

The Potential of Titanite for Tracing and Dating Dissolution Precipitation Processes: Implications for Geochronology

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Titanite is a relevant mineral for geochronology. Titanite is involved in various metamorphic reactions during subsequent stages of a P-T-deformation history and readily reacts with fluids by dissolution-precipitation processes (Lucassen et al. 2011). The initial isotopic composition of newly precipitated titanite is controlled by both, the isotopic composition of the interacting fluids and the dissolved precursor phases(s). We use isotopic fingerprints to get insights in the mechanisms of mineral replacement and mass transport on the grain scale during dissolution-precipitation processes related to exhumation of deeply subducted continental crust. The presented isotope data are from a titanite megacryst (3 cm in diameter) in a calc-silicate marble from the Dabie UHP unit (China). The titanite megacryst has been incompletely replaced during exhumation. Its primary core that survived deep subduction and exhumation and the reaction rim around the core have been sampled separately. Rb-Sr, Sm-Nd, U-Pb investigations of the core constrain that the titanite megacryst (i) precipitated from a homogeneous fluid source, (ii) preserved the initial isotopic signature, (iii) yields an accurate pre-(UHP) crystallization age (244 ± 2 Ma, Wawrzenitz et al. 2006). In contrast, the Sr isotope composition of the titanite in the reaction rim, and of the minerals in the marble matrix record two pulses of infiltration of external fluids distinct in their Sr isotopic composition. During the first stage, fluids with unusually low $87\text{Sr}/86\text{Sr}$ values induced dissolution-precipitation reactions resulting in the titanite reaction rim. This first stage is also recorded by the isotopically homogeneous phases calcite, clinozoisite, amphibole and small titanite in the marble matrix. The origin of the very unradiogenic fluids may be dehydrating young mafic rocks from the downgoing slab. Dissolution-precipitation reactions efficiently support material transport and isotope chemical exchange. This is obvious from the large marble volumes from the UHP unit showing these unusually low $87\text{Sr}/86\text{Sr}$ signatures (Romer et al. 2003). This first stage of fluid-infiltration is recorded by a U-Pb isochron age (224 ± 2 Ma, Wawrzenitz et al. 2006) of titanite, clinozoisite, feldspar, epidote from a marble from the same unit, assuming a common pressure-temperature-time history. During the second stage, allanite and calcite precipitated in veins related to brittle deformation of the titanite megacryst. The fluid interacting at this second stage had an initial Sr isotopic composition even more radiogenic than that of the titanite megacryst core. This fluid may be derived from dehydrating subducted crustal rocks that were juxtaposed to the marble during a later stage of exhumation. Our results indicate that Sr and Nd isotope compositions are a tool to identify the reaction history and titanite sample volumes that precipitated from isotopically homogeneous fluid sources, as required for (U-Pb isochron) geochronology. Particularly suited is Sr, as titanite, calcite, clinozoisite, allanite essentially carry no Rb, precluding reaction-induced isotopic heterogeneity to be camouflaged by in situ 87Sr growth.

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Wawrzenitz, N., Romer, R.L., Oberhänsli, R., Dong, S., 2006. *Lithos* 89, 1-2, 174-201.