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Permeability of alkaline magmas: a study from Campi Flegrei, Italy

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Knowledge of permeability is of paramount importance for understanding the evolution of magma degassing during pre-, syn- and post-eruptive volcanic processes. Most permeability estimates existing to date refer to magmas of calc-alkaline compositions. We report here the preliminary results of permeability measurements performed on alkali-trachyte products erupted from the Campanian Ignimbrite (CI) and Monte Nuovo (MTN), two explosive eruptions from Campi Flegrei (CF), an active, hazardous caldera west of Naples, Southern Italy. Darcian (viscous) permeability spans a wide range between 10-11 and 10-14 m2. We observe that the most permeable samples are the scoria clasts from the upper units of MTN; pumice samples from the Breccia Museo facies of CI are instead the least permeable. Non-Darcian (inertial) permeability follows the same trend as Darcian permeability. The first implication of this study is that porosity in alkaline as well as calc-alkaline magmas does not exert a first order control on permeability (e.g. the MTN samples are the most permeable but not the most porous). Second, sample geometry exhibits permeability anisotropy (higher permeability in the direction of vesicle elongation), suggesting stronger degassing in the vertical direction in the conduit. In addition, inertial effects are higher across the sample. As inertial effects are potentially generated by tortuosity (or tortuous vesicle paths), tortuosity is likely higher horizontally than vertically in the conduit. Finally, the measured CF permeability values overlap with those of rhyolitic pumice clasts from the Kos Plateau Tuff (Bouvet de Maisonneuve et al., 2009), together with CI one of the major Quaternary explosive eruptions of the Mediterranean region. This indicates that gas flow is strongly controlled by the geometry of the porous media, which is generated by the bubble dynamics during magma ascent. Therefore, permeability will depend on composition through the rheological properties of the magma. Preliminary results indicate in fact that there are variations in the correlation between permeability of magmas with different composition and viscosity and the style of eruptive activity.