New data on anisotropy and composition dependence of Na/K-interdiffusion in alkali feldspar

A.-K. SCHAEFFER[1], E. PETRISHCHEVA[1], G. HABLER[1], R. ABART[1] AND D. RHEDE[2]

[1]University of Vienna, Department of Lithospheric Research, Vienna, Austria (anne-kathrin.schaeffer@univie.ac.at)
[2]GFZ German Research Centre for Geosciences, Telegrafenberg, 14473 Potsdam, Germany

Cation exchange experiments have been conducted using crystallographically oriented plates of gem quality sanidine as starting material.

The observed geometry of the diffusion fronts can be explained by a composition dependence of the interdiffusion coefficient. We extracted the composition dependence of the interdiffusion coefficient from our measured data by use of the Boltzmann transformation in the composition interval between X_{Or} 0.5 and 1 for the directions (001) and (010).

At 850°C the interdiffusion coefficient D is nearly constant at 0.3 $x10^{-15}m^2s^{-1}$ over the composition range X_{Or} 0.50 to 0.95 and then rises steeply to values of 2.5 $x10^{-15}m^2s^{-1}$ for profiles normal to (001). Normal to (010) D is nearly constant at 0.03 $x10^{-15}m^2s^{-1}$ over the composition range X_{Or} 0.5 to 0.97 before, too, rising steeply at higher X_{Or}. Thus interdiffusion normal to (001) is faster by a factor of about ten than interdiffusion normal to (010).

Christoffersen *et al*. [1] measured interdiffusion coefficients in the composition range between X_{Or} 0.1 to 0.8 in diffusion couple experiments. They observed a similar anisotropy but they find a composition dependence of D for intermediate compositions which disagrees with our findings. Also, their absolute values for the interdiffusion coefficient at a given composition are smaller by about a factor of ten.

Comparison with theoretical calculations of the interdiffusion coefficient from self-diffusion data found in literature [2, 3] using the Manning relation for interdiffusion in ionic crystals shows a rough fit for interdiffusion normal to (001) while the slower interdiffusion normal to (010) deviates significantly from what would be expected.

The activation energy also shows an anisotropy; normal to (001) it is about 340 kJ/mole while it is 250 kJ/mole normal to (010).

[1] Christoffersen *et al*. (1983) *American Mineralogist*, **68**, 1126-1133. [2] Foland (1974) *Geochemical Transport and Kinetics,* 77-98. [3] Kasper (1975) *Ph.D. thesis, Brown University*.

The geochronological signal of a dying magma system

U. SCHALTEGGER[1], C. BRODERICK[1] AND J.F. WOTZLAW[1]

[1]Section of Earth and Environmental Sciences, University of Geneva (urs.schaltegger@unige.ch, joern.wotzlaw@unige.ch, cindy.broderick@unige.ch)

U-Pb dating of zircon is the most commonly used geochronometer for temporal quantification of pluton and batholith forming processes. High-precision zircon $^{206}Pb/^{238}U$ dating repeatedly produces a dispersion of ~50-200 ka between the oldest and youngest zircon of the same sample, and of up to 1 Ma within a plutonic unit, pointing to a prolonged magmatic evolution with non-monotonously varying parameters like melt temperature, crystallinity and melt composition. Combining high-precision U-Pb dates with trace element and Hf isotope analysis on the same dated volume of zircon, we are able to trace different processes acting during the assembly of a pluton and quantify their timing: 1) changing melt composition due to fractional crystallization of zircon and of other accessory minerals (e.g., titanite) over time; 2) quantify the evolution of overall crystallinity of a magmatic body over time; 3) changes in magma temperature by identifying periods of enhanced and suppressed zircon crystallization, and correlate them with periods of mafic magma recharge and thermal rejuvenation of the system; 4) changing sources of incoming melts over time by linking initial Hf isotopes to crystallization age.

Probability density functions of $^{206}Pb/^{238}U$ zircon dates of a pluton usually point to several peaks of enhanced zircon crystallization during a prolonged period of increasing crystallinity of the magma, leading to stalling of the crystal mush and subsequent complete solidification at upper crustal levels. The non-steady decrease of the volume of potentially eruptible crystal-poor liquid leads eventually to the "plutonic death" of a magmatic system.

www.minersoc.org
DOI:10.1180/minmag.2013.077.5.19