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Assessing intragrain chemical heterogeneities in white mica and their impact on $^{40}Ar/^{39}Ar$ and Rb-Sr dates.

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White mica often show highly variable and younger $^{40}Ar/^{39}Ar$ dates than Rb-Sr isochron dates in greenschist to amphibolite facies rocks. Consequently, $^{40}Ar/^{39}Ar$ dates are commonly interpreted as cooling ages [1], validating the application of thermochronology. In contrast, petrochronological studies show that in many cases, chemical re-equilibration reset $^{40}Ar/^{39}Ar$ dates [2]. So far, a petrochronological approach have never been applied to slowly cooled terranes, which are optimal to test assumptions in thermochronology. A metasedimentary sequence in the Black Hills, South Dakota, underwent Barrovian-type metamorphism followed by a HT-LP overprint associated with a granitic intrusion (1715 ± 6 Ma). Previous $^{40}Ar/^{39}Ar$ step-heating and in-situ studies concluded that thermally activated volume diffusion was the cause of highly dispersed $^{40}Ar/^{39}Ar$ dates [3, 4]. However, the paucity of spatially resolved chemical data renders their interpretations uncertain. We combine EPMA and EBSD mapping with in-situ $\delta^{18}O$ (SIMS), $^{40}Ar/^{39}Ar$, Rb-Sr dating and trace element analysis of white mica from the Black Hills to test i) if Ar-diffusion profiles are preserved, and ii) understand the influence of chemical heterogeneities on $^{40}Ar/^{39}Ar$ and Rb-Sr dates, and Ar, Rb and Sr isotope mobility.

All 31 EPMA-maps reveal intragrain heterogeneities in stoichiometric elements. Phenocrystic and porphyroblastic white mica have cores that are altered by secondary phases along cleavage planes and grain boundaries. The product phase's intragrain nucleation retains the original crystal's shape and volume, indicating an interface-coupled-dissolution-precipitation mechanism. Product white mica are depleted in mobile elements (e.g. Na, B, Cs and Rb) and are associated with the breakdown of another mineral phase, which modified the fluid composition. In-situ $^{40}Ar/^{39}Ar$ dates of granitic white mica span from the Rb-Sr isochron date of 1674.72 ± 3.14 Ma (of cores) to 1284.9 ± 4.8 Ma from crosscutting product white mica (Fig. 1). Consequently, $^{40}Ar/^{39}Ar$ dates were reset during fluid-assisted re-equilibration. In contrast, Rb-Sr isochrons reflect the age of grain-scale equilibrium crystallisation of the white mica.

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