Early Cretaceous metamorphism in the Tisza and Dacia mega-units following the obduction of the South Transylvanian Ophiolites: new results from U-Th-Pb monazite and Sm-Nd garnet dating in the Apuseni Mountains (Romania)

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Petrographic data evidences two separate medium-grade metamorphic overprints in both, Tisza and Dacia mega-units of the Apuseni Mountains. New Th-U-Pb monazite data in combination with Sm-Nd garnet analyses allows the correlation of one of these two medium-grade overprints to Late Jurassic–Early Cretaceous times. Furthermore, different age clusters and monazite-allanite reactions were observed according to the structural position in the nappe stack. Permian and Late Jurassic ages in samples from the structural top of the Biharia Nappe System (i.e. the Vidolm Nappe) correlate with geochronological data from neighboring tectonic units and are interpreted as inherited detrital monazite. Together with previously published thermochronological data from the same unit and observed monazite breakdown reactions, a Late Jurassic thermal overprint of 400-450 °C is inferred. The central part of the nappe stack (i.e. the Baia de Arieș Nappe) shows allanite breakdown reactions and newly formed Th-rich monazite. Some relict Variscan and Permian ages are present, but Late Jurassic to Early Cretaceous ages are predominant. The age range shows a good agreement with the range of Sm-Nd garnet dates from the same sample. Polyphase garnet growth is observed in thin-sections and supported by medium-grade *P-T* conditions (~550° C/0.5-0.8 GPa). Thus, the formation of new monazite in the Baia de Arieș Nappe occurred due to prograde allanite breakdown at peak metamorphic conditions. Together with previously published geochronological data and structural observations, we correlate the Late Jurassic to Early Cretaceous prograde overprint of the Dacia Mega-Unit with E-directed Alpine nappe stacking following Late Jurassic obduction of the South Apuseni Ophiolites on top of the Biharia Nappe System. Two samples from the structurally lowest position in the nappe stack (i.e. the Bihor Unit, Tisza Mega-Unit) yielded Variscan (Carboniferous to Permian) and Triassic ages, together with a significant peak of mid-Cretaceous ages from low-Y monazites. The mid-Cretaceous age cluster shows a good agreement with a Sm-Nd garnet age (104±2 Ma) from one of the samples and correlates with other geochronological data from the eastern periphery of the Bihor Unit. We consider NW-directed thrusting, followed by E-directed exhumation of the Bihor Unit to be responsible for the observed distribution of mineral isograds and geochronological data. Together with petrographic evidence of polyphase garnet growth, this implies that also the Tisza Mega-Unit experienced a strong regional metamorphic overprint and synkinematic garnet-growth during late Early Cretaceous times. Our new findings contrast earlier views that attributed medium-grade metamorphism in the Apuseni Mountains exclusively to the Variscan orogeny and low-grade metamorphism to the Alpine orogeny.