Thermal evolution of an orogenic wedge: the Austroalpine (AA) of the Eastern Alps; inferences from numerical modelling

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Two-dimensional numerical modelling techniques are used to study the tectono-thermal evolution of Cretaceous continent-continent collision of the Austroalpine microcontinent, following the closure of the Mid–Triassic to Jurassic/Early Cretaceous Meliata–Hallstatt ocean (e.g., Neubauer, 1994). During this event, major tectonic units (Upper-, Middle- and Lower Austroalpine) were stacked, bringing the AA in a lower plate position, as indicated by the presence of Eo-Alpine eclogites within Middle AA basement series. In our kinematic model we have investigated an approximately N–S running cross section, adopting underthrusting as the mode of stacking. Timing and conditions of metamorphic and deformation events are constrained by geochronological, stratigraphic and petrological data.

Deformation and lower greenschist facies metamorphism within the Upper AA unit, which represents the southern margin of the AA microcontinent, took place ca. 100–90 Ma ago, as indicated by $^{40}Ar/^{39}Ar$ age data of synkinematically grown white micas from the base of the Northern Calcareous Alps and the Graywacke zone (Dallmeyer et al., 1996).

Ongoing convergence led to the accretion of the Middle AA domain, parts of which were subjected to high–P metamorphism. P–T conditions for this event were estimated by Miller (1990) at c. 1.8 GPa/ 580–630°C for the eclogites of the Saualm–Koralm region. Radiometric data from the eclogites and the encasing metapelites gave an age range of 150–90 Ma for the high-P metamorphism, showing a tendency towards younger ages (in average 95 Ma), followed by nearly isothermal exhumation of the eclogites and amphibolite facies overprint at ca. 90 Ma (Thöni & Jagoutz, 1992; Thöni & Miller, 1996).

In our model, we achieve isothermal exhumation, adopting a rapid decompression phase lasting from 95–90 Ma, assuming the P–peak to have occurred at 95 Ma, thus supporting the younger ages of Thöni & Jagoutz (1992) and Thöni & Miller (1996). The model results show, that slower exhumation rates cause a pronounced temperature rise and would obliterate the high–Paessemblages. Additionally, underthrusting of the Middle AA unit leads to cooling in the hangingwall Upper AA complex, prohibiting a higher degree of metamorphism.

Further exhumation and cooling of the Middle AA domain is contemporaneous with underplating of the Lower AA realm, which displays max P–T conditions at its southern parts of 0.8–0.9 GPa and 500–550°C (Moine et al. 1989). From our model, we deduce that cooling during exhumation of the Lower AA unit is largely governed by subduction of the S-Penninic ocean at c. 80–60 Ma.