Abstract 2975

Lava texture classification as a function of scale for RMS Height and Area Ratio methods

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Introduction and research objectives

Mapping lava flow textures is necessary to interpret the conditions under which they were emplaced. Understanding emplacement conditions is crucial to constraining the eruptive history of a volcano.

This study has two main goals:

- To create an objective tool for lava texture classification
- To investigate data resolutions at which surface roughness can differentiate flow textures. Selected measures of roughness include the Root-Mean-Square Height and the Area Ratio.

Data collection and quantitative methods

- High-resolution aerial images were collected using an Unmanned Aerial Vehicle (UAV) at the Craters of the Moon (COM) lava field, Idaho, US. Digital Surface Models (DSMs) were created from these aerial images using Structure-from-motion (ex. Westoby et al., 2012). DSMs were downsampled to resolutions typical of planetary satellite data: 0.1, 0.5, 1.0, and 2.0 m/pixel.
- The RMS Height is the standard deviation of heights about the mean within a given window (ex. Shepard et al., 2001; Neish et al., 2017). The Area Ratio is the ratio of the planar area to the surface area (ex. Jenness, 2004; Grohmann et al., 2011). A 3 x 3 moving window was used. Lava-rise pits and large vegetation were removed prior to calculation of statistics in order to focus on the lava textures. (For more background, see Mallonée, poster 2992.)

Different textures are highlighted at different data resolutions

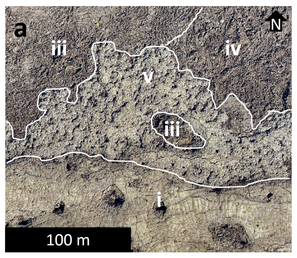


Figure 1a: This area shows smooth pāhoehoe (i), rubbly pāhoehoe (iii), hummocky-rubbly pāhoehoe (iv), and hummocky pāhoehoe (v).

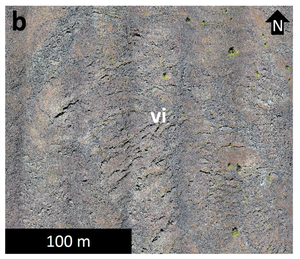
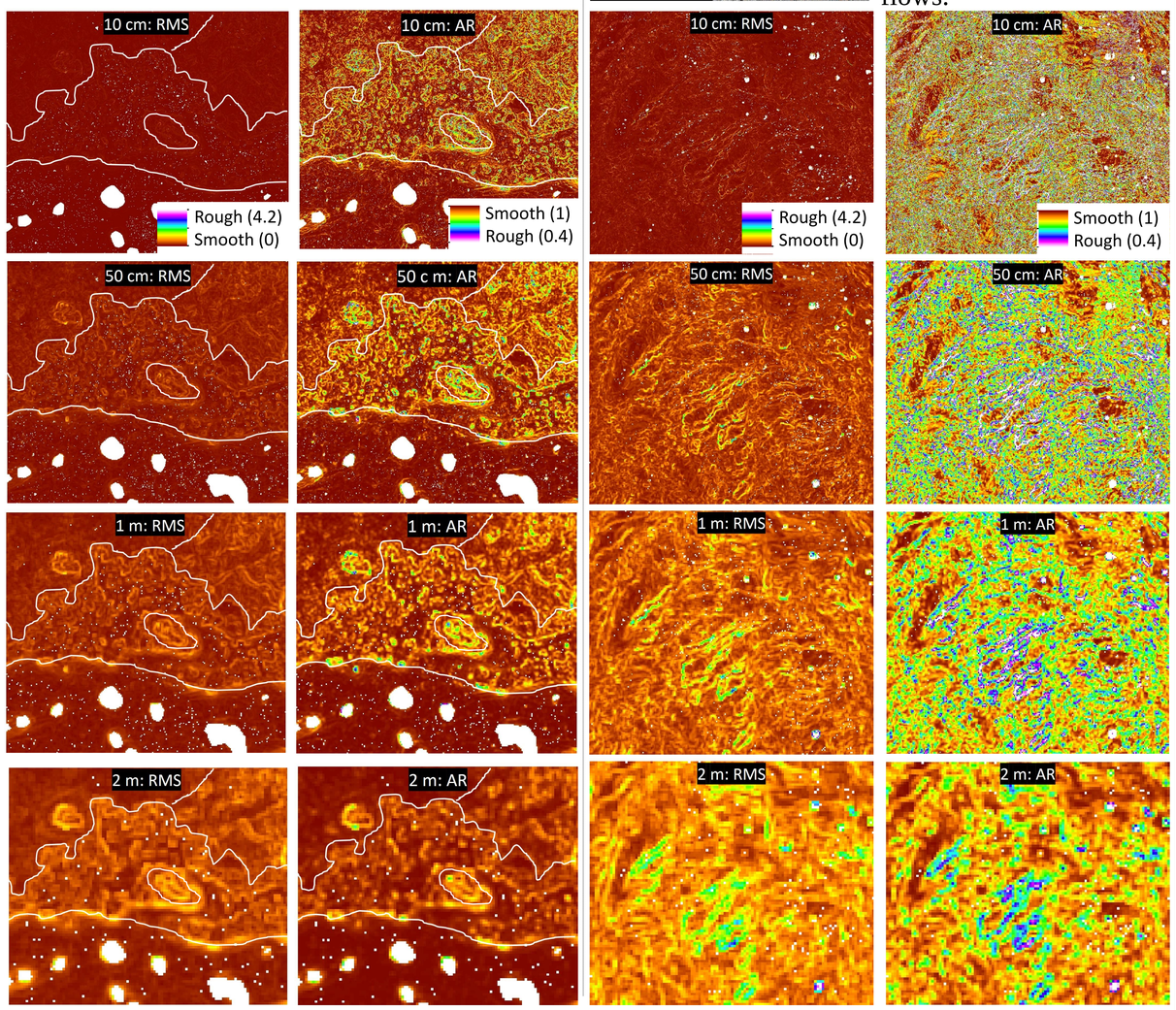


Figure 1b: The texture in Area B is ‘a‘ā-blocky (texture v). This rugged flow (the Highway Flow) is a latite flow, with a slightly more evolved composition than basalt flows.



RMS Height and Area Ratio quantitatively distinguish textures

- ***The mean RMS Height and Area Ratio distinguish some textures***. ‘A‘ā-blocky has a distinct mean (Figure 2a, 2b) at all data resolutions. Also, hummocky pāhoehoe and smooth pāhoehoe have different means from each other at all resolutions.
- ***Intermediate textural distinctions were more distinguishable at resolutions ≥ 0.1 m/pixel.*** Less height variation occurs over shorter lengths, which results in similar values for smooth and intermediate textures.

vi. ‘A‘ā-blocky	v. Hummocky
iv. Hummocky-rubbly	iii. Rubbly
ii. Slabby	i. Smooth

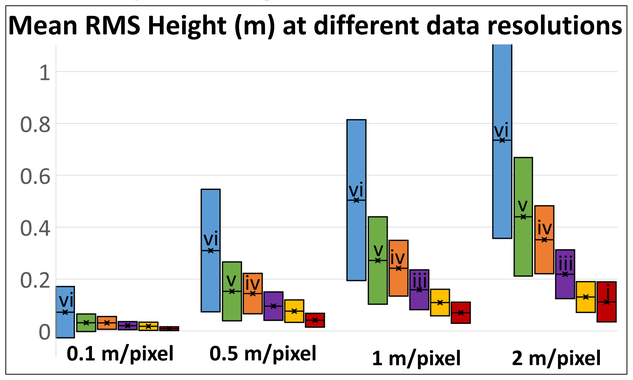


Figure 2a: The RMS Height results for lava textures at the selected resolutions. Note that the mean and one standard deviation are displayed. 27 areas were included in this analysis. See legend to the left for textures.

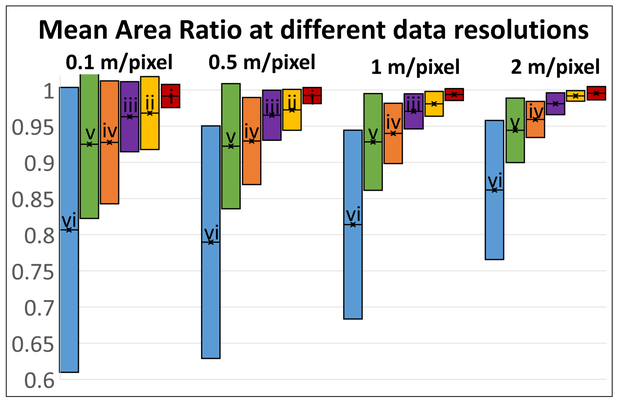
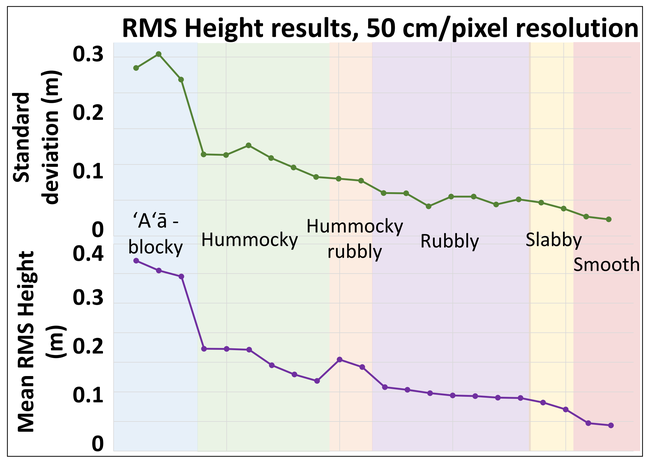


Figure 2b: The Area Ratio results for lava textures at the selected resolutions. Note that the mean and one standard deviation are displayed. 27 areas were included in this analysis. See legend above for textures.

- ***Textures not immediately apparent in visual imagery can be found with these methods.*** Hummocky-rubbly pāhoehoe has RMS Height and Area Ratio values between hummocky and rubbly pāhoehoe, but appears to be rubbly pāhoehoe in aerial imagery (Figure 1a).
- ***As resolution decreases, the range of RMS Height values increases, and the range of Area Ratio results decreases.*** The RMS Height distinguished textures better than the Area Ratio at coarse resolutions and vice versa.

The importance of standard deviation in distinguishing texture

- ***Textures with similar mean RMS Heights or Area Ratios can be distinguished with the standard deviation.*** In Figure 3 (right), hummocky and rubbly textures can result in similar mean RMS Height values. However, the standard deviation of the RMS Heights for each texture are very different. Incorporating the standard deviation thus further constrains the textural classification.



Conclusions

- The RMS Height is more useful at coarse resolutions, and the Area Ratio is more useful at finer resolutions. The mean and the standard deviation should be used to help constrain the texture.
- Additional methods of roughness, including the Allen Deviance and the Hurst Exponent, will be needed to fully characterize intermediate textures. LROC and HiRISE data will be analyzed to assess utility on other planetary bodies.
- These quantitative techniques can be used to map lava flow textures, and can aid in making objective interpretations regarding emplacement conditions and eruptive history of volcanoes on Earth and other planets.

Acknowledgements and Citations

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