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Ti diffusion in feldspar

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Abstract

Chemical diffusion of Ti has been measured in natural K-feldspar and plagioclase. The sources of diffusant used were TiO_2 powders or pre-annealed mixtures of TiO_2 and Al_2O_3. Experiments were run in crimped Pt capsules in air or in sealed silica glass capsules with solid buffers (to buffer at NNO). Rutherford backscattering spectrometry (RBS) was used to measure Ti diffusion profiles. From these measurements, the following Arrhenius relations are obtained for diffusion normal to (001):

For oligoclase, over the temperature range 750–1050 °C:

$D_{Olig} = 6.67 \times 10^{-12} \exp(-207 \pm 31 \text{ kJ/mol/RT}) \text{ m}^2\text{s}^{-1}$

For labradorite, over the temperature range 900–1150 °C:

D_{Lab} = of $4.37 \times 10^{-14} \exp(-181 \pm 57 \text{ kJ/mol/RT}) \text{ m}^2\text{s}^{-1}$

For K-feldspar, over the temperature range 800–1000 °C:

$D_{Ksp} = 3.01 \times 10^{-6} \exp(-342 \pm 47 \text{ kJ/mol/RT}) \text{ m}^2\text{s}^{-1}$.

Diffusivities for experiments buffered at NNO are similar to those run in air, and the presence of hydrous species appears to have little effect on Ti diffusion. Ti diffusion also shows little evidence of anisotropy. In plagioclase, there appears to be a dependence of Ti diffusion on An content of the feldspar, with Ti diffusing more slowly in more calcic plagioclase. This trend is similar to that observed for other cations in plagioclase, including Sr, Pb, Ba, REE, Si, and Mg. In the case of Ti, an increase of 30% in An content would result in an approximate decrease in diffusivity of an order of magnitude.

These data indicate that feldspar should be moderately retentive of Ti chemical signatures, depending on feldspar composition. Ti will be more resistant to diffusional alteration than Sr. For example, Ti zoning on a 50 μm scale in oligoclase would be preserved at 600 °C for durations of ~1 million years, with Sr zoning preserved only for ~70 000 yr at this temperature. These new data for a trace impurity that is relatively slow-diffusing and ubiquitous in feldspars (Hoff and Watson 2018) have the potential to extend the scope and applicability of *t-T* models for crustal rocks based on measurements of trace elements in feldspars.

Keywords: Titanium, feldspar, diffusion, Rutherford backscattering spectrometry