

Emplacement dynamics and lava field evolution of the flood basalt eruption at Holuhraun, Iceland: Observations from field and remote sensing data

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The Holuhraun eruption (Aug 2014- Feb 2015) is the largest effusive eruption in Iceland since the Laki eruption in 1783–84, with an estimated lava volume of ~ 1.6 km³ covering an area of ~ 83 km². The eruption provides an unprecedented opportunity to study i) lava morphologies and their emplacement styles, ii) Morphological transitions iii) the transition from open to closed lava pathways and iv) the implication of lava pond formation.

This study is based on three different categories of data; field data, airborne data and satellite data. The field data include tracking of the lava advancement by Global Positioning System (GPS) measurements and georeferenced GoPro cameras allowing classification of the lava margin morphology. Furthermore, video footage on-site documented lava emplacement. Complimentary observations have been provided from aircraft platforms and by satellite data. Of particular importance for lava morphology observations are 1–12 m/pixel airborne Synthetic Aperture Radar (SAR) images (x-band), as well as SAR data from TerraSAR-X and COSMO-SkyMed satellites.

The Holuhraun lava field comprises a continuum of morphologies from pāhoehoe to ‘a‘ā, which have varied temporally and spatially. Shelly pāhoehoe lava was the first morphology to be observed (08-29). Spatially, this lava type was not widely distributed, but was emplaced throughout the eruption close to the vent area and the lava channels. Slabby pāhoehoe lava was initially observed the 08-31 and was observed throughout most of the eruption during the high-lava-flux phase of new lava lobe emplacement. ‘A‘ā lavas were the dominating morphology the first three months of the eruption and was first observed 09-01 like Rubbly pāhoehoe lava. Finally, Spiny pāhoehoe lava was first observed the 09-05 as a few marginal outbreaks along the fairly inactive parts of the ‘a‘ā lava lobe. However, throughout the eruption this morphology became more important and from mid-November/beginning of December the spiny pāhoehoe was the main type of lava emplacement. The morphological transitions observed in the field has been summarized in a transformation cycle, where the main cycle revolve from ‘a‘ā to rubbly and slabby pāhoehoe lava morphologies. As these morphologies come to rest, outbreaks of degassed, cooler and more viscous lava would form irregular spiny lobes. A continued low discharge, high viscosity lava supply to these lobes would result in inflation and new break outs of spiny pahoehoe lobes that eventually would create a compound lava field.

Overall, the Holuhraun lava field evolution has been divided into three main phases. Phase 1, which was dominated by open lava channels, and horizontal stacking of 1 km sized ‘a‘ā branches (31 August to mid-October). Phase 2 was dominated by lava pond formation east of the vent area and became the dominant distributary center for lava emplacement during this period (Mid-October to December). Finally, in phase 3, closed lava pathways, inflation and vertical stacking became increasingly important, dominating type of lava emplacement in the end of the eruption (December to 27th February).