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Composition dependent annealing kinetics of ion tracks in natural apatite

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When high energetic heavy ions penetrate a solid, energy is lost predominantly through inelastic collisions with the target electrons. Such interactions can leave narrow cylindrical trails of damage as the ions traverse through the material, termed 'ion tracks'. In minerals such as apatite, track formation can occur as a result of spontaneous fission from naturally occurring uranium inclusions. The highly energetic fragments damage the matrix material in an analogous manner to heavy ions penetrating a solid, resulting in these so called 'fission tracks'. Upon exposure to elevated temperatures, these tracks are known to reduce in size and the crystalline structure is restored.

In this study, the annealing kinetics of ion tracks (simulating fission tracks) in natural apatites with different F/Cl ratios are investigated using synchrotron based small-angle x-ray scattering (SAXS) combined with ex situ isochronal annealing experiments. Results show that track structure resembles that of cylinders with a constant density and sharp boundaries consistent with amorphous ion tracks. Annealing leads to a reduction in the track radii and the annealing behaviour clearly differs for the four compositions studied. Activation energies for the recrystallization process were extracted from the data obtained.

The results have relevance for fission track geo- and thermochronology.

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