

Recent advances in mass spectrometry have enabled routine *in situ* Rb-Sr analyses, but uncertainties remain regarding the Rb-Sr system in metamorphic rocks: do Rb-Sr dates reflect thermal closure, fluid-mediated recrystallization, or both? Here, we present new Rb-Sr isotopic data from metamorphic biotite from the Ivrea-Verbano Zone (IVZ, Italy), collected using an ESL™ imageGEO™ laser ablation system coupled to a Thermo Scientific™ Neoma™ MC-ICP-MS/MS. These data were supplemented with new LA-ICPMS biotite compositional maps from the same samples.

We analyzed six samples from amphibolite-facies metapelites at the top of the IVZ (peak $P-T \sim 0.6$ GPa, $\sim 650-700^\circ\text{C}$) to granulite-facies metapelites at its base (peak $P-T \sim 1$ GPa, $\geq 850^\circ\text{C}$). Previous garnet, zircon, and monazite geochronology demonstrates that the uppermost IVZ metapelites experienced peak $P-T$ conditions >300 Ma, decreasing to 260-240 Ma in the lowermost metapelites [1]. Hornblende Ar/Ar and biotite K/Ar dates similarly decrease from ~ 270 -200 Ma and ~ 245 -155 Ma, respectively, from the top to the base of the IVZ [2]. In contrast, rutile U-Pb dates are ~ 200 -150 Ma in the bottom half of the section, with no depth-related pattern [3,4].

Like most other chronometers, our new biotite Rb-Sr dates decrease with depth, with average ~ 220 Ma dates in the top ~ 2 -3 km grading to ~ 180 Ma for the majority of the IVZ section. The topmost Rb-Sr dates match biotite K/Ar dates at the same structural depth, but Rb-Sr dates at the base are ~ 30 Myr older than the K/Ar dates. If related to diffusive closure, this observation would imply progressively slower cooling rates with depth. However, several observations suggest that the biotite Rb-Sr dates are not a thermally activated diffusive record. For example, single-spot Rb-Sr isochron dates reveal several date “pulses”, consistent with multiple (re)crystallization episodes; sample-averaged Rb-Sr dates are constant over the basal ~ 10 km of section; and the map data suggest that Sr may have been added to biotite grain rims and cleavage planes. These data suggest that the biotite Rb-Sr system in the IVZ reflects a combination of thermal and fluid effects related to Tethyan rifting, as opposed to a purely temperature-driven diffusive effect.

1 Connop et al. 2024 EPSL

2 Siegesmund et al. 2008 GSL-SP

3 Ewing et al. 2015 CMP

4 Smye et al. 2019 EPSL