface and near-surface roughness of Athabasca lava features range from 1.09m to 1.76m. We show that the RMS height response is generally consistent with facies transitions confirming the linkage between surficial morphologies and lava flow roughness, including the ability to constrain the relative spatial and temporal evolution of emplacement processes. Roughness patterns and facies localities suggest that the emplacement of Athabasca lava experienced a dynamic progression of local discharge surges and substrate influence on morphology. Additionally, we consider derived roughness from radar sounders, including RMS height a superior tool for distinguishability between most transitional lava facies; however, facies become obscured when distributed over small mapping areas and when characterized by similar topographic features of the same order of magnitude.

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