

Melting of a partially oxidised upper mantle: an oxygen filter for the Earth?

R. Myhill*¹ D. J. Frost¹

¹ Bayerisches Geoinstitut, University of Bayreuth, 95440 Bayreuth, Germany

Several lines of evidence suggest that Earth's mantle became oxidised early in its history. Likely factors contributing to the progressive oxidation of the mantle are recycling of an oxidised surface and iron disproportionation in the lower mantle. For example, efficient loss of iron after the formation of ferric-rich perovskite could leave the lower mantle with about 40% of iron as Fe³⁺.

The evolution of oxygen concentration and homogeneity within the Earth's mantle remains poorly understood. This evolution is important as mantle redox state would have been a key control on the composition of late core-forming liquids and the early atmosphere.

Here, we investigate the effect of ferric iron on solidus temperatures in the upper mantle. Multi-anvil experiments performed at 6 GPa show that the addition of ferric iron to mantle compositions causes a profound decrease in melting temperatures, especially in Si- and Al-poor compositions where ferric iron cannot be incorporated into garnet or spinel. Melts in equilibrium with olivine, pyroxene and garnet are stabilised at <1673 K. We suggest that the formation of dense Fe³⁺-rich melt during upwelling of partially oxidised material could act as a mantle oxygen filter, reducing residual ferric concentrations and redistributing oxygen to more reduced regions.

* Corresponding author: bob.myhill@uni-bayreuth.de