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Three-dimensional textural analysis of products from the 1997 Vulcanian explosions of Soufrière Hills Volcano, using X-ray computed microtomography

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X-ray computed microtomography is a powerful, non-destructive method for imaging textures and for quantifying vesicle spatial relationships and size distributions. It was applied to one breadcrust bomb and three pumices from the 1997 Vulcanian explosions of the Soufrière Hills Volcano, Montserrat. A detailed 2D textural study of these same samples, including high-resolution vesicle size distributions, has already been carried out. In order to cover the wide range of vesicle and crystal sizes (few μm to a few hundreds of μm), we acquired tomographic images at three magnifications (0.37, 4.0 and 17.4 μm voxel-1) on each sample. Each magnification covers only part of the whole vesicle size range, but with large overlaps. Vesicle walls were reconstructed using ImageJ and 3DMA_Rock softwares, and a Matlab code was written to combine the data from the three stacks and to calculate vesicle size and sphericity distributions for the whole sample.

Comparison with the 2D results show only minor differences in the vesicle size distributions. Cumulative vesicle number densities obtained by the two methods are of the same order of magnitude ($\sim$1015 m-3 of glass). Three vesicle populations are recognized in the samples, the same three recognized in 2D, although minor shifts in modes are observed. As in 2D, vesicle sphericity decreases with size, vesicle shape being progressively more complicated as the vesicle grows and coalesces with neighbours.

Coalescence in all samples appears to occur between neighbouring vesicles of any sizes, but, as intuitively expected, the larger the vesicle, the more connected it is. Our results show that coalescence affected indifferently pre- and syn-eruptive bubbles. This suggests that the syn-eruptive gas was rapidly connected to large-scale pathways through which it could escape. Depending on clast permeability, this mechanism has the potential to double the amount of gas available for propulsion of the Vulcanian jet.