

Experimental development of new oxybarometers based on V-Sc exchange between mafic minerals and hydrous silicate melts

ENZO ENRICO CACCIATORE, ALEXANDRA TSAY AND ZOLTÁN ZAJACZ

University of Geneva

Presenting Author: enzo-enrico.cacciatore@unige.ch

Redox conditions have a significant impact on phase equilibrium and the physical-chemical behavior of volatiles, such as sulfur, in magmas. Therefore, a better understanding of the initial redox state of magmas and its evolution during magma differentiation may help assess the fertility for associated magmatic-hydrothermal ore deposit genesis and provide new insights into the importance of magmatism and volcanic degassing in the redox evolution of the Earth's upper spheres. However, there are only a few studies on oxybarometric methods calibrated at elevated pressure in the presence of hydrous melts, conditions typical of magma differentiation at convergent plate boundaries.

We conducted experiments in a rapid-quench Molybdenum-Hafnium Carbide pressure vessel apparatus equipped with Shaw membrane to develop oxybarometers based on the exchange coefficient of V and Sc between mafic minerals and hydrous silicate melts [1]. These are expected to exhibit reduced dependence on pressure, temperature, and silicate melt composition in comparison to those relying on the partition coefficient of V. The first set of experiments was performed at constant pressure (200 MPa) and temperature (1030 °C), under water-saturated conditions at oxygen fugacity varied from +0.5 to +3.5 log units relative to the FMQ buffer, resembling the relevant range for arc magmatic systems. The exchange coefficient of V and Sc between olivine and silicate melt can be described by the following linear regression equations for medium-K calc-alkaline (MKCa) and shoshonitic (Sh) systems, respectively:

$$\log K[(V/Sc)^{(Ol/melt)}] \quad (MKCa) \quad = -1.26 \pm 0.03 - 0.22 \pm 0.02 * \Delta FMQ$$

$$\log K[(V/Sc)^{(Ol/melt)}] \quad (Sh) = -1.50 \pm 0.05 - 0.18 \pm 0.04 * \Delta FMQ$$

In the case of clinopyroxene, which is more abundant in shoshonitic systems, the equation can be defined as:

$$\log K[(V/Sc)^{(Cpx/melt)}] = -0.93 \pm 0.08 - 0.13 \pm 0.03 * \Delta FMQ$$

These values are consistent with the expected degree of variation in V-partitioning as a function of fO_2 based on previous studies. Both the olivine and clinopyroxene-based oxybarometer can in turn be applied to mafic volcanic rocks with suitable silicate melt inclusions-host mineral pairs to reconstruct the redox history of deep-seated magma reservoirs.

References:

[1] Alex A. & Zajacz Z. (2022), *Am. Mineral.* 107, 692–702.