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Lattice-Boltzmann simulation on vesicular Stromboli basalt glass

L. Bai (1), D. Baker (1), R. Hill (2)

(1) Earth and Planetary Sciences, McGill University, Canada, (2) Department of Chemical Enginering and McGill Insitute for Advanced Materals, McGill University, Canada (bailping@eps.mcgill.ca / Fax: +1 514-3984680 / Phone: +1 514-3987485)

The permeabilities (k) of experimentally produced, vesicular samples of Stromboli basalt were calculated using Lattice-Boltzmann simulations. The porosity (Φ) structure of the samples was measured with 3D tomographic image analysis and the tomograms used as input for the simulations. The simulation results indicate that the permeability-porosity function follows a power-law relationship, with k = $2.1^{-10} \times \Phi^{4.91}$for porosities between 2.9% and 83.1%. The calculated permeability of the samples is in the range of 10^{-17} to 10^{-14} m^2 below the percolation threshold of $\sim$ 27%; the permeability increases markedly by about 2 orders of magnitude at the percolation threshold, and the calculated permeability falls in the range of 10^{-13} to $10^{-9}m^2$above the percolation threshold. Our maximum calculated permeabilities are about 2 orders of magnitude higher than the measured permeabilities of silicic volcanic rocks at high porosity ($>$30%). The high permeabilities we calculated are attributed to two mechanisms: one is that the low viscosity of Stromboli basaltic melts easily leads to rupture of bubble walls during bubble coalescence at high porosity ($\sim$ 30% to 65%); the other is that basaltic melt degassing tends to reach equilibrium at higher porosity ($\sim$ 65% to 83%) than silicic melts, which results in bubble coalescence by rupture of the plateau borders of bubbles, increasing the interconnectivity of the bubble net-work.