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The third dimension and the study of vesicle textures in volcanic rocks

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The textures of volcanic rocks have long proved to provide important constraints on processes occurring in magma chambers, volcanic conduits and beyond the craters during magma emplacement on the volcano flanks. Information on the vesiculation and deformation history of magmas may be obtained for example by investigating the size, shape, distribution and content of vesicles in eruptive products. One approach to address this topic was to acquire 2D images of volcanic samples via optical and/or scanning electron microscopy on areal clast sections (i.e. thin sections). This procedure has the advantage of offering a fast qualitative inspection of volcanic textures in 2D, and can prove useful for eruption monitoring purposes. However, because it provides no direct information in the third dimension, it cannot be used to investigate the internal structure of volcanic materials, limiting the inferences that can be made on eruption dynamics. Recently, the application of X-ray computed microtomography to geological specimens has opened the opportunity to visualize the internal structure of porous materials, such as volcanic scoria and pumice clasts, in 3D. With this contribution we will first demonstrate how we reconstructed the 3D vesicle textures in volcanic products from eruptions at Stromboli, Etna, and Campi Flegrei, as well as from experimental products of degassing experiments. We will compare the 3D results with 2D results and then describe how we used the 3D results to constrain the dynamics of vesiculation and degassing in basaltic and trachytic magmas, and, ultimately, the implications of this on the eruptive style of active, hazardous volcanoes.