

Evaluating mantle oxygen fugacity proxies along the Reykjanes Ridge

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Mantle oxygen fugacity (fO_2) controls the speciation of volatile elements and as a consequence melting processes within the Earth's silicate mantle. In order to understand the geochemical evolution of the solid Earth and its forcing on the surface environment through volcanic activity, it is therefore important to precisely know the fO_2 of the mantle.

Mantle fO_2 has been constrained using the ferric iron content (Fe^{3+}/Fe^{tot}) or trace element ratios (V/Sc) of basaltic lavas [e.g. 1,2]. Transition metal isotopes have also been proposed as possible tracers of fO_2 [e.g. 3]. However, fO_2 values calculated using various methods can show a striking difference of more than 1 log unit relative to the QFM (quartz-fayalite-magnetite) reference buffer. Potential sources of error in these calculations include the presence of lithological source heterogeneities, the different sensitivities of the proxies to low pressure differentiation, and fO_2 changes in the magma driven by the degassing of volatiles.

Here we investigate a well-characterised suite of submarine glasses from the Reykjanes Ridge (Iceland), which show systematic changes in trace element, radiogenic isotopes and (Fe^{3+}/Fe^{tot}) with distance from Iceland [4,5]. As such, they provide an ideal test case to evaluate the co-variation of potential redox proxies. We present new laser ablation trace element data alongside stable vanadium isotopic compositions of glasses spanning the range of (Fe^{3+}/Fe^{tot}) and distance from Iceland. We investigate the interplay between melting, potential lithological heterogeneity, degassing and fractional crystallization to evaluate the cause(s) of disagreement in fO_2 estimates between the redox proxies.

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