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Migration of deformation, subsidence, and basin formation in the SW Pannonian Basin (central Europe) and the change to contractional deformation

László Fodor[1,2], Attila Balázs[3], Gábor Csillag[2,4], István Dunkl[5], Gábor Héja[1,2,6], Péter Kelemen[5,7], Szilvia Kövér[1,2], András Németh[8], Dániel Nyíri[8], Éva Oravecz[1,2], Ildikó Selmeczi[6], Mirka Trajanova[9], Marko Vrabec[10], and Mirijam Vrabec[10]

[1]Eötvös Loránd University, Institute of Geography and Earth Sciences, Department of Geology, Budapest, Hungary
[2]MTA-ELTE Geological, Geophysical and Space Research Group at Eötvös University
[3]ETH Zürich, Department of Earth Sciences, Switzerland
[4]Institute for Geological and Geochemical Research, Research Centre for Astronomy and Earth Sciences ELKH
[5]University of Göttingen, Germany
[6]Mining and Geological Survey of Hungary, Budapest
[7]Eötvös University, Institute of Geography and Earth Sciences, Department of Petrology and Geochemistry, Budapest, Hungary
[8]MOL Plc., Budapest, Hungary
[9]Geological Survey of Slovenia, Ljubljana
[10]University of Ljubljana, Department of Geology, Ljubljana, Slovenia

The Pannonian Basin is a continental extensional basin system with various depocentres within the Alpine–Carpathian–Dinaridic orogenic belt. Along the western basin margin, exhumation along the Rechnitz, Pohorje, Kozjak, and Baján detachments resulted in cooling of diverse crustal segments of the Alpine nappe stack (Koralpe-Wölz and Penninic nappes); the process is constrained by variable thermochronological data between ~25–23 to ~15 Ma. Rapid subsidence in supradetachment sub-basins indicates the onset of sedimentation in the late Early Miocene (Ottnangian? or Karpatian, from ~19 or 17.2 Ma). In addition to extensional structures, strike-slip faults mostly accommodated differential extension between domains marked by large low-angle normal faults. Branches of the Mid-Hungarian Shear Zone (MHZ) also played the role of transfer faults, although shear-zones perpendicular to extension also occurred locally.

During this period, the distal margin of the large tilted block in the hanging wall of the detachment system, the pre-Miocene rocks of the Transdanubian Range (TR) experienced surface exposure, karstification, and terrestrial sedimentation. The situation changed after ~15–14.5 Ma when faulting, subsidence, and basin formation shifted north-eastward. Migration of normal faulting resulted in fault-controlled basin subsidence within the TR which lasted until ~8 Ma.

3D thermo-mechanical lithospheric and basin-scale numerical models predict similar spatial migration of the depocenters from the orogenic margin towards the basin center. The reason for

this migration is found in the interaction of deep Earth and surface processes. A lithospheric and smaller crustal-scale weak zones inherited from a preceding orogenic structure localize initial deformation, while their redistribution controls asymmetric extension accompanied by the upraising of the asthenopshere and flexure of the lithosphere. Models suggest ~4–5 Myr delay of the onset of sedimentation after the onset of crustal extension and ~150–200 km of shift in depocenters during ~12 Myr. These modeling results agree well with our robust structural and chronological data on basin migration.

Simultaneously with or shortly after depocenter migration, the southern part of the former rift system, mostly near the MHZ, underwent ~N–S shortening; the basin fill was folded and the boundary normal faults were inverted. The style of deformation changed from pure contraction to transpression. The Baján detachment could be slightly folded, although its synformal shape could also be considered a detachment corrugation. Deformation was dated to ~15–14 Ma (middle Badenian) in certain sub-basins while in other sub-basins deformation seems to be continuous throughout the late Middle Miocene from ~15 Ma to ~11.6 Ma.

Another contractional pulse occurred in the earliest Late Miocene, between ~11.6 and ~9.7 Ma while the western part of the TR was still affected by extensional faulting and subsidence. All these contractional deformations can be linked to the much larger fold-and-thrust belt that extends from the Southern and Julian Alps through the Sava folds region in Slovenia. Contraction is still active, as indicated by recent earthquakes in Croatia.

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