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

Ernst Willingshofer¹, Jan Diederik van Wees¹, Sierd Cloetingh¹ & Franz Neubauer²

¹ Institute of Earth Sciences, vrije Universiteit Amsterdam, The Netherlands
² Department of Geology, University of Salzburg, Austria

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 ⁴⁰Ar/³⁹Ar age data of synkinematically grown white micas from the base of the Northern Calcareous Alps and the Graywacke zone (Dalmeyer 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 Sauralm–Koral region. Radiometric data from the eclogites and the enclosing 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–P assemblages. 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.

3D-flexural modelling of the West- and East Carpathian transition zone: problem description and preliminary results

Reini Zoetemeijer¹, J.D. van Wees¹, Ihor Bubniak² & Andrzej Ślączka³

¹ Faculty of Earth Sciences, Vrije Universiteit, De Boelelaan 1085, 1081 HV Amsterdam, The Netherlands
² Institute of Geology and Geochemistry of Flues, Naukova 3a, 290053 Lviv, Ukraine
³ Institute of Geological Sciences, Jagiellonian University, Oleandry 2a, 30-063 Kraków, Poland

The transition zone between the West- and East-Carpathian mountain belt and foredeep are characterized by the change in strike from W–E to NW–SE. This change is probably controlled by the differential strength of the West- and East-European lithosphere and shape of the plate margins. Especially the role of the Russian Platform as fixed and rigid boundary is dominant. Furthermore, the transition zone is also characterized by widening of the foredeep in S.E. Poland. With 3D-modelling we analyse the flexural expression of the obliquely interacting subducting/underthrusting processes acting on the West- and East-European lithosphere. We concentrate on the lateral variation in effective elastic thickness (cet) of the lithosphere. The weak zones, expressed in low cet-values, control the main flexural bending of the lithosphere and the stronger zones, expressed in the higher cet-values, are able to transfer the flexural intra-plate stresses. However, in order to explain the folded shape of the foredeep in S.E. Poland, passive interaction is not sufficient: we suggest possible NW continuation of the East-Carpathian system under the foredeep in S.E. Poland. In earlier studies of 3D kinematic reconstructions (Morley, Tectonics, 4, 1996), lateral space problems are documented for arc-shaped thrust belts. He notes that due to the divergence of the over-thrusting foreland extension may occur parallel to strike. These space problems do also exist for the under-thrusting/underthrusted European lithosphere, for which the plate boundaries converge and even overlap(?).