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Understanding how active volcanoes work: a contribution from synchrotron X-ray computed microtomography

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Volcanoes are complex systems that require the integration of many different geoscience disciplines to understand their behaviour and to monitor and forecast their activity. In the last two decades an increasing amount of information on volcanic processes has been obtained by studying the textures and compositions of volcanic rocks. Five years ago we started a continuing collaboration with the SYRMEP beamline of Elettra Sincrotrone, a third generation synchrotron light source near Trieste, Italy, with the goal of performing high-resolution, phase-contrast X-ray tomographic scans and reconstructing 3-D digital volumes of volcanic specimens. These volumes have been then used for the visualization of the internal structure of rocks and for the quantification of rock textures (i.e., vesicle and crystal volume fraction, individual vesicle volumes and shapes, vesicle connectivity, vesicle volume distributions, permeability simulations etc.). We performed tomographic experiments on volcanic products erupted from different hazardous volcanic systems in Italy and around the world: Campi Flegrei, Stromboli, Etna (Southern Italy), Villarrica (Chile), Yasur and Ambrym (Vanuatu Islands). As an example, we used the results of these studies to constrain the dynamics of vesiculation and degassing in basaltic (Polacci et al., 2006; Burton et al., 2007; Colò et al., 2007; Andronico et al., 2008; Polacci et al., 2008a) and trachytic (Piochi et al., 2008) magmas. A better knowledge of how gas is transported and lost from magmas has led us in turn to draw new implications on the eruptive style of these active, hazardous volcanoes (Polacci et al., 2008b). Work in progress consists of optimizing our procedure by establishing a precise protocol that will enable us to quantitatively study the 3-D texture and composition of rocks in a statistically representative way. Future work will concentrate on the study of the spatial relations between phases (crystals, vesicles and glass) in rocks and their implications on the rheological properties of magmas and on the intensity of explosive activity at volcanoes.

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