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Comparison of SAM and OBIA as Tools for Lava Morphology Classification - A Case Study in Krafla, NE Iceland

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The Krafla volcanic system is part of the Icelandic North Volcanic Zone (NVZ). During Holocene, two eruptive events occurred in Krafla, 1724-1729 and 1975-1984. The last eruptive episode (1975-1984), known as the "Krafla Fires", resulted in nine volcanic eruption episodes. The total area covered by the lavas from this eruptive episode is 36 km^2 and the volume is about 0.25-0.3 km^3. Lava morphology is related to the characteristics of the surface morphology of a lava flow after solidification. The typical morphology of lava can be used as primary basis for the classification of lava flows when rheological properties cannot be directly observed during emplacement, and also for better understanding the behavior of lava flow models. Although mapping of lava flows in the field is relatively accurate such traditional methods are time consuming, especially when the lava covers large areas such as it is the case in Krafla. Semi-automatic mapping methods that make use of satellite remote sensing data allow for an efficient and fast mapping of lava morphology.

In this study, two semi-automatic methods for lava morphology classification are presented and compared using Landsat 8 (30 m spatial resolution) and SPOT-5 (10 m spatial resolution) satellite images. For assessing the classification accuracy, the results from semi-automatic mapping were compared to the respective results from visual interpretation. On the one hand, the Spectral Angle Mapper (SAM) classification method was used. With this method an image is classified according to the spectral similarity between the image reflectance spectrums and the reference reflectance spectra. SAM successfully produced detailed lava surface morphology maps. However, the pixel-based approach partly leads to a salt-and-pepper effect. On the other hand, we applied the Random Forest (RF) classification method within an object-based image analysis (OBIA) framework. This statistical classifier uses a randomly selected subset of training samples to produce multiple decision trees. For final classification of pixels or – in the present case – image objects, the average of the class assignments probability predicted by the different decision trees is used. While the resulting OBIA classification of lava morphology types shows a high coincidence with the reference data, the approach is sensitive to the segmentation-derived image objects that constitute the base units for classification.

Both semi-automatic methods produce reasonable results in the Krafla lava field, even if the identification of different pahoehoe and aa types of lava appeared to be difficult. The use of satellite remote sensing data shows a high potential for fast and efficient classification of lava morphology, particularly over large and inaccessible areas.