Ar diffusion in muscovite

J. CÉLÉRIER[1] T.M. HARRISON[1,2] AND J. HERMANN[1]

[1] Research School of Earth Sciences, Australian National University, Canberra, A.C.T. 2601 AUSTRALIA ; julien.celerier@anu.edu.au

[2] Department of Earth and Space Sciences & IGPP, UCLA, Los Angeles, CA 90095, U.S.A.

Muscovite is among the most utilised mineral in $^{40}Ar/^{39}Ar$ geochronology and thermochronology. Despite its importance to geochronological studies, no experimental study of the diffusion behavior of Ar in muscovite – key to assigning a value of closure temperature – has yet been published. Instead, the thermochronological community has tended to adopt a nominal value for closure temperature (*1* & refs. therein), based largely on empirical calibrations of age vs. metamorphic grade (e.g., *2*). Here we present preliminary results from diffusion experiments designed to constrain the Arrhenius parameters for Ar diffusion in muscovite.

As starting material, we use a large muscovite crystal from a pegmatite in the Harts Range, Central Australia. This sample has been analysed by the $^{40}Ar/^{39}Ar$ step-heating method which reveals a uniform concentration of ^{40}Ar within the sample over >90% of the gas release. We thus infer that it has been closed to loss of ^{40}Ar since 325.8±2.5 Ma. Three size fractions of the starting material of 38-45 µm, 75-90 µm, and 125-150 µm were loaded in gold capsules together with $AlOH_3$ to buffer Al_2O_3 and H_2O activity in the experiments. The capsules were run in a piston cylinder apparatus for 1-6 weeks at temperatures ranging from 600°C to 730°C at 10 kbar pressure. The high temperature limit represents the upper bound of muscovite stability under these conditions and the lower bound dictated by the need to generate measureable (>5%) loss in the run products. The loss of ^{40}Ar resulting from this treatment has been measured and used to calculate Arrhenius parameters, thus permitting direct calculation of closure temperature.

References

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