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Textural and geochemical constraints on eruptive style of the 79AD eruption at Vesuvius

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The 79AD eruption of Vesuvius, also known as the “Pompeii eruption”, is the reference for one of the explosive eruptive styles, the plinian-type eruption. The eruption involved H2O-rich phonolitic magmas and is commonly divided into three phases: an initial phreatomagmatic phase, followed by a plinian event which produced a thick pumice fallout deposit and a final phase that was dominated by numerous column-collapse events. During the plinian phase, a first white pumice fallout was produced from a high steady eruptive column, followed by a grey pumice fallout originated by an oscillatory eruptive column with several partial column collapse events. This study focuses on the pumice fallout deposits, sampled in a proximal thick section, at the Terzigno quarry, 6 km southeast of the present crater. In order to constrain the degassing processes and the eruptive dynamics, major element compositions, residual volatile contents (H2O, Cl) and textural characteristics (vesicularity and microcrystallinity) were studied.
A previous study that we performed on the pre-eruptive Cl content has shown that Cl may be used as an indicator of magma saturation with Cl-rich fluids and of pre-eruptive pressures. Cl contents measured in melt inclusions show that only the white pumice and the upper part of the grey pumice magma were H2O saturated prior eruption. Large variations in residual volatile contents exist between the different eruptive units and textural features strongly differ between white and grey pumice clasts but also within the grey pumice clasts. The degassing processes were thus highly heterogeneous: the white pumice eruptive units represent a typical closed-system degassing evolution whereas the first grey pumice one, stored in the same pre-eruptive saturation conditions, follows a particular open-system degassing evolution. Here we propose a new model of the 79AD eruption where pre-eruptive conditions (H2O saturation, magma temperature and viscosity) are the critical parameters which determine the diversity of the syn-eruptive degassing processes and hence the eruptive dynamics. We suggest that the oscillatory regime that dominates the grey pumice eruptive phase is linked to the pre-eruptive water undersaturation of most part of the grey magma and to the time delays necessary for H2O exsolution.