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Metal transport in magma

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The recent rhyolitic eruptions of Chaitén and Cordón Caulle volcanoes in Chile threw the spotlight on hybrid explosive-effusive volcanism and the role of fragmentation and fracturing of magma in mediating gas and metal mobility. The deposits of both eruptions contain tuffisite veins, which result from the pre-eruptive or syn-eruptive release of gas and deeper-fragmented magma through fractures in country rock or conduit-filling magma. Tuffisite veins are associated with element mobility resulting in both depletions and enrichment of elements in both the vein walls and vein-filling material. Water and metal diffusion profiles have been used to constrain the lifespan of the veins from minutes to hours, timescales consistent with observations of explosions during the eruption at Cordón Caulle. During this time gases and particles are advected through vein networks within the shallow conduit. These gases are derived mostly from deeper, partially fragmented and outgassing magma and are enriched in metals. Elements are redistributed between the gas, the host and the vein-filling material.

This contribution looks closer at the spatial distribution of elements between the host and vein-filling pyroclasts, and the processes by which the elements are redistributed at different levels within the shallow conduit by magma-gas interaction. Three tuffisite veins with similar appearance and from the 2008-2011 eruption were studied using tandem LIBS-ICP-MS analysis of 5 broad groups of components: host, angular nearly aphyric clasts, vesicular near-aphyric clasts, microcrystalline clasts, and the matrix of sintered ash, to learn more about the source and processes leading to enrichment. We find that the three veins have different H and Cl concentrations suggesting formation at different depths. The matrix and the microcrystalline clasts consistently are depleted in major and incompatible trace elements. They are however enriched in volatile metals (e.g. Cu, In, Cd, Sb) and in this enrichment and the metal associations the veins differ. Multivariate analysis suggests that the depletion in most and enrichment in some elements are the result of a single process of mobilization and redistribution of elements.