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# Experimental determination of high field strength element partition coefficients between ilmenite and melt: Implications for ore fertility and metal enrichment in granitic systems

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Petrogenesis of granite-related critical metal deposits is contingent on element partitioning between silicate melt, the anatectic residua, and the subsequent magmatic mineral assemblage. Such partitioning results in incompatible element enrichment in the melt phase and can fractionate geochemical twins, including Nb/Ta and Zr/Hf. While the critical role of biotite in this context has been elucidated, the effect of oxide minerals, such as ilmenite, are less constrained. Understanding oxide mineral stability and their capacity to partition critical metals is vital to developing a comprehensive metallogenic model for granitic systems. We present results from a suite of experiments which determined the partitioning behaviour of high field strength elements (HFSE; Zr, Nb, Mo, Hf, Ta, W) between ilmenite and melt. Experimental charges consist of peraluminous Macusanite doped with FeO and $TiO_2$ to force ilmenite crystallization, with distilled water added to depress the liquidus. Graphite inner capsules buffer $fO_2$ and limit Fe loss. Experiments are performed in a piston-cylinder apparatus, with pressure maintained near 1.0 GPa. Samples are first heated to 1300°C to produce a homogenous melt, followed by cooling to lower temperatures. We employed thermal cycling, during which the temperature is oscillated by ca. 150°C, to crystallize ilmenite large enough to analyze by electron microprobe. After thermal cycling, final temperatures of 1050°C, 950°C, and 850°C are maintained for 72 hours before quenching. In general, D(Ta) > D(Nb) > D(Mo) > D(W) > D(Hf) > D(Zr), with ranges of 17.87 - 43.85, 18.90 - 32.69, 4.13 - 24.94, 0.35 - 2.94, 0.76 - 0.81, and 0.71 - 0.75, respectively. Partition coefficients are negatively correlated with temperature for Nb, Mo, Ta, and W, and are positively correlated for Zr and Hf. Contrary to published data, we show that ilmenite has D(Ta) > D(Nb) in felsic systems, and that D(Mo) and D(W) are higher than previously reported. We model equilibrium batch melting and fractional crystallization in granitic systems with our new partitioning data to show that ilmenite acts as a geochemical “poison”, preventing enrichment of some metals to economic grade and altering the geochemical patterns typical of mineralized intrusions, such as the protracted decrease in Nb/Ta.