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Subsidence History and Tectonic Control During the Development of the Western Carpathian Neogene Basins

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Based on subsidence history data and model of tectonic activity during the development of the Vienna, Danube and East Slovakian Basins, some common 3rd order stages of the Western Carpathian intramontane basins formation can be distinguished (Horváth 1993; Kováč et al. 1997; Bada 1999).

Initial rifting stage – from the Carpathian till Early Badenian (17.5–15 Ma) is characterized by opening of pull-apart type depocentres in all the mentioned Western Carpathian intramontane basins (Royden 1988; Csontos et al. 1992; Fodor 1995; Kováč et al. 1995; Hrušecký 1999). The onset of the basin formation, associated with extrusion of the ALCAPA lithospheric fragment from the Alpine domain, accelerated by subduction pull in front of the Carpathian orogene. The initial rifting stage was followed by filling up of the basin depocentres till the end the of Early Badenian.

Synrift stage of the basin development, which lasted till the Late Miocene (15–10.5 Ma) was controlled by diapiric mantle uprise in the back-arc domain (Tari et al. 1992; Horváth 1993; Lankreijer et al. 1995; Kováč et al. 1997). The generally slowing subsidence, accompanied by the whole-lithospheric extension was several times interrupted by phases of increased tectonic activity reflecting an accelerated roll-back effect of the individual segments (microslabs) of the subduction zone in front of the Carpathians.

Middle Badenian extesional phase (15–14 Ma) led to graben and halfgraben-type depocentres development. High rate of the tectonic subsidence can be documented in the Danube and East Slovakian Basins. This extensional event reflects most probably a partial rifting at the mantle diapir margin. The Late Badenian sedimentation (14–13 Ma) ended by filling up of the most sedimentary basins and represented time of the crust thermal relaxation.

Early Sarmatian extensional phase (13–12.5 Ma) can be traced in the northern part of the Vienna Basin and the East Slovakian Basin. The opening of new depocentres reflects the partial rifting at the mantle diapir margin but also the active tectonic elongation of the Western Carpathians due to subduction roll--back in the front of the Eastern Carpathians (Csontos 1995). The Late Sarmatian to earliest Pannonian (12.5–10.5 Ma) represents time of the crust thermal relaxation during the synrift filling up of the sedimentary basins.

Early Pannonian extesional phase – the second, late rifting stage (10.5–9.5 Ma) can be observed only in the Danube Basin, e.g. in the area of back-arc uprise of the mantle (Lankreijer 1998).

Stage of thermal postrift subsidence (9.5–1.8 Ma) is represented by the Late Pannonian to Quaternary deposition in the Pannonian Back-arc Basin System (Horváth 1993; Kováč et al. 1997). Similarly to the stage of synrift subsidence, the postrift sedimentation also shows phases of an accelerated subsidence.

Pliocene extensional phase (5.6–1.8 Ma), documented by development of flexural sag basins during the late rifting and following thermal relaxation of the crust, is known only in the Danube Basin. In the Vienna and East Slovakian basins, a Pliocene relief inversion took place during this time (Lankreijer et al. 1995; Baráth et al. 1997; Hók et al. 1999).

Quarternary extensional phase (1.8–0 Ma) can be observed in the Vienna Basin (Zohor – Plavec graben) and Danube Basin (Gabčikovo depression) and lasted till present time.

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Miocene 3rd Order Cycles Reflected in Basins of the Western Carpathians.

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Neogene paleogeography of the Western Carpathian region, as a combination of aquatic and continental environments, was influenced besides the geodynamic factors also by the regional manifestations of global sea-level changes.

Interaction of sea-level changes and tectonics had an important influence on the paleogeography and thereby also on the paleoenvironment of the Western Carpathian basins, which formed the northern bays of the Central Paratethys epicontinental sea in the Miocene (Kováč et al. 1998). The depth and the shape of the basins were predominantly controlled by the main tectonic events. Relative eustatic changes reflected in coastal onlaps were followed mostly by the rise of water paleodepth in the offshore environment. The correlation of the constructed curves for the coastal onlap and estimated paleodepth with the global reference curves (Haq et al. 1988; Haq 1991) shows some discrepancies, because the relative sea-level changes in the Western Carpathian basins have been considerably shaped apart from eustacy, also by local tectonic events and thus they are neither always identical with the defined global cycles, nor with each others, found in different basins of the region (Kováč and Hudáčková 1997; Kováč and Zlinská 1998; Kováč et al. 1999b) On the other hand, we are able to date many biostratigraphically and paleoecologically important paleogeographic events in the studied region, as well as to correlate them with the events in the Central Paratethys and the Mediterranean area.

In the following those relative 3rd order sea-level cycles will be described that can be traced by means of seismostratigraphy, sedimentology and paleoecology in the Western Carpathian during the Miocene (Kováč et al. 1999a). These cycles are marked by symbols from CPC 1 to CPC 6 (3rd order relative sea-level cycles in the Carpathian-Pannonian region).

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