Geophysical Research Abstracts
Vol. 13, EGU2011-12926, 2011
EGU General Assembly 2011

What are the implications of two diffusive pathways for natural argon in K-feldspar ?

Simon P. Kelley (1), Ethan F. Baxter (2), and Patricia L. Clay (3)

(1) Open University, Department of Earth Sciences, Milton Keynes MK7 6AA, UK. (s.p.kelley@open.ac.uk, +44-1908-655151), (2) Department of Earth Sciences Boston University 685 Commonwealth Avenue Boston, MA 02215, USA., (3) School of Earth, Atmospheric and Environmental Sciences University of Manchester Williamson Building Oxford Road Manchester M13 9PL, UK.

Laboratory experiments diffusing argon into gem quality K-feldspar, combined with UV laser depth profiling, reveal two diffusion mechanisms in gem-quality K-feldspar. We will explore some of the implications of these experiments for natural argon diffusion, and for Ar-Ar dating of young volcanic samples.

Laboratory produced argon diffusion profiles revealed two distinct pathways for argon diffusion in K-feldspar resulting in a kinked diffusion profile. Deep diffusion was observed up to 60μm into the K-feldspar with a low solubility ($\sim$4ppb/bar), and consistent within previous diffusion rates based on bulk loss, laser depth experiments, and step heating of natural samples. A second shallow diffusive profile into the first 0.5μm of the mineral surface was also observed, characterized by high solubility ($\sim$500ppb/bar), a very low pre-exponential factor and low activation energy similar to those measured in quartz and other minerals (e.g. Watson and Cherniak 2003, Thomas et al. 2008).

Closure temperatures calculated for the deep diffusion mechanism are consistent with observations of natural systems, whereas the shallow diffusion mechanism yields anomalously low closure temperatures, and impossibly low for grain sizes less than 90μm. Modelling of two scenarios, for a volcanic system and a low temperature burial, yielded little evidence for the shallow mechanism dominating natural systems. However, while it seems unlikely that the shallow diffusion mechanism dominates any natural systems, it has been consistently detected by different technique in a laboratory experiments in several mineral species.

We will explore the implications of the second diffusion mechanism, and in particular the scenario of such a mechanism acting only in the near surface of grains in natural systems. There are several implications of this hypothesis. Argon diffusion would be enhanced in fine grained systems with high surface areas such as deformed or deforming rocks. In addition while not dominating argon diffusive loss from coarser grained systems, a mechanism resulting in incorporation of high concentrations of argon close to grain boundaries would have important implications for storage and transport of argon and other noble gases in the deep Earth. Finally, the same mechanism may incorporate modern atmospheric argon close to mineral surfaces at room temperature, but the contamination would only be released high temperature during vacuum experiments.

References

Thomas, J.B., Cherniak, D.J., Watson, E.B., 2008. Lattice diffusion and solubility of argon in forsterite, enstatite, quartz and corundum. Chemical Geology 253, 1-22.

Watson, E.B., Cherniak, D.J., 2003. Lattice diffusion of Ar in quartz, with constraints on Ar solubility and evidence of nanopores. Geochimica Et Cosmochimica Acta 67, 2043-2062.