Isostatic and dynamic controls on neotectonic differential vertical movements and sediment transport reorganization of the Pannonian Basin, Central Europe

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Extensive geophysical studies on gravity anomalies and seismic structure of the Pannonian Basin have determined that this extensional sedimentary basin is more elevated than predicted by Airy-type isostatic compensation models. European regional models assuming a two-layered lithosphere containing a uniform crust and a lithospheric mantle estimated ca. 750-1000 meters difference between the actual and calculated isostatic topography for the Pannonian region. We have revisited this early finding and calculated a refined residual topography map of the Pannonian Basin that also takes into account the low-density sedimentary fill. We show that the actual residual topography of the eastern part of the region is much lower than previously thought and ca. 4-500 meters of positive residual topography characterizes the central and western part of the Pannonian Basin.

In order to interpret the observed residual topography of the basin we carried out a series of elasto-visco-plastic thermo-mechanical numerical models. Our simulation of the last 9Myr covering the classical “post-rift” phase of the Pannonian Basin analyzes forcing factors, such as asthenospheric-scale mantle convection, elastic flexure of the lithosphere due to increased external stress and sediment re-distribution, and ductile lower crustal deformation. The large-scale positive residual topography is dominantly controlled by mantle dynamics.

Finally, 3D stratigraphic numerical forward modelling has been carried out by DionisosFlow, constrained by our previously calculated tectonic scenario. We analyzed the substantial reorganization of the main sedimentary transport routes in the Pannonian Basin mainly controlled by the development of the observed positive dynamic topography of the basin. Our preliminary model results are in good agreement with geological records, such as the ca. 200 km Pliocene eastward migration of the Paleo-Danube drainage network.