Mitt. Ges. Geol. Bergbaustud. Österr. 41, Wien 1996, 101-148

The Southern Carpathians - wrench-fault corridor on the Western Margin of the Moesian Platform

Franz Moser and Wolfgang Frisch

Geological Institute, University of Tübingen, Germany

The Southern Carpathians mark the northwestern continuation of the Balkan orocline, forming an almost 100 km wide wrench fault corridor on the western margin of the Moesian platform. Their large-scale geometry proofs a transpressional nappe system due to collision in the Cretaceous and fragmentation due to dextral transpression since the Oligocene. Mylonites within the Danubian nappe show Late Cretaceous ductile shear, recording oblique collision and translation of the Transylvanian block towards the NE around Moesia (Ratschbacher et al. 1993).

Dextral strike slip movement on a NE trending fault system penetrates the Romanian Southern Carpathians. It was active at least since late Oligocene showing brittle deformation. A major tectonic lineament, the Cerna-Jiu-Cisnadie fault system, cuts convex across the Southern Carpathians from S to NE, showing a dextral offset of 35 km (Berza & Draganescu 1988). Along it's northern section the Petrosani basin was opened in Upper Oligocene as a negativ flower structure, whereas transpressional features are common west of the Godeanu massif. Southeast of the Cerna-Jiu fault the Mehedinti nappes were thrusted simultanously.

Due to the beginning of retreating subduction (Royden 1993) along the northern boundary of Moesia, NE directed motion of the Transylvanian block became E directed. The eastward movement was partially compensated by the E striking dextral Bistra-Lotru-Cozia fault system showing a dextral displacement of at least 10 km. Along this fault system the Hateg basin was opened as a pull apart basin showing mainly Sarmatian subsidence.

A re-organisation of tectonics in the western Southern Carpathians is proved during the Badenian due to extension in the Pannonian realm (~16.5 to ~14 Ma). Mostly along the contact between Danubian unit and Getic/Supragetic unit Sichevita-, Bozovici- and Caransebes-Mehadia basin subsided. The Getic/Supragetic block W of these intramontane basins was transported towards the Pannonian basin by at least 1 km. Subsidence dies out successively, starting with the Sichevita and Bozovici basin during the Sarmatian (~ 13 Ma) and ending with the Caransebes basin in the Pannonian (~8.5 Ma).

S of the Cerna-Jiu-Cisnadie fault strike slip tectonics were active throughout the Miocene and major displacement shifted from the Cerna-Jiu-Cisnadie fault to the dextral Baia de Arama-Severin-Timok fault system translating an paleozoic ophiolite 50km towards North. Along this major fault the Timok basin subsided (~ 16.5 Ma).

Tertiary subduction mechanism of the Carpathian-Pannonian region

Michal Nemcok[1], L. Pospisil[2] and Jaroslav Lexa[3]

[1] Department of Geology and Paleontology, University of Salzburg, Austria
[2] Geofysika a.s., Brno, Czech Republic
[3] Slovak Geological Survey, Bratislava, Slovakia

During the Late Cretaceous-Eocene, the future Karpathian orogen was part of the Alpine-Karpathian orogen formed by known southeastward subduction (135-55 Ma) of the Penninic realm and collision of European and Adriatic continents. While the Eocene Alps were at the converging (collisional) fronts, the remnant Eocene Karpathian Flysch Basin (rCFB) experienced subduction. The subduction in the Alpine region ended by delamination of subducting oceanic lithosphere from the light continental one and related magmatism (42-25 Ma).

During the Late Oligocene-Early Miocene, the rCFB was experiencing ongoing subduction, that formed the free interface for the East Alpine extrusion from the "Alpine collisional node". The oceanic plate underlying rCFB subducted southwestwards, later westwards while northeastward and eastward migration velocity of the accreting plate boundary was decreasing through the time. Slower subduction rates caused steeper dip of the subduction zone, Eggenburgian onset (22-19 Ma) and following duration of hinterland extension accompanied by asthenosphere elevation, onset of crustally derived volcanism above elevated asthenosphere and younger mantle-derived volcanism, progressively less contaminated by crustal material, all contemporaneous with shortening in frontal, accretionary, parts of the Carpathians.

Subduction of the rCFB led during the end of the Early Miocene to a collision with continental margin at the westernmost part of the present Carpathian arc. Northeastward, later eastward subduction roll-back of the subducting slab of the rCFB under the advancing Inner Carpathians, oblique closure of the basin, progressive change of subduction to collision from the west to the east along the Carpathian arc drove delamination of the remaining oceanic slab. Delamination has started in the west of the Carpathian Arc since Erly Miocene, ran along the arc to its present onset position in the bend area between the East and South Carpathians. The delamination lateral propagation rate had also decreasing trend in time. Delamination-related volcanism was synchronous with final stages of the collision, as it was in the case of Eocene-Oligocene "Alpine delamination".

Kinematics of the Periadriatic Fault in the Eastern Alps: evidence from paleostress analysis, fission track dating and basin modelling

Franz Nemes[1], Franz Neubauer[1], Sierd Cloetingh[2] and Johann Genser[1]

[1] Department of Geology and Palaeontology, University of Salzburg, Austria.
[2] Faculty of Earth Sciences, Vrije Universiteit Amsterdam, The Netherlands

New kinematic data along the eastern part of the Periadriatic Fault (PF) in the Eastern Alps, show polyphase kinematic patterns due to a succession of distinct deformation phases. The PF and related structures mark a first order tectonic boundary between the Austro-Alpine and the South Alpine units that differ in style and timing of deformation in metamorphic conditions.

Initiation of the future PF may have been occurred during Oligocene break-off of the subducted lithosphere where tonalitic magmas intruded in a continuous belt along the future PF within a wrench zone controlling the location of the future PF.

Depth determinations using the Al-in hornblende barometry yielded c. 5-6 Kb. The deformed metamorphic basement units of the Gailtal metamorphic complex, Eisenkappel zone and Palaeozoic carbonate complexes of the Southern Alps (Eder unit, Devonian) show E-W striking mylonitic foliation and mineral stretching lineation gently plunging to the east. High ductile strain affected Periadriatic plutons after emplacement, as the PF acted as a „stretching fault" during transpressive N-S shortening, leading also to exhumation of the Periadriatic tonalites. Rheological and frictional properties and fluid pressure allowed a deformation on plutons that lengthen in the slip direction while strike-slip accumulated.

Subsequent brittle deformation led to changing convergence directions within a transpressive regime. These stages include:

(1) Early Miocene N-S directed contraction caused transpressional structures expressed by N-directed thrusts and S-directed backthrusts, NW-striking dextral faults (R faults), and NE-trending sinistral faults (R' faults).

(2) Late Miocene top-to-NW nappe stacking N of the PF (e_3 NW-SE, e_1 subhorizontal). The final overthrust of Karawanken Mountains during Miocene, which form a positive flower structure, also includes flexure of the northern foreland, and formation of a narrow Sarmatian to Quaternary foreland basin, the Klagenfurt Basin.The final NNW-directed overthrust of the Karawanken mountains onto the foreland is depicted by several NW-SE striking dextral tear faults and NW- to NNW-directed thrust planes in Upper Tertiary sediments.

2D-numerical modelling of crustal flexure and strength profile calculations were carried out in order to calculate the effective elastic thickness and shape of the Austro-Alpine crust underneath the basin using Bouguer anomaly data (Steinhauser et al., 1980, Meurers, pers. comm.). The best-fit models gave very low effective elastic thicknesses for the bending plate of between 1.7 and 0.9 km. Estimated bending moment and vertical shear forces alone create too shallow deflection, so additional horizontal forces (horizontal forces approx. -1.5 kbar) must be estimated.

The low effective elastic thicknesses indicate that only the a small part of the lithosphere supports the regional isostatic response to the load by the Karawanken Mountains. The lithosphere to north of the Karawanken Mountains is characterised by crustal thicknesses of between 40 and 45 km and elevated heat flows. Rheologic models for this lithospheric configuration indicate a strong decoupling of upper crust, lower crust and mantle and generally low strengths for the lower crust and mantle. This strength distribution suggests that only the upper crust elastically supports the topographic load and lower crust and perhaps mantle deformed by ductile flow. Ductile flow of the lower crust is also supported by the absence of a crustal root beneath the Karawanken chain (Steinhauser et al., 1980).

Data derived from apatite fission track dating on samples north and south of the PF show Miocene or Oligocene cooling ages. These range from 36.5 ± 1.5 to 31.7 ± 1.9 Ma for South Alpine Werfen Formation in Slovenia, and 12.8 ± 0.9 to 13.1 ± 1.4 Ma for tonalites between Lesach Valley, the Karawanken Mountains and the Pohorje massif north of the PF. Confined track length distributions from all samples indicate different cooling histories. Mean track lengths are confined to the range of 11,46 to 13,38 µm. The track length distribution from the South Alpine Werfen Fm. has shorter tracks which indicates that the sample spent a longer time in the upper part of the partial annealing zone (approx. 100° C).