Diffusion and fluid-interaction in Itrongay pegmatite (Madagascar): the results of *in situ* Ar-Ar dating of gem-quality alkali feldspar and U-Pb dating of apatite inclusions within it

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Constraining how the temperature of rocks changes with time is an important aspect of many geological studies. Geoscientists commonly address this problem by interpreting step-heating Ar-Ar data obtained from feldspars [e.g. 1 and therein] and increasingly more often by interpreting U-Pb data obtained from apatite [e.g. 2 and therein]. Reconstruction of thermal histories using these approaches is underpinned by the assumption that the redistribution of radiogenic Ar in feldspars and Pb in apatite over geological timescales is controlled by volume diffusion. However, is this assumption always valid?

Here we revisit the mechanisms of Ar redistribution in famous gem-quality alkali feldpsar from Itrongay pegmatite by combining *in situ* Ar-Ar dating with cathodoluminescence imaging. Previous *in situ* Ar-Ar studies of Itrongay feldspar suggested that it has partially lost radiogenic Ar by diffusion [3, 4], supporting the underlying assumption of feldspar Ar-Ar thermochronology. However, our results indicate that this feldspar records a protracted history of interaction with fluids between ~475 Ma (dates in the core) and ~180 Ma (dates at the rim), casting doubt on previous interpretations.

Alongside, we have obtained *in situ* U-Pb dates of three apparently protogenetic apatite inclusions within the studied feldspar crystal. These yield older dates than feldpsar (~490-535 Ma), and in contrast to feldspar seem to have been partially reset by diffusion, possibly prior to their entrapment.

[1] Harrison and Lovera (2013) GSL Spec. Pub., 378, 91-106; [2] Paul et al. (2018) GCA, 288, 275-300 [3] Flude et al. (2014) Geol. Soc. London Spec. Pub., 378, 265–275; [4] Arnaud and Kelley (1997) GCA, 61, 3227–3255.