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Evidences in the Pannonian Basin: giant canyon incisions in the Late-Miocene (Pannonian s.l.), connected to SB Pa-4 (ca. 6.8 Ma), Hungary

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New evidences of intra-pannon tectonic activity and connecting relative lake-level drop has been revealed in the central part of the Hungarian Plain where giant incised canyons were recognized in Late-Neogene (Pannonian s.l.) post-rift sediments in several seismic lines. Conventional and modern models and examples of deep-water canyons were all worked out for deep-marine settings so we have to be careful with the full understanding of our small restricted basin. What could be the causes forming such large-scale phenomena in a lake? The aim was to find the answer to this question.

The study area is located in the Pannonian Basin System which is situated inside the Central European Carpathian loop, surrounded by the orogenic belts of the Eastern Alps, Carpathians and Dinarids. The gradual filling up and shrinking of Lake Pannon took place appr. from 11.6 to 4.4 Ma. The sedimentary succession of the lake shows significant signs of relative lake level variations, controlling factors defined both tectonic and climatic (Csató 1993, 2007, Vakarcs et al 1994, Vakarcs 1997, Sacchi et al. 1999, Juhász et al. 2006, 2007a).

In the route of a main fluvio-deltaic feeder system approaching the lake from the NW direction (i.e. the "ancient Danube"), at the zone of the coeval shelf-edge now found in the central part of the basin, the valleys of a deep, giant canyon system can be recognized in several seismic lines. The incision surface is connected to sequence boundary SB Pa-4 (6.8 Ma by Vakarcs 1997), similarly to other incised valleys in the region. This SB surface was considered to have been associated with a significant relative base-level fall in some areas of the basin, due to structural changes (Tari 1994, Vakarcs et al. 1994, Juhász et al. 2006, 2007a). Accordingly, the canyon development is presumably also connected to these structural changes (Juhász et al. 2007b).

The recently recognized canyon system has a surprisingly large size for a lacustrine setting. The size of the major valleys is several times larger than the height of active feeder channels of large deep sea fans. Width of the individual canyon valleys range from 5 to 10 km but 1 to 2 km wide tributaries can also be seen. Generally at least two or even more canyons can be seen next to each other. This can be either the representation of a meandering feature, or this is the area of a major trunk valley where confluences can be seen on the seismic profiles. The depth of the valley is greatest at and around this confluence area (it can reach 600-700 m) and in the deepest part it erodes almost entirely the Late–Miocene (Pannonian s.l.) sedimentary succession. The canyons are filled mostly with clayey deposits, rarely intercalated by some silty-sandy succession. Basinwards fine-grained gravity sediments form the basal part of the sedimentary fill. In a definite time interval the canyons served as feeder channels for the turbidites of the Makó-trough.

The deepest part of the canyon system is incised several hundred meters into the pre-existing substrate, into an extremely thick aggrading deltaic complex, depending on its position to the shelf edge. Towards the canyon head area (i.e. landward) as well as towards downdip direction (i.e. the basin plain areas) the canyons become shallower and either they loose topographic expression or were eroded partially or entirely during a subsequent lowstand phase. The canyon fills are mostly overlain by the strong seismic reflectors of large-scale fluvial channels in the NW part of the study area.

As for the tectonic background detailed mapping of the non-sequential Riedel fractures in the canyon area a large releasing bend and/or extensional duplex of the SW-NE oriented Paks-Kisújszállás strike-slip zone has been revealed. therefore the canyon system can be found at this large releasing bend and/or extensional duplex of the Paks-Szolnok strike-slip system, which was active as sinistral during the Late Miocene (Juhász et al. 2007b). The Paks-Kisújszállás wrench zone was identified earlier on seismic network (Pogácsás et al 1989a, 1989b). This more than 200 km long wrench zone consists of a few, several tens of kilometers long left lateral main strike slip faults. The offset lengths of the individual main faults varies between a few and a dozens of kilometres. Activity timing of strike-slip was Late Miocene-Quaternary (Pogácsás et al 1989a, 1989b, Detzky Lőrincz et al 1993, 1997, Lőrincz et al. 2002). As the canyon system coincides with the flower structures (both positive and negative) on the seismic lines timing of the reactivation of the tectonic activity became more confined at around SB Pa-4.

Conclusions:

There are no other incised canyons of a considerable depth (more than 50 m) around the preexisting shoreline of the basin mapped by several methods during that time interval only in the study area though relative lake level drop and collapse of the shelf edge is most common in the main fluvio-deltaic feeder system arriving from the NE as well (Juhász et al. 2006, 2007). The fact that this is the only location for a 400-700 m deep incision connected to SB Pa-4 (ca. 6.8 Ma) indicates that the formation of the deep canyons was presumably generated by the close interaction of several factors in time and space. The coincision of the following factors were needed to take place at the same time and same place: 1. relative base-level fall, 2. the reactivation and bending/duplexing of a strike-slip system 3. the coeval shelf edge being right in the same area, and 4. the sediment supply carried by overfed rivers from the NW had to change (i.e. to decrease) suddenly, generating strong incision in the tectonically weakened substrate.

This gives way to several thoughts concerning the sedimentary and tectonic evolution of the Pannonian Basin. 1. It supports the theory of considerable relative base-level fall at SB Pa-4 controlled by tectonics. 2. Strike-slip movements must have been active during the formation of the canyons which fact has been neglected up to now. 3. Tectonic rearrangement of the basin at this time interval was probably connected to that of the Mediterranian. 4. Following the SB Pa-4 tectonic subsidence continued in the SE part of the study area.

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