Constraining deformation phases in the Tauern window, Eastern Alps, using Th-Pb crystallization ages of fissure monazite-(Ce)

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Hydrothermal monazite-(Ce), (LREE,Th)PO_4, hereafter called monazite, is found in Alpine fissures and clefts that formed during Oligocene-Miocene tectonic movements in the Tauern window, Eastern Alps. It was estimated that they crystallized at temperatures of ~200-300°C in the eastern part of the Tauern window (Gnos et al., 2015), thus postdating early fissure formation. Early fissures are oriented perpendicular to the main fold axis (and lineation) of the Tauern window, whereas younger fissures are oriented pependicular to strike-slip faults. However, both fissure generations are sub-parellel.

In a fluid-filled fissure, chemical disequilibrium induced by tectonic movements triggers dissolution of minerals and can lead to crystallization or reprecipitation of monazite and to resetting of the isotopic system (e.g. Grand'Homme et al., 2016; Seydoux-Guillaume et al., 2002, 2012). Therefore, hydrothermal monazite is able to record several deformation events through multiple growth and dissolution episodes (e.g. Bergemann et al., 2017; Berger et al., 2013). Crystallization ages of fissure monazite from the Tauern window were measured at the Nordsim and SwissSIMS facilities. Th-Pb data of monazite growth domains yielded weighted mean ages between 21.3 ±2.1 and 7.69 ±0.88 Ma, indicating protracted deformation over ~14 Ma. N-S shortening between the Northern Calcareous Alps and the Dolomites indenter increases from east to west in the Tauern window and led to folding and exhumation of the European subduction wedge (e.g., Rosenberg et al., 2018). Whereas early monazite crystallization is related to late upright-folding and lateral extension of the nappe stack, younger monazite growth domains predominate in fissures associated with the younger, conjugated strike-silp faults frequent in the central and western part of the Tauern window. The low amounts of Si, Ca and Y in the dated monazite grains indicate very limited solid solution with huttonite (ThSiO4), brabantite (CaTh(PO4)2) and xenotime (YPO4).

Comparison of Th-Pb fissure monazite crystallization ages to existing crystallization and cooling ages (zircon/apatite fission tracks, white mica ages from fault zones, (U-Th)/He ages; e.g. Bertrand et al., 2017; Schneider et al., 2013) shows that monazite crystallization ages do not show the U-shaped distribution like cooling ages, when plotted on a section perpendicular to the main fold axis of the Tauern window.