Identifying lava surface textures and flow relationships using multispectral thermal infrared data

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Introduction
Thermal emission (TIR) remote sensing of silicic lava flows can detect and map distinct compositions and surface textures. The identification and comparison of the degree and distribution of vesicular textures along flow’s length and between successive flows are relevant to decipher changes in the flow’s thermo-chemistry and volatile content. With recent orbital TIR data acquired during an active silicic eruption, surface textural changes are evident throughout the lava emplacement. The identification of, and changes to, these distributions during an ongoing flow emplacement can improve the understanding of the dynamics and potential hazards.

Results
In DCS red surface regions have higher absorption at shorter wavelengths. The DCS result shows distinct contrast between more distal regions of BGMF (figure 3, black ROI) compared to the central regions. At BGMF (figure 4), lower surface vesicularity is observed on lava flows with lower silica content (black ROI).

The MLDF DCS shows spectral contrast between the central southern regions of the flow (black ROI) compared to the upper marginal regions (figure 5). At MLDF (figure 5), lower surface vesicularity is observed on the central and southern margins of the flow (black ROI) with radial channels of higher vesicularity (black arrows).

The DCS for the Chaitén Volcano highlights the lava dome, with some spectral contrast within its structure (figure 6). At Chaitén Volcano, surface vesicularity generally decreases with distance from the center of the dome with a small region of low surface vesicularity at the very center of the dome (figure 7). Figure 7a was acquired shortly after the 2009 eruption and shows highly variable surface vesicularity. Temporally, the overall dome vesicularity decreases during its continued growth until September 2011.

Methods
First, a decaloration stretch (DCS) was applied to enhance spectral variations in three wavelengths and reveal regions that have significant spectral variability useful for subsequent spectral analysis. Bands 48, 44, 42 and bands 14, 12, 10 were used in the MASTER and ASTER data, respectively.

Secondly, a linear deconvolution model was utilized to detect textural variability, using laboratory TIR emissivity spectra of obsidian and blackbloom (figure 2). These served as endmembers for the model with the blackbloom spectrum mimicking that of exposed vesicles (figure 4,5).

Conclusions and Future Work
Multispectral TIR data is ideal for highlighting individual lava flows, and compositional and textural variability within those flows. Comparing the DCS and image deconvolution images implies there is a correlation between highly vesicular lava surfaces and more silicic compositions, especially as MLDF is nearly compositionally homogeneous and has low vesicularity variability (~28%). As more silicic lavas are generally more viscous and have a higher volatile content it can be inferred that the higher vesicularity lavas at Medicine Lake had slower emplacement velocities and less volatile release. At Chaitén Volcano, we observe more vesicular surfaces at the center of the dome and decreasing vesicularity with time, which indicates progressive volcanic flow after emplacement. Initially, concentric rings of variable vesicularity around the dome could suggest progressive flows, similar to those seen at Medicine Lake. In the 2011 data, we also observed a low vesicularity region on the eastern flank, which could infer a recent partial collapse of the dome.

To validate these interpretations, field samples from Medicine Lake Volcano will be analyzed through both hand sample observations and laboratory TIR spectroscopy. Also, published field observations of the Chaitén eruption will be compared with remote sensing results and interpretations.

Acknowledgements
This research was funded by the National Science Foundation (Geological Hazard Mitigation and Sustainable Development Grant #1200110) and the National Aeronautics and Space Administration (NASA) under Grant Number NNX14AQ96G. The authors would like to thank the ASTER project and science team, and Dr. Watson for reviews.

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