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Multi-method approach to understanding the migration mechanisms of Pb in apatite and Ar in alkali feldspar from Proterozoic granitic batholiths from the Mt. Isa Inlier (Australia)

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Understanding the mechanisms by which radiogenic isotopes are redistributed within and between minerals is critical for the accurate interpretation of geochronological data. This study aims to i) improve our understanding of the roles of diffusion and fluid-induced dissolution-reprecipitation in the redistribution of radiogenic Pb in apatite and radiogenic Ar in alkali feldspar, and ii) establish whether or not fluid-induced dissolution-reprecipitation necessarily resets apatite U-Pb and alkali feldspar $^{40}Ar/^{39}Ar$ dates to the time of fluid interaction. We present data obtained from zircon, apatite and alkali feldspar extracted from eight samples of Proterozoic granitic batholiths in the Mt. Isa Inlier (Australia). Petrological characterisation of these minerals is combined with U-Pb dating of zircon (LA-ICP-MS) and apatite (LA-ICP-MS, TIMS), Pb isotope analysis (ICP-MS) and in situ $^{40}Ar/^{39}Ar$ dating of alkali feldspar. In each sample all three minerals provide textural evidence for fluid-induced dissolution-reprecipitation. Zircon U-Pb data from most rocks are discordant and define narrow linear arrays in concordia space that span between crystallisation ages of ~1.8 to ~1.5 Ga and Pb loss events at ~0.3 Ga. All of the U-Pb dates from apatite are Proterozoic and show significant scatter when common Pb correction is introduced using the Stacey and Kramers (1975) model, and sometimes they exceed the crystallisation age. Pb isotopic compositions of alkali feldspar from most samples are more radiogenic than that predicted by the model of Stacey and Kramers (1975) for their crystallisation ages. In situ $^{40}Ar/^{39}Ar$ dates of a single alkali feldspar crystal from the oldest sample (1.83 Ga) are significantly scattered, and apparently similar veins of replacive feldspar yielded the oldest and the youngest dates of ~1.8 and ~0.9 Ga, respectively. Our working hypothesis is that these textural and isotopic observations are explained by one or several fluid-interaction events at ~0.3 Ga, when radiogenic Pb was mobilised from zircon (and other U-Th-bearing minerals) and redeposited primarily into apatite and alkali felspar as they recrystallised within a semi-closed system. We further hypothesise that the same fluids have mobilised and partly redeposited radiogenic Ar within alkali feldspar, such that it forms an excess ^{40}Ar reservoir within replacive veins.