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Replacement of primary monazite by apatite-allanite-epidote coronas in an amphibolite facies granite gneiss from the eastern Alps

FRITZ FINGER, IGOR BROSKA,* MALCOLM P. ROBERTS, AND ANDREAS SCHERMAIER

Institut für Mineralogie der Universität Salzburg, Hellbrunnerstrasse 34, A-5020 Salzburg, Austria

ABSTRACT

Accessory monazite crystals in granites are commonly unstable during amphibolite facies regional metamorphism and typically become mantled by newly formed apatite-allanite-epidote coronas. This distinct textural feature of altered monazite and its growth mechanism were studied in detail using backscattered electron imaging in a sample of metagranite from the Tauern Window in the eastern Alps. It appears that the outer rims of the former monazites were replaced directly by an apatite ring with tiny thorite intergrowths in connection with Ca supply through metamorphic fluid. Around the apatite zone, a proximal allanite ring and a distal epidote ring developed. This concentric corona structure, with the monazite core regularly preserved in the center, shows that the reaction kinetics were diffusion controlled and relatively slow.

Quantitative electron microprobe analyses suggest that the elements released from monazite breakdown (P, REE, Y, Th, U), were diluted and redistributed in the newly formed apatite, allanite, and epidote overgrowth rings and were unable to leave the corona. This supports the common hypothesis that these trace elements are highly immobile during metamorphism. Furthermore, microprobe data suggest that the preserved monazite cores lost little, possibly none of their radiogenic lead during metamorphism. Thus, metastable monazite grains from orthogneisses appear to be very useful for constraining U-Th-Pb protolith ages.

On the basis of these findings and a review of literature data, it seems that monazite stability in amphibolite facies metamorphic rocks depends strongly on lithologic composition. While breaking down in granitoids, monazite may grow during prograde metamorphism in other rocks such as metapelites.