Structural evolution of the Transylvanian Basin (Romania) and FEM stress modeling of the E and S Carpathian collision with the Transylvanian block

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Structural analysis and paleostress results for the Transylvanian Basin and its borders with the surrounding regions are presented together with finite element stress modelling of the collision of the Transylvanian block with the E–European craton and the Moesian platform.

We identify at least six deformation phases in the Tertiary: 1) N–S small-scale extension of Oligocene age affecting dominantly the N part of the basin; 2) NW–SE compression of Late Oligocene age which produced important thrust and regional scale folds in the NW part of the basin; 3) NNE–SSW compression of Late Oligocene/Early Miocene age which produced SSW directed thrusts in the northern part of the basin; 4) E–W small-scale extension of Mid to Late Miocene age that affected vast areas and caused some important normal faulting in the SE of the basin; 5) E–W compression of late Miocene and younger age which produced significant folds and thrusts all around the Transylvanian basin. We identified major backthrusts with WSW transport direction in the internal part of the E-Carpathians, which we correlate with the climax in E–W compression. The onset of back thrusting coincides with the strong exhumation and erosion of the E Carpathians, demonstrated by apatite fission track analysis; 6) In the Pliocene/Quaternary we document a shift of the compressive stress field towards a WNW–ESE direction. The backthrusts reactivated in a strike slip manner accommodating further contraction in the southern part of the E-Carpathian segment and creating the small pull apart basins of Quaternary age located, on the internal border of the E Carpathians.

The results show that the tectonic history of the Transylvanian Basin is mainly characterised by compressional deformation. The Neogene basin subsidence can be explained by an initial phase of small-scale extension in the Mid Miocene and subsequent contractional loading by the East Carpathians and the Apuseni Mts in the Late Miocene and Pliocene, and passive infill with the sediments shed from the uplifted surrounding mountains.

We use plan-view finite element modelling to simulate the stress field of the collision of the Transylvanian block with the E-European craton and the Moesian platform. We employ an elastic rheology. To simulate the East and South Carpathians we introduce zones of weakness in the model. The Transylvanian plate, the Moesian platform and E-European platform behave as strong semi-rigid blocks. We apply an east directed compressive force at the western boundary of the Transylvanian plate, simulating the rift push force beneath the Pannonian Basin due to lithospheric thinning. The model reproduces the first order features of the stress field of the last two stages of the collision. That is a homogeneous more or less E–W directed stress field in the Transylvanian area and strong deviations from the regional pattern in the weakness zones representing the E and S Carpathians.