Meteoritic fluid infiltration along a detachment fault triggering exhumation: A case study from the Buckskin-Rawhide metamorphic core complex

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Résumé

Fluid infiltration along major detachment faults and the associated mineral alteration can affect the stability of the continental crust by significantly modifying the rheology of the infiltrated rocks. Although many tools have been developed to track fluid infiltration, fluid imprints may still be subtle when total fluid quantities are small, especially at the onset of fluid circulation. Here we present new SIMS in-situ oxygen isotopes data for quartz, K-feldspar, plagioclase and biotite in a deformed granitoid located in the immediate footwall of the Buckskin-Rawhide metamorphic core complex (Arizona, USA).

Myrmekites, intergrowths of oligoclase and quartz, occur along foliation-parallel K-feldspar porphyroclast faces at inferred high normal stress sites. Neoblastic K-feldspar fills fractures in plagioclase porphyroclasts and occurs in pressure shadows of plagioclase and K-feldspar porphyroclasts. Regardless of microstructural position, plagioclase (An20-25) and K-feldspar (Ab8) compositions are similar, suggesting that fluid amount was rather small. Oxygen isotopes, in contrast, record infiltration by a low-d18O fluid: K-feldspar and plagioclase porphyroclast cores preserve d18O _˜6-6.5‰, whereas myrmekitic plagioclase intergrowths and neoblastic K-feldspar have d18O of _˜3-4‰. Both plagioclase and K-feldspar porphyroclasts show core-to-rim diffusional profiles with decreasing d18O. CL images reveal crack-seal features within K-feldspar porphyroclasts that are cross-cut by low-d18O textural features. Oxygen isotope equilibrium fractionation between biotite (_˜ -1‰) and the later-formed feldspars reveal that this fluid infiltration occurred at 400-450 ◦C. The infiltrating fluid is calculated to have an oxygen signature of 1-2‰. Such a low d18O signature strongly suggests it was a meteoric fluid.

We suggest that these microstructural and geochemical patterns are consistent with an essentially isothermal (_˜450 ◦C) switch in K-feldspar deformation mechanism within the shearing middle crust from crack-seal deformation to myrmekite formation and recrystallization triggered by low-d18O fluid infiltration. We propose that grain-size reduction through the replacement of K-feldspars by myrmekites enhanced localization of deformation, altered midcrustal rheology, and ultimately triggered the exhumation of the midcrust into the Buckskin-Rawhide core complex footwall. The finding that meteoric fluid infiltration into the middle crust could trigger its exhumation has implications for the long-term stability of the crust and needs to be evaluated in other regions.

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Mots-Clés: fluid, rock interactions, oxygen isotopes, SIMS, metamorphic core complex