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Capturing low-δ18O fluid infiltration along a detachment fault: A case study from the Buckskin-Rawhide metamorphic core complex

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In situ multi-tracer geochemical studies in mylonites can provide detailed information on the timing, composition, and thus possible rheological consequences of aqueous fluids infiltration during deformation. Here we present a microstructural and oxygen isotope study of a muscovite-free granitic mylonite from the footwall of the Buckskin-Rawhide metamorphic core complex (Arizona, USA).

CL images of large K-feldspars porphyroclasts exhibit complex patchy textures that are interpreted as deformation-related, and later overprinted by pervasive crack-seal microstructure, and then by myrmekite formation. Fluid-mediated myrmekitic intergrowths of oligoclase and quartz occur along folation-parallel faces at inferred high normal stress sites. In some areas close to the grain edges, patchy textures can be linked to the myrmekites. Neoblastic K-feldspar occurs in pressure shadows and along filling fractures in plagioclase porphyroclasts. Regardless of microstructural position, plagioclase ($An_{20\text{-}25}$) and K-feldspar (Ab_8) compositions are similar, suggesting that mineral compositions were rock- rather than fluid-buffered and that recrystallizing fluids were NaCl-poor. Oxygen isotopes, in contrast, record open-system infiltration by a low-$\delta^{18}O$ fluid, such that K-feldspar and plagioclase porphyroclast cores preserve $\delta^{18}O$~6-6.5‰, myrmekitic plagioclase intergrowths and neoblastic K-feldspar have $\delta^{18}O$ ~ 3-4‰. Both plagioclase and K-feldspar porphyroclasts show core-to-rim decreasing $\delta^{18}O$, probably due to diffusive relaxation superimposed on recrystallized boundaries. Diffusion modeling using the FGB model [1], however, predicts $\delta^{18}O$ zoning of only ~1‰ for closed system cooling, further supporting open-system fluid infiltration. Crack-seal features within K-feldspar porphyroclasts are not associated with low $\delta^{18}O$ and are interpreted to largely pre-date low-$\delta^{18}O$ fluid infiltration and fluid-mediated mirmekite formation.

We suggest that these microstructural and geochemical patterns are consistent with an essentially isothermal (ca. 450°C) switch in K-feldspar deformation mechanism from crack-seal deformation to myrmekite formation and recrystallization coeval with, and possibly triggered by, low-$\delta^{18}O$ fluid infiltration. The relative timing of and deformation-mechanism switch related to incursion of meteoric fluids may support the Singleton and Moser (2012) [2] model for the Buckskin core complex in which a shallowly dipping midcrustal shear zone was exhumed after being captured by through-going, steeply dipping upper plate faults.

[1] Kropf, Bonamici, Borchers (2021) *Computer Geosciences* 151, 104753.

[2] Singleton, Mosher (2012) *Journal of Structural Geology* 39, 180–198.