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Hydrogen diffusion in Zircon

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Hydrogen mobility in gem quality zircon single crystals from Madagascar was investigated through H-D exchange experiments. Thin slices were annealed in a horizontal furnace flushed with a gas mixture of $Ar/D_{2(10\%)}$ under ambient pressure between 900 ˚C to 1150 ˚C. FTIR analyses were performed on oriented slices before and after each annealing run. H diffusion along [100] and [010] follow the same diffusion law D = D_0exp[-E /RT], with log D_0 = 2.24 $\pm$ 1.57 (in m^2/s) and E = 374 $\pm$ 39 kJ/mol. H diffusion along [001] follows a slightly more rapid diffusion law, with log D_0 = 1.11 $\pm$ 0.22 (in m^2/s) and E = 334 $\pm$ 49 kJ/mol. H diffusion in zircon has much higher activation energy and slower diffusivity than other NAMs below 1150 ˚C even iron-poor garnets which are known to be among the slowest (Blanchard and Ingrin, 2004; Kurka et al. 2005).

During H-D exchange zircon incorporates also deuterium. This hydration reaction involves uranium reduction as it is shown from the exchange of U^{5+} and U^{4+} characteristic bands in the near infrared region during annealing. It is the first time that a hydration reaction $U^{5+} + OH^- = U^{4+} + O^{2-} + 1/2H_2$, is experimentally reported. The kinetics of deuterium incorporation is slightly slower than hydrogen diffusion, suggesting that the reaction is limited by hydrogen mobility. Hydrogen isotopic memory of zircon is higher than other NAMs. Zircons will be moderately retentive of H signatures at mid-crustal metamorphic temperatures. At 500 ˚C, a zircon with a radius of 300 μm would retain its H isotopic signature over more than a million years. However, a zircon is unable to retain this information for geologically significant times under high-grade metamorphism unless the grain size is large enough.

Refrences

Blanchard, M. and Ingrin, J. (2004) Hydrogen diffusion in Dora Maira pyrope. Physics and Chemistry of Minerals, 31, 593-605.

Kurka, A., Blanchard, M. and Ingrin, J. (2005) Kinetics of hydrogen extraction and deuteration in grossular. Mineralogical Magazine, 69, 359-371.