

A vanadium-based redox proxy for eclogites

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Eclogites may detail spatiotemporal variations in the redox state of fluids passing through the subduction system [1], or they may retain information about the oxygen fugacity (fO_2) of their MORB protolith [2]. Determining the fO_2 s recorded by metabasalts, and the geological significance of these values, requires an eclogite redox proxy that can be easily applied and will not be reset by mantle metasomatism.

We present an empirical oxybarometer for eclogites that utilizes the redox-dependent exchange of the multivalent trace element vanadium (V) between phases. We have determined how the incorporation of V in rutile, pyroxene, garnet and silicate melt changes as a function of oxygen fugacity ($\log fO_2 = \text{QFM}-3$ to $\text{QFM}+5$), temperature (850-1050 °C) and pressure (1.2-2 GPa). Vanadium is extremely soluble in rutile, with rutile/melt partition coefficients ($D_{V_{\text{rt/melt}}}$) for V similar to those obtained for Nb and Ta at fO_2 s where V^{4+} is most abundant [3]. Vanadium compatibility in rutile is an order of magnitude greater than in pyroxene or garnet at all conditions investigated and V compatibility in all mineral phases increases down temperature. The greater solubility of V^{4+} and V^{5+} in rutile relative to other phases drives a linear increase in rutile/mineral partitioning of V over an eight-log unit change in oxygen fugacity. We have calibrated V partitioning between rutile and pyroxene for use as an empirical oxybarometer that can be applied to natural eclogites by measuring the distribution of V between coexisting phases. We apply the new redox proxy to ~3.55 Ga eclogite xenoliths from West Africa to cross-calibrate our oxybarometer and trace spatiotemporal variations in slab fO_2 .

[1] Simakov (2006), *Contributions to Mineralogy and Petrology* 151, 282-296. [2] Aulbach and Stagno (2016), *Geology* 44, 751-754. [3] Xiong et al. (2011), *Geochimica et Cosmochimica Acta* 75, 1673-1692.