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Geometry, evolution and kinematic correlations of a buried segment in the Tisza – Rhodopian fragment contact: the pre-Neogene tectonic evolution of the Transylvania basin

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The Transylvania basin represents an adequate example for the study of complex buried tectonic margins, superposed basins with poly-phase structural evolution and late-stage orogenic basins with no significant internal deformations. Although Transylvania has been considered for a long time a backarc basin formed during Neogene contractional episodes of the Carpathians, it actually represents a complex system of basins with distinct geometries and kinematics. Due to the deep burial below thick and overall widespread Neogene sediments, the earlier basin evolution has been less studied and previous tectonic models are generally based on a wide range of assumptions and speculations in the absence of published detailed exploration data.

The first major extensional event is marked by the Triassic-Lower Cretaceous rifting, opening of the Transylvanides domain and subsequent evolution of an asymmetric passive margin system locally superposed over the rifting structures. Our study reveals a presently NNE-SSW trending normal fault system and associated Jurassic-Lower Cretaceous sedimentary wedges. The inferred mechanism assumes a simple-shear asymmetric extension, with a master detachment fault dipping westwards at high depths near the South Apuseni Mountains. This detachment has abandoned during shearing and upwelling a portion of the main mobile area in the central-southern part, i.e. the Tarnave basin. The main extensional area is partially preserved north-

wards, in the direct continuation of the exposed South Apuseni Transylvanides, in a deep basin (i.e., Puini), comprising a thick sequence of Jurassic? – Lower Cretaceous sediments deposited directly over presumably oceanic crust. The structure furthermore is completely inverted in later tectonic episodes.

The first moment of basin inversion takes place in Middle Cretaceous (Aptian) and corresponds to the coeval crustal shortening taking place in the adjacent orogens. This deformation is characterized by presently N-S oriented thrusts, accommodating the E-ward vergent nappe stacking of the Internal Dacides (North Apuseni Mountains) on top of the Transyilvanides. A first stage of thrusting of the ophiolites on top of the Rhodopian basement and pre-Aptian cover is recorded during this time interval both in the Puini area, but also on randomly preserved Transylvanides patches across the entire eastern border of the basin, clearly recognised through basement thrusting on top of Lower Cretaceous sediments. In the south, only minor thrusts are recorded on the eastern flank of Tarnave basin, corresponding to lateral variations in the orogenic stacking. Local subsidence is recorded during Senonian, when small scale extensional basins associated with minor normal faulting trending N-S are preserved mostly in the same Jurassic – Lower Cretaceous (Puini) northern basin. Although the Senonian subsidence mechanisms are largely unknown, one can correlate this extension with the Gosau-type of basins developed in the adjacent orogens.

Subsidence accelerated during Paleogene times, a thick package of marine deposits being still preserved at depth in the western Transylvania and exposed in the NW-most corner. This period is interrupted by a second moment of basin inversion during the Eocene, when the Middle Cretaceous thrusts where re-activated in the NW Transylvania. Two basins are affected by these structures, Puini (north) and Sinmiclaus (west), a typical foredeep develops in the footwall of the main thrust and piggy-back basins are observed in the hanging-wall. This Eocene reactivation of presently NE-SW oriented thrusts is of regional significance, the thrusts being easily correlable with those exposed in the South Apuseni Mountains. These findings would suggest a bi-modal evolution, during Aptian and Eocene of the main frontal thrusting of the Transylvanides, with a presently E-ward and respectively SE-ward vergence.

At the end of the Paleogene a large part of the basin is uplifted and subsequently eroded, earlier structures being preserved either in the two main sub-basins, or in randomly distributed isolated patches. During Upper Oligocene – Lower Miocene (Burdigalian), only the northern part of the Transylvania basin responded as an E-W oriented foredeep basin to shortening and southward thrust loading of the Piennides (senso largo) and footwall nappes. This basin has clear wedge-type geometry with small flexural normal faults. The study of the internal unconformities has enabled mapping of at least three thrusting moments during this time span, presently S-ward

vergent. Following the Middle Miocene the entire Transylvania subsided, developing the juxtaposed Neogene basin, as a direct response to shortening and collision in the external part of the Carpathians.

The regional analysis of the pre-Neogene evolution of the Transylvania basin has outlined and clarified for the first time most of the previously missing key elements in the tectonic reconstructions, such as the kinematics of the basin opening and closure, correlations between the exposed margins of the Tisza, Rhodopian fragment, Piennides and Transylvanides, and a clear timing and geometry of internal deformations during the polyphase evolution which took place during the Jurassic, Cretaceous, Eocene and Lower Miocene.