Statistical classification of tephra from rootless eruptions

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Rootless cones (RCs) are classified into a peculiar type of pyroclastic cones formed by lava-water interaction (Thordarson and Hoskuldsson, 2002). Different from other cone-forming eruptions the size is generally small so that they can be used as a miniature of volcanic eruptions which unite between large scale natural eruptions and laboratory scale experiments. In this context, the data about the morphology of the edifice as well as physical characteristics of eruption products (hereafter called as rootless tephra) are important in the comparison although the available data are quite limited until recently. In the recent decade there appear several researches on the RCs in Iceland mainly from planetological interests (Reynolds *et al.*, 2015; Noguchi *et al.*, 2016; Hamilton *et al.*, 2017; Fitch *et al.*, 2017). Fitch *et al.*, 2017 investigated detailed grain morphology of rootless tephra and found correlation among mean grain size and tephra morphologies; blocky, mossy, fluidal, shard, and aggregate. The study is based on the analysis of morphological classification for about 100 hand-picked grains. The results seem interesting but always associated with morphological investigations the limited numbers of specimens and the sampling uniformity are controversial.

In this study we investigated morphology of rootless tephra by using automated particle-morphology analyzer. Thanks to the recent advances of the device, we can obtain information of morphology for thousands of grains in a short time. By using this device we try to overcome the above-mentioned problems. The target samples were collected in three fields of RCs in Iceland (Myvatn, Landbrot and Thjorsardalur). We used seven parameters to characterize the morphology: aspect ratio, circularities (circularity and high-sensitivity one), convexity, solidity, intensities (mean and standard deviation) which are measured on Morphologi G3S[TM] (an automated particle analyzer, Malvern Instrument[TM]) in AIST. The target of this investigation is to explore the magnitude of lava-water interaction of rootless eruptions in comparison with other phreatomagmatic/phreatic eruptions based on the morphology of tephra.

In the analysis we seek possible correlations between morphological parameters and the magnitude of rootless eruptions (volume and average slope of the cone). We found that transparent elongated-irregular shaped grains are notable in the samples which were collected from the lower layer of RCs. Looking at the images of specimen, these grains include bubbles and/or bubble walls. This might indicate the lava which was still at the degassing stage was quenched and fragmented at the beginning of rootless eruptions. To verify this idea, the bubble and crystal size and density analyses are necessary.

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