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TRACKING THE OXYGEN FUGACITY TRAJECTORIES OF ENCLAVE-FORMING MELTS THROUGH PLAGIOCLASE TRACE ELEMENT SIGNATURES: A REASSESSMENT OF EXPERIMENTAL DATA

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It has been experimentally demonstrated that the initial stages of the xenolith assimilation process might involve local and transient perturbations of the magma redox potential, which can lead to preferable stabilization of reduced oxidation states of multivalent elements, especially in cases where granite magmas intrude sulfur and graphite-bearing rocks. As suggested by classic and contemporary experimental studies, the partition of multivalent elements (particularly Eu) into the plagioclase structure is a function of the prevailing fO_2 conditions. Moreover the high Sr and low Rb contents of plagioclase crystals allow tracking of contamination process on the mineral scale, which makes plagioclase a suitable candidate for the investigation of simultaneous contamination and fO_2 perturbation of the granite magmas from which it crystallizes.

We reassessed the available experimental data in order to propose a new regression equation relating Eu multivalent ratios and fO_2 conditions (eg. Drake, 1975; Geochim. Cosmochim. Acta 39, 55-64).

$\log fO_2 = -4.27\ (+/-0.24) x \log(Eu^{2+}/Eu^{3+}) - 11.752\ (+/-20)$ $r2=0.76$ Std error = 1.26 log units

The equation successfully reproduces experimental fO_2 data within 2 log units (with 60% within 1.0 log unit).

We tested the possibility of combining plagioclase trace and isotope data on felsic microgranitoid enclaves (FME) from two granite occurrences. The Mauá pluton intrudes graphite-bearing metassediments that frequently occur as xenoliths within the granite. Multivalent Eu ratios were calculated using the Lattice Strain Model and partition coefficients (D) for Gd and Sr as proxies to D_{Eu3+} and D_{Eu2+}, respectively.

Resultant Eu^{2+}/Eu^{3+} ratios define a strong positive correlation with Sr isotope composition, implying a total fO_2 variation of 4 log units. Plagioclase cores are reduced and more contaminated with fO_2 of -12.5 and $^{87}Sr/^{86}Sr = 0.7131$, followed by gradually more oxidized and less contaminated rims ($fO_2 = -8.5$ and $^{87}Sr/^{86}Sr = 0.71046$ (in equilibrium with whole rock data. Sr isotope data from Alves et al., 2009; J.Petrol. 50, 2221-2247). Apparently assimilation of metapelites implied fO_2 reduction and increased radiogenic signatures, and this was followed by a gradual diminution of the contaminant/resident magma ratio, with the recovery of the original redox conditions and isotope signatures.

The second case investigates FME from the Salto pluton, a small granite occurrence that intrudes sulfur- and organic matter-free orthogneisses and bears a negligible amount of xenoliths. Inedited plagioclase (xenocrysts, matrix crystals from FME, and phenocrysts from a host granite) trace element and isotope data were used to calculate multivalent Eu ratios and to track the contamination processes. Sr isotopes vary broadly ($^{87}Sr/^{86}Sr$ from 0.7087 to 0.7121) and exhibit no clear correlation with calculated multivalent Eu ratios. Variations in calculated fO_2 values are discreet and reveal slightly more reduced xenocrysts compared to matrix crystals (average values of -7 and -5.7, respectively), whereas a phenocryst from a host granite shows a broader variation range (-8.1 to -6.2 log units), not correlated to $^{87}Sr/^{86}Sr$ values. The resultant fO_2 variation is roughly within the standard error of Eq. 1. Therefore we consider that assimilation of orthogneisses xenoliths did not imply important perturbation of the magma redox conditions. Interestingly, fO_2 values obtained for Salto and Mauá plutons directly reflect the nature of the country-rocks they intrude.