Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.18075

Assessing mechanisms of argon isotope redistribution in muscovite: Preliminary results from the Black Hills, South Dakota

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Several key assumptions form the basis of extracting continuous thermal history information from the Ar isotopic compositions of minerals. Recent in-situ $^{40}Ar/^{39}Ar$ and geochemical analyses have shown that argon distributions can be a consequence of fluid-associated retrograde reactions, even in gem-quality mica and K-feldspar [1, 2]. Mica can retain $^{40}Ar/^{39}Ar$ crystallisation ages at temperatures above 500°C [3], despite predicted closure temperatures. However, retrograde re-equilibration often occurs [4], rendering mica useful for hygrochronometry [5]. We test the hypothesis that diffusion profiles in white mica can remain over geological timescales, despite the effects of partial retrograde re-equilibration.

A Mesoproterozoic metasedimentary sequence is intruded by a granitic core in the Black Hills. The metasedimentary rocks yield white mica $^{40}Ar/^{39}Ar$ total-fusion dates that increase with distance from the granite, span several 100 Ma and have been interpreted to record cooling [6]. However, the role of fluid interaction on the Ar isotopic compositions has not been thoroughly assessed. To test the hypothesis, we have re-sampled the meta-sedimentary units and the Harney Peak Granite. White micas have been initially classified using optical light petrology and QEMSCAN, and they will be characterised using EPMA, EBSD, TEM, SIMS - $\delta^{18}O$ and K-Ca dating to add a petrographic and temporal context for the in-situ Ar isotopic data. In-situ Ar isotope analyses will be compared to Ar isotopic data acquired using furnace step-heating to assess the causes of inflexions in Arrhenius trajectories.

Thin section petrographic categorisation has identified three co-existing white mica types in the mica schists of the Black Hills: pre-deformational, syn-deformational, and porphyroblastic vein-associated growth. These white micas were subsequently affected by a sillimanite overprint, late crosscutting hydrothermal white mica nucleation, and local retrograde chloritization. By studying a range of textures, we aim to provide recommendations for interpreting $^{40}Ar/^{39}Ar$ mica ages.

1 Naumenko-Dèzes et al., (2021). *Chemical geology*, *573*, 120215.

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4 Allaz et al., (2011). Journal of Petrology, 52(4), 691-716.

5 Villa, I. M. (2016). Chemical Geology, 420, 1-10.

6 Dahl & Foland (2008). *American Mineralogist*, *93*(8-9), 1215-1229.