

LAVA TEXTURE CLASSIFICATION AS A FUNCTION OF SCALE FOR RMS HEIGHT AND AREA RATIO METHODS

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Introduction: Mapping lava flow textures is crucial to understanding the eruptive history of a basaltic volcanic field. Flow textures are the result of conditions affecting the flow during emplacement, including shear strain, viscosity, and surface disruption [1-5]. Maps based on aerial imagery of lava flows frequently rely on qualitative observations of flow morphologies [e.g. 5]. Quantitative measures of roughness have been used to characterize lava flows and other natural surfaces on Earth and other planetary bodies [6-13]. This study examines the impact of data resolution on ability to differentiate lava flow textures using root-mean-square (RMS) height and Area Ratio methods.

Data collection and processing: Aerial imagery from Unmanned Aerial Vehicles was used to create Digital Surface Models (DSMs) at Craters of the Moon (COM) lava field using Structure-from-motion [14]. We downsampled the DSMs to resolutions more typical of satellite data: 0.1, 0.5, 1.0, and 2.0 m/pixel.

Selected measures of roughness: The RMS height is the standard deviation of heights around the mean height within a given window [6-10], while the area ratio is the ratio of the planar area to the surface area [11-13]. Both indicate the roughness of a three-dimensional surface. (For more information, see Mallonee 1, this meeting.) We calculated RMS height and Area Ratio (AR) values for all the downsampled data resolutions using a 3 x 3 pixel moving window in order to avoid numerical effects from varying the number of pixels used between calculations.

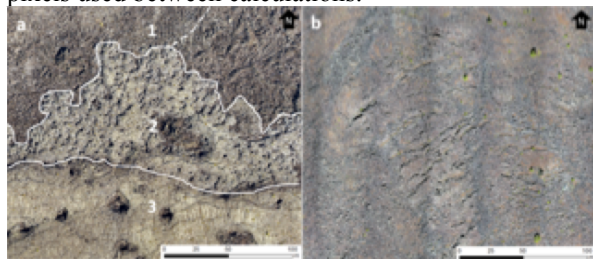


Figure 1: Flow textures in this study: (a1) rubbly pāhoehoe (Big Craters flow), (a2) hummocky pāhoehoe (North Crater flow), (a3) smooth pāhoehoe (North Crater flow), (b) 'a'ā-blocky (Highway flow).

Results: *RMS Height:* At the 0.1 m/pixel resolution, the RMS height distinguished between the 'a'ā-blocky flows and pāhoehoe flows (Figs 2&3). The RMS height showed significantly more detail at resolutions ≥ 0.1 m/pixel, as textural distinctions, including

of the transitional pāhoehoe textures, became more visible. This is due to the varying scales of roughness in the flows, with less height variation occurring over shorter lengths. At all RMS heights, however, it was nearly impossible to differentiate between the inflated rubbly pāhoehoe and hummocky pāhoehoe.

Area Ratio: The Area Ratio output consistently provided clear differentiation between the 'a'ā-blocky and pāhoehoe textures (Figs 2&3). Differences between most of the transitional pāhoehoe textures were

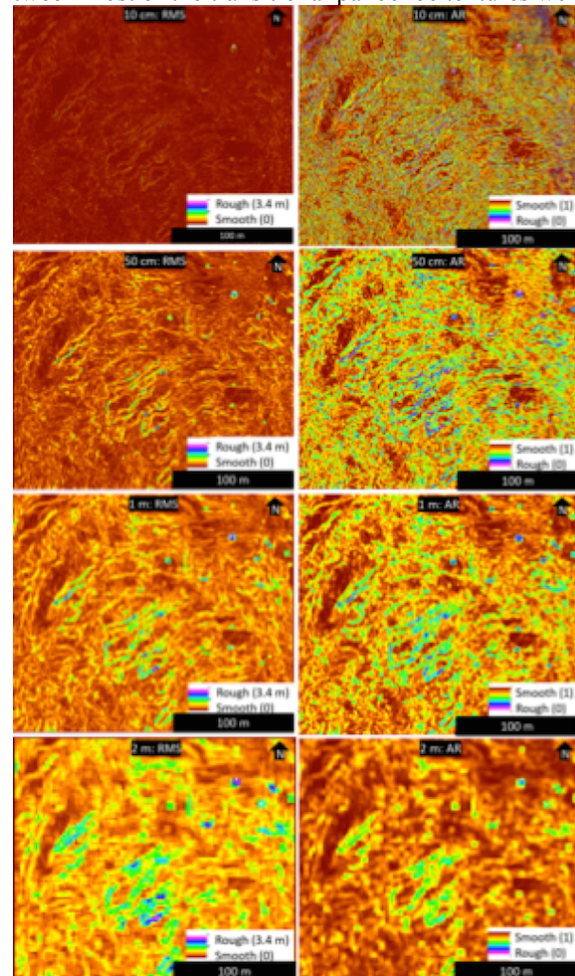


Figure 2: The output for the 'a'ā-blocky lava. visible in the Area Ratio output at all resolutions, however differences between inflated rubbly pāhoehoe and hummocky pāhoehoe faded at resolutions >0.5 m/pixel, as did differences between rubbly and smooth pāhoehoe.

Classification values: The median RMS height value changed significantly for each data resolution (Figure 4a). The lowest median RMS height was consistently the smooth pāhoehoe. The highest RMS height was the 'a'ā-blocky flow – at the 0.1 m/pixel resolution, these values are only 0.02 above the rubbly pāhoehoe values. The difference in median RMS height increases dramatically with decreases in resolution, and so the 'a'ā-blocky flow is always distinguishable. At the 0.1 and 0.5 m/pixel resolutions, the rubbly and hummocky pāhoehoe have similar median RMS heights; however, at the 1 and 2 m/pixel resolutions, the hummocky pāhoehoe has values twice that of the rubbly pāhoehoe.

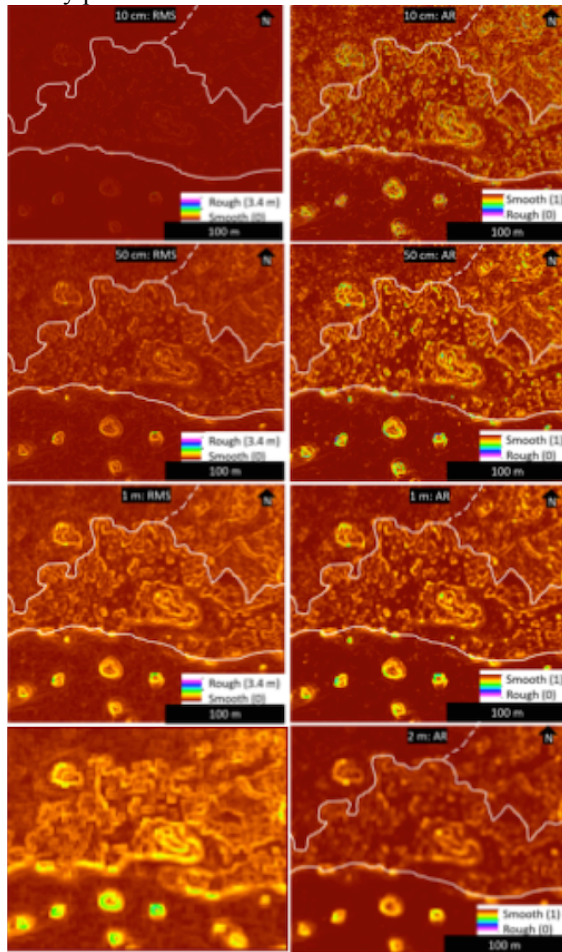


Figure 3: The output for the pāhoehoe region.

The results of the area ratio (Figure 4b) vary from 0 (rough) to 1 (smooth). The 'a'ā-blocky flow had the lowest median Area Ratio, which was <0.97 for every data resolution (Figure 4b). The smooth pāhoehoe had the highest, with values > 0.99. The median Area Ratios for rubbly and hummocky pāhoehoe varied between 0.97 and 0.99 depending on the data resolution, but the hummocky pāhoehoe was 0.02 less than the rubbly at each data resolution.

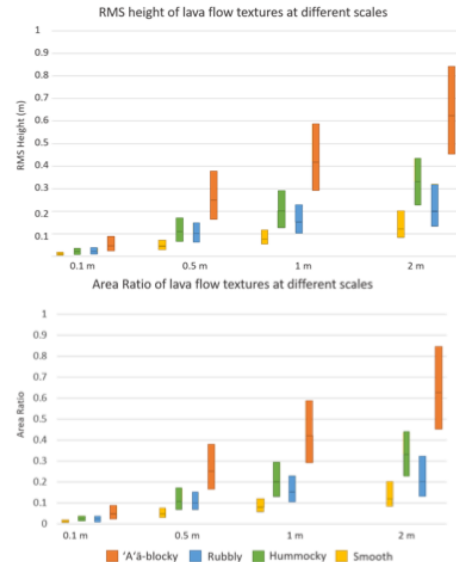


Figure 4a: The RMS height results at 0.1, 0.5, 1, and 2 m/pixel. Figure 4b: The area ratio results.

Ratios for rubbly and hummocky pāhoehoe varied between 0.97 and 0.99 depending on the data resolution, but the hummocky pāhoehoe was 0.02 less than the rubbly at each data resolution.

Conclusion: Both the RMS Height and Area Ratios techniques can be used to distinguish lava flow textures. However, the RMS height is better suited to lower resolution data, and the Area Ratio is better suited to high resolution data. These techniques can aid in mapping lava flows and guide interpretations while identifying planetary lava flows.

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