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Satellite monazites: A peculiar microstructural feature in polymetamorphic basement rocks of the Alps and its origin

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The (retrograde) marginal decomposition of monazite, with the formation of a secondary apatite-allanite corona, is a frequently observed feature in low to medium grade metamorphic environments (Finger et al. 1998, Broska and Siman 1998). If the host rock undergoes a renewed later stage of metamorphism, it may happen that these apatite-allanite coronas in turn spawn small secondary monazite grains, which arrange themselves like satellites in some distance from the older monazite core. This distinct feature of monazite destruction and regrowth has been identified in various rocks from the polymetamorphic Alpine basement and was studied in two samples in more detail. These include a metapelite from the northern Tauern window (Zwölferzug) and a metagranite from the central Ötztal unit (Sulztal granite gneiss).

Electron microprobe based chemical Th-U-Pb dating was applied to both samples. In the metapelite sample from the Tauern window, the monazite core is Variscan in age and formed during a high-grade Barrow-type metamorphic event. The satellite monazites grew in the Tertiary, when the rock suffered a low-T Alpine overprint. The sample from the Ötztal contains Early Palaeozoic monazite cores (magmatic monazite from the granite protolith). The satellite monazites here are Variscan in age and formed within the frame of a high-grade Barrow type regional metamorphism.

Notably, monazite regrowth from the apatite-allanite paragenesis occurred at low-T metamorphic conditions in the sample from the Tauern window, but at high-T metamorphic conditions in the sample from the Ötztal. Although the metagranite sample from the Ötztal experienced another metamorphic event at T$\sim$500°C in the Cretaceous, no satellite monazites of this age were found within the apatite-allanite coronas.

This shows that the intermediate temperature range around 500˚C is not favourable to initiate regrowth of satellite monazites. The same is indicated by the work of Finger et al. (1998), who investigated a late Palaeozoic metagranite from the Tauern window, where magmatic monazite was systematically replaced by apatite-allanite coronas during medium grade Alpine metamorphism (T $\sim$ 550 ˚C). Again no satellite monazites formed. These observations fit nicely with observations made by Wing et al. (2003) for prograde metapelite series. Namely that allanite often occupies a distinct stability window at around 450-550˚C, whereas monazite is the stable LREE phase below and above this intermediate temperature range. The exact position and extent of this allanite stability window in the P-T space depends on the whole rock composition (Wing et al. 2003).

One further conclusion from this study is that the creation of two monazite age populations in a polymetamorphic rock is favoured when allanite occurs as an interim product, i.e. when a rock with primary monazite has received an upper greenschist/lower amphibolite facies overprint first and then renewed metamorphism at a lower or higher temperature. If not transformed into allanite, the primary monazite will often remain stable, even in a polymetamorphic rock, and thus not provide a fertile source for new metamorphic monazite growth.