Chemical heterogeneity in rhyolite caused by magma degassing

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Gas moves through magma via bubbles and fractures. During this transport (open system degassing, gas fluxing or streaming), elements are continually redistributed between melt and gas phase. However, this redistribution takes time and not all elements can keep up. Hence, magma is likely to be heterogeneous with respect to volatile elements. The extent of this heterogeneity is determined by the volatilities and the diffusivities of the elements, and time. Maps of the chemical heterogeneity of magma can therefore provide an insight into the flux of gases through magma directly preceding an eruption.

In this contribution we show that tuffisite veins, glass-filled fractures formed when magma fragments during deformation and degassing within the conduit, are associated with both enrichments and depletions of volatile elements. A rhyolitic tuffisite vein within an obsidian-rimmed bomb erupted from Chaitèn volcano (Chile) in 2008 is enriched in As, Pb, Zn, Sb and Mo and depleted in Li. In contrast, a tuffisite vein from Torfajökull (Iceland), from a shallow dissected lava-filled conduit, is depleted in all measured elements. Both veins locally contain vesiculated clasts, which are enriched in volatile elements compared to the host glass.

From the spatial distribution of the chemical variations we were able to estimate a total gas flux through the veins showing that tuffisite veins form highly efficient gas pathways, which channel pre-exsolved volatiles to the surface. We also infer significant vertical transport of clasts within interconnected tuffisite vein networks, indicating that degassing pathways may extend hundreds of metres below the surface.