

Vanadium partitioning during eclogite melting and arc cumulate fractionation in subduction zones

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Vanadium is a multivalent element that may speciate as V^{2+} , V^{3+} , V^{4+} and V^{5+} in silicate and oxide phases. The relative abundance of V in planetary materials can be used as a proxy for oxygen fugacity (fO_2) when its partitioning behavior has been calibrated with controlled experiments. Here we present the results of 20 piston-cylinder experiments executed over a 10-log unit range of fO_2 at temperatures from 800 to 1230 °C, at 1.8–2 GPa, to quantify the partitioning of V between garnet, clinopyroxene, rutile and hydrous silicate melt under conditions relevant to eclogite melting and high-pressure arc cumulate fractionation in subduction zones [1]. In all experiments, the partitioning of V between phases is controlled sub-equally by fO_2 and by temperature (and/or compositional effects that are directly related to temperature, e.g., Fig. 1). Vanadium is most compatible in experimental rutile, followed by clinopyroxene, then garnet, with calculated mineral/melt partition coefficients ≥ 1 for all three phases in our experimental series. The strong compatibility of V in eclogitic minerals results in negligible mass transfer of V during eclogite melting or high-pressure arc cumulate fractionation under all fO_2 conditions investigated. Melts in equilibrium with garnet, clinopyroxene and/or rutile in the investigated range of T - P - x will be depleted in V relative to melts of peridotitic mantle. Oxidized species of V are more soluble in rutile compared to garnet and clinopyroxene, leading to a linear increase in rutile/cpx and rutile/garnet inter-mineral partition coefficients as fO_2 increases. We calibrate the partitioning of V among rutile-cpx and rutile-garnet pairs for use as a possible fO_2 proxy for natural rocks and test its application to eclogitic xenoliths from the Koidu kimberlite suite (Sierra Leone).

[1] Holycross M, Cottrell E (2022) *Contrib Mineral Petrol* 177: 1-23.

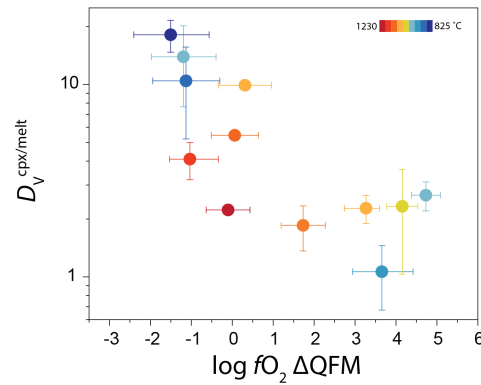


Figure 1 Variation in $D_V^{\text{cpx/melt}}$ plotted against fO_2 with colored contours for experiment temperature. Cold, reducing experiments produced the highest values of $D_V^{\text{cpx/melt}}$. We observe similar trends in $D_V^{\text{rt/melt}}$ and $D_V^{\text{grt/melt}}$ as a function of redox state and temperature.