Oxidation state of melt generated at the site of mantle metasomatism

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Arc magmas are generally more oxidised than mantle derived magmas from other tectonic settings and the cause of this difference remains controversial. The main hypotheses suggest either that arc magmas inherit their higher oxidation from the mantle source or that oxidation occurs through secondary processes, such as fractionation or degassing. Although metasomatised xenoliths from arc settings appear to be relatively oxidised, and the oxidation state of arc lavas correlates with indicators of slab fluid involvement (e.g. Ba/La)[1], direct evidence linking melting of metasomatised mantle with the genesis of oxidised magma is still missing.

In this study we used X-ray absorption near edge structure spectroscopy (XANES) to measure the $Fe^{3+}/\Sigma Fe$ of silicate glasses preserved in mantle xenoliths from Victoria, Australia. These xenoliths sampled metasomatised mantle and contain hornblende and phlogopite that were partially melted and quenched upon eruption to produce silicate glasses. Metasomatic alteration may have occurred during subduction preceding the mid-Ordovician Delamerian Orogeny, whereas the melting event is associated with decompression during the eruption that brought the xenoliths to the surface, about 5000 years ago.

Our results show that melt generated by the break down of metasomatic phlogopite and hornblende has high $Fe^{3+}/\Sigma Fe$ ratio ranging from ~0.15 to ~0.25. These values are similar to those of primary arc melts [1], indicating that: i) the relative oxidation of metasomatic assemblage is directly transferred to the partial melt, and ii) the high $Fe^{3+}/\Sigma Fe$ of arc magmas can be a primary feature directly inherited from metasomatised mantle, not requiring secondary processes *en-route* to the surface.

[1] Brounce N. M., Kelley K.A., Cottrell E., 2014. Variation in $Fe^{3+}/\Sigma Fe$ of Mariana arc basalts and mantle wedge fO_2. Journal of Petrology, 55, 2513-2536.