CONDUIT FLOW DYNAMICS OF ALKALINE VS CALC-ALKALINE ERUPTION BY NUMERICAL MODELING AND PUMICE TEXTURES

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We have performed a parametric study on the dynamics of trachytic (alkaline) versus rhyolitic (calc-alkaline) eruptions by employing a steady, isothermal, multiphase non-equilibrium model of conduit flow and fragmentation. The employed compositions correspond to a typical rhyolite and to trachytic liquids from Phlegrean Fields eruptions, for which detailed viscosity measurements and modeling have been performed. Conditions investigated include conduit diameters in the range 20-90 m and total water contents from 2 to 6 wt%, corresponding to mass flow-rates in the range 106-108 kg/s. Results show that rhyolites fragment much deeper in the conduit and at a gas volume fraction ranging 0.65-0.75, while for trachytes fragmentation is found to occur at higher vesicularities (0.80-0.85) and at much shallower levels. The complex, non-linear relationships between mass flow-rate and magma composition were investigated. An unexpected result is that low-viscosity trachytes can be associated with lower mass flow-rates with respect to more viscous rhyolites. This is due to the combined effect of viscosity and water solubility affecting the whole eruption dynamics. While mixture viscosity is lower for trachytes, delayed fragmentation for this magma composition implies a longer bubbly flow region, where viscous forces are dominant. Therefore, the total dissipation due to viscous forces can be higher for the less viscous trachytic magma. The results of the simulations agree with textural characteristics presented by natural pumice clasts of both magma compositions. Measured vesicularities range from 0.80 up to more than 0.90 in pumice products of alkaline eruptions at Phlegrean Fields, while they tend to be lower (0.68-0.85) in calc-alkaline pumices, consistent with magma vesicularities at fragmentation as obtained from the simulations. Higher vesicularities in alkaline products are ascribed to the lower viscosity and delayed fragmentation of magmas with this composition. Despite large differences in
the distribution of flow variables occurring in the deep conduit region and at fragmentation, the flow dynamics of rhyolites and trachytes in the upper conduit and at the vent are very similar, for equal conduit size and total water content. This is consistent with similar characteristics for eruptions and associated deposits of the two magma types.