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Integration of porosity, connectivity and permeability measurements to determine syn-eruptive degassing processes during a sub-plinian basaltic eruption

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Degassing of the volatile phases is considered to have a major control on the eruption dynamics, particularly in controlling shifts between explosive and extrusive eruption styles. The sub-plinian eruption of the basaltic monogenetic La Vache and Lassolas cone complex in the Chaîne des Puys, France, about 8600 years ago, was an unusual large event that raises the question of the processes that controlled the explosivity of non-differentiated magma and the evolution of this sub-plinian event. This study combines the results of density, porosity, connectivity and permeability measurements of juvenile clasts to determine the state of vesiculation and the presence of open degassing pathways within the melt prior to fragmentation. The volume of connected vesicles is measured using a Helium-Pycnometer, while permeability measurements are conducted using a permeameter recently built at the Laboratoire Magma et Volcans, following Takeuchi et al. (2008). The permeameter has broad measurement ranges of pressure difference (10^1-10^5 Pa) and gas-flow rate (10^{-9}-10^{-5} m^3/s). These ranges enable us to measure viscous (Darcian) permeability in the range of 10^{-17}-10^{-9} m^2 for 1 centimetre-scale samples (such as scoria clasts) using the Forchheimer equation (Rust and Cashman, 2004) that accounts for inertial effects caused by non-laminar flow at high gas flow rates. This technique is a relatively new approach to determine the permeability of quenched samples. The integration of porosity and connectivity measurements provides information about the percentage of connected and isolated vesicles, with the connected vesicles forming potential degassing pathways. Our results show that the permeability and the vesicularity of the La Vache and Lassolas pyroclasts correlate very well, defining a trend that is also shown by the permeability data derived from the literature for the Cascades (Saar and Manga, 1999) and the Ambrym volcano (Polacci et al., 2012). The connectivity data of the samples, however, show that the vesicles in each clast are fully connected to each other, while the permeability of the clasts varies by two orders (10^{-11}-$10^{-13}$$m^2$). Textural analysis of the different vesicle networks will give better insights into the cause of this discrepancy. These interesting results indicate the importance of both connectivity and permeability measurements and textural analysis for the evaluation of the presence of a vesicle network and the potential for degassing prior to fragmentation.

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