

AR DIFFUSION IN MUSCOVITE: 2D IN SITU IMAGING AND NUMERICAL MODELLING OF COUPLED LATTICE AND DEFECT MEDIATED DIFFUSION.

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Solid state diffusion is the main process governing atomic transport in minerals. In thermochronology, the understanding of this process is crucial for an accurate determination of parameters such as diffusion coefficients which are used in the calculation of closure temperatures. While elemental/isotopic gradients in minerals have been usually modelled as volume diffusion profiles, developments in microanalytical tools such as the ion and laser microprobe have revealed that spatial distributions of radiogenic isotopes often do not involve lattice (volume) diffusion alone, but the effect of microstructural defects as well. These may serve as high-diffusivity pathways in crystal to the extent of significantly changing their bulk diffusivity (and retention) properties. This study aims at investigating the diffusional behaviour of radiogenic Ar in muscovite using spatially-resolved UV laser in situ mapping in spectacularly Ar-zoned magmatic muscovites from the slowly-cooled ~1.7 Ga Harney Peak Granite (HPG). Age gradients in HPG muscovites are dominated by (but do not strictly conform to) a simple volume diffusion mechanism, illustrating the combination of at least two diffusional mechanisms. Assuming that Ar diffusion occurs through both the lattice and high-diffusivity pathways, we develop a 2D numerical model to reproduce the observed Ar distribution, and then consider the inverse problem of recovering the spatially heterogeneous diffusion coefficient across the crystals to assess the effect of extended defects on Ar bulk diffusivity in muscovite.

Key Words : Ar Diffusion, High diffusivity pathways, Muscovite