How trustworthy are absolute age data from reprecipitated mineral grains?

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Absolute dating of rock deformation is often hampered by the observation that the affected minerals are only partly re-equilibrated with respect to their isotopic composition.

Generally, three different processes enable mineral grains to adjust isotopically during the deformation event, i.e. volume diffusion, recrystallisation as well as dissolution and reprecipitation.

The degree to which the crystal structure is affected by these processes is different and thus the extent of isotopic equilibration during these processes generally differs in a way that diffusive element exchange is believed to be the most ineffective and slowest process, whereas re- and neo-crystallization seem to be fast and thorough.

Fluid-induced dissolution and reprecipitation is a very common mineral reaction mechanism in the solid Earth and as the crystal lattice is intensively reworked during this process, elemental and isotopic exchange between matrix and the newly formed crystal should be facilitated.

Commonly, element and isotopic exchange during such mineral reactions is thought to occur via aqueous solutions, but new experimental as well as natural data show that the element transfer during mineral dissolution and reprecipitation can also occur in an amorphous material that forms directly by depolymerization of the crystal lattice.

Furthermore, precipitation of product minerals occurs directly by repolymerization of the amorphous material at the product surface, hence the entire element and isotopic transfer between reactant and product mineral might not involve equilibration with the intercrystalline transport medium with important consequences for the interpretation of age data from re- and neo-crystallized grains.