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The relationship between basin opening, post-rift subsidence, inversion and sea-level variations in complex backarc settings: Miocene-Quaternary structures in the transition area between the Pannonian basin and the Apuseni Mountains

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Formation and evolution of back-arc basins is a direct response of orogenic evolution, predating or coeval with the main phase of collision. Despite the overall regional convergent regime, the local deformation in the backarc reflects large scale subsidence linked or not with extensional deformation and associated thermal events. The Pannonian-Carpathian system allows testing models for basin formation and subsequent deformation, for ongoing orogeny and continental collision. This system comprises some of the best documented sedimentary basins in the world, located within the Alpine orogenic belt, at the transition between the western European lithosphere and the East European Craton. A crucial element of the dynamics of lithospheric deformation is the mechanics of coupling the Miocene back-arc deformation in the Pannonian basin, with continental collision and foreland basin evolution along the Carpathian arc.

One of the key areas of the Pannonian basin evolution in terms of basin formation and late Pliocene-Quaternary inversion is its transition to the Apuseni Mountains and South Carpathians, where a series of extensional basins (Borod, Beius, Zarand, Caransebes) were mapped in the surface geology. The depocenter of the Pannonian basin displays a second series of extensional basins with significant syn- and post-rift

sediments (i.e., Nyirseg, Derecske, Bekes and Mako). A direct correlation between these basins is not straightforward, as second-order structures separate smaller basins mapped by the hydrocarbon exploration in the Romanian sector of the Pannonian basin (e.g., Carei, Abramut, Socodor, Tomnatec).

The first moment of normal faulting coeval with the main subsidence onset postdates Lower Miocene siliciclastic sedimentation. This deformation resulted in the formation of largely distributed normal faults separating (tilted half-)grabens filled with Middle Miocene (Badenian) age sedimentation, while the footwall of the normal faults display erosional patterns. Deformation continued during a second, period of normal faulting, Sarmatian in age, slightly reduced in amplitudes. Listric-shaped normal faults formed during these two deformation stages are generally lower in angle, but they do not seem to connect in a major listric system.

At the end of the Sarmatian, an overall first moment of basin inversion is recognized through large-wavelenght folding, regional tilting and a basin-wide unconformity. This first moment of basin inversion is generally related to the collision taking place at the exterior of the Carpathians. A significant amount of subsidence is recorded during the Pannonian, being subsequently followed by gradual filling patterns, possibly interrupted by an intra-Pontian (Messinian) sea-level drop.

During the Pliocene, a second moment of basin inversion is commonly interpreted in the Pannonian basin, but also in the Carpathians and Transylvania, related to the Adriatic indentor push and stress transfer through the weak Pannonian lithosphere. The sedimentation style changed from gradual filling pattern towards syn-tectonic onlaps, regional scale folds and significant uplift of the Apuseni Mountain. The latter has induced an overall W-ward tilting of the Pannonian basin. The observed associated structures are higher-angle normal faults and/or strike-slip zones.

The case study of the transition between the Pannonian basin and the Apuseni Mountains demonstrate that the interplay between internal basin evolution features and far-field driven stresses transmitted from the active plate tectonic margins are the main driving elements of active backarc basins.