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The Tufo Giallo della Via Tiberina eruptions (Sabatini Volcanic District, Roman Province): insights on H2O- and temperature-zoning in magma chambers

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Textural and chemical variations of juvenile clasts are widely observed features in pyroclastic deposits. In particular, the co-existence of whitish, pumiceous, and dark-grey, scoriaceous, juvenile clasts has been observed in many eruptive units of well-known volcanoes (i.e. Somma-Vesuvius, Vulsini, Colli Albani, Stromboli). Here we report the example of the Tufo Giallo della Via Tiberina (TGVT) pyroclastic succession, which comprises two eruptive units emplaced at ca. 561 and 548 ka, during the early explosive activity of the Sabatini Volcanic District (0.8-0.08 Ma; Roman Province, central Italy). TGVT deposits are characterized by coexisting whitish pumice and black-grey scoria juvenile clasts showing homogeneous phonolitic composition in spite of different textural features: white pumice is vitrophyric and highly vesicular and contains scarce, >50 μm-sized, feldspar and clinopyroxene crystals; black-grey scoria is highly crystallized and poorly vesicular and contains abundant leucite phenocrysts. The diffuse occurrence of leucite phenocrysts in black-grey scoria records crystallization at H2O-undersaturated, P=150-200 MPa and T=890-920°C conditions, while the vitrophyric texture of white pumice indicates H2O-saturated conditions and higher temperature (T=920-940°C). On these grounds, the phonolitic magma chamber feeding the TGVT eruptions is modelled as a temperature- and H2O-zoned system. The emission of white pumice from the inner zone of the magma chamber at the onset of individual eruptive events was mostly controlled by water diffusion from the cooler, highly crystallized, peripheral magma chamber portions. By considering a near-concentric geometry for the TGVT magma chamber, the inward water diffusion from peripheral toward inner and smaller portions of the magma reservoir progressively increased the H2O content in the magma up to saturation. In this regard, evidence of re-melting, i.e. glass embayment and rounded-shapes and of sanidine in white pumice, records the effect of a progressive increase in H2O content by a reduction of feldspars+leucite stability field in the inner portion of the magma chamber. Then, emission of black-grey scoria toward the end of the eruptions was driven by the decompression induced by the withdrawal of white pumice magma that increased the stability fields of leucite and plagioclase, thus causing H2O-oversaturation of the cooler, highly crystalline peripheral portions of the magma chamber.

A number of volcanic eruptions involving the emplacement of both vitrophyric and crystalline juvenile clasts of similar bulk composition could be re-interpreted in the light of a H2O-zoned model. Moreover, present model may also explain the eruption of large volumes of vitrophyric juvenile material for which pre-eruptive H2O-oversaturation cannot be driven by a simple fractional crystallization process.