

# **Tectonic Control on Changes in Older Quaternary Sediment Supply in the Körös Sub-basin, and Neotectonic Movements in the Eastern Part of Great Hungarian Plain – Relationship of the Plate Tectonics and Environmental Change**

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**Abstract** – The paper reports on the neotectonic movements of the eastern part of the Great Hungarian Plain (Körös Basin and Érmellék region), which controlled by the crustal deformation of the Pannonian Basin, corresponding the change of plate-tectonic environments in the Alp-Carpathian terrain. The tectonic model implies two phases of uplift of the Apusen Mountains source area during the Late Neogene and Quaternary, which was strongly controlled by the evolution of the subduction zone along Eastern Carpathians. The micro- and morphotectonic measurements show so good that there are two phases of deformations. These phases based on new OSL age data the older neotectonic movement in the study area took place till 40 ka, while the younger movements started after 40 ka BP. We concluded that these tectonic movements had important allogenic control on the development of river dynamics of the Great Hungarian Plain.

**Keywords:** pleistocene / stratigraphy / neotectonics / stress-field / Körös Basin / Érmellék

## **1. INTRODUCTION**

The formation of the Pannonian Basin started in the Early-Middle Miocene by back-arc style rifting, coeval with the late stages of thrusting of the Carpathian belt. Following the Middle Miocene rifting characterized by two independent extensional phases, a post-rift thermal subsidence occurred during the Late Miocene-Pliocene (HORVÁTH 1993). The subsided basin was covered by the Pannonian lake, which was in contact with the former Paratethys up to the end of the Badenian. After the complete isolation of the Pannonian lake from the marine environment, it was filled up by prograded delta system coming from the northwest and northeast. Therefore, the Upper Miocene-Pliocene sequence represents a time-transgressive facies change from offshore basin sediments through basin slope and delta slope to delta front and delta plain sediments, passing up into the alluvial facies, which represent the latest stage of basin fill.

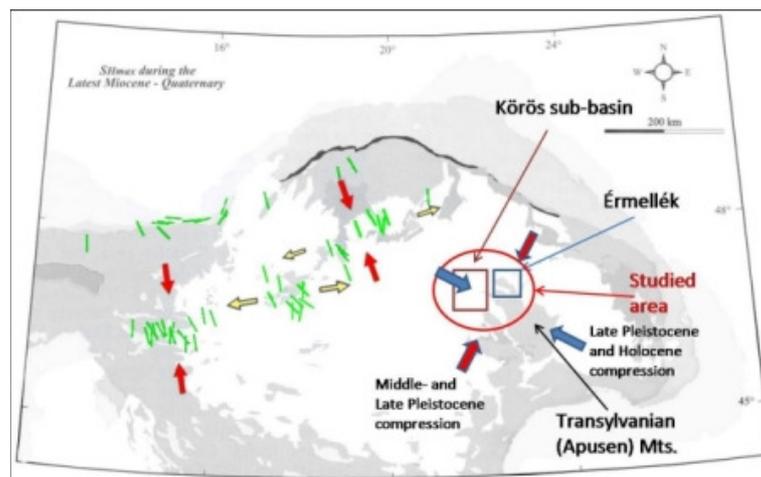
The latest phase of the multistorey development of the Pannonian Basin comprises a still active basin inversion, characterized by NW-SE and N-S compression, which resulted in

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significant uplift of the marginal parts and local subsidence of the basin centre during the Quaternary. The crustal deformation of the Pannonian Basin, which is controlled by the counterclockwise rotation of Adria with respect to Europe around a pole at the  $45^{\circ}$  latitude and  $6-10^{\circ}$  E longitudes resulted the change of plate-tectonic environments in the Alp-Carpathian terrain (CSONTOS et al. 1992; SANDERS 1998).

The change of the direction of main stressfield resulted the change of the plate tectonic environments, which correlate the moving of Earth crust. We can't study the change of plates in this time, but we can research the environmental changing in the lost, which we can correlate the plate tectonics of the Carpathian Basin and surround area. The Körös subbasin and the Érmellék region are the two main studied area (*Figure 1*), where we researched the basin subsidence and the uplift of the sourround area with microtectonic, geological mapping, stratigraphical, morphotectonic and morphological analysis methods.



*Figure 1. Studied area in the Carpathian Basin with neotectonics stress fields. Two phases Quaternary deformation in the eastern part of Hungarian Plain (Apusen Mts., Érmellék and Körös Basin).*

## 2. NEOTECTONICS OF THE KÖRÖS-SUBBASIN

As a result of this varied morphology, the main rivers transported sediments from the northwest, north, northeast and east mountain regions toward the central part of the Pannonian Basin. The uninterrupted subsidence of the Körös subbasin, which has been investigated here, was one of the largest subsiding areas, represented by a 400-500 m thick continuous Pleistocene fluvial record. Variations in transport direction, determined on the basis of detrital micromineral composition as revealed by cluster analysis, were caused by changes in sediment supply, source areas and drainage pattern reorganization. These changes have been shown to be comparable to transport directions predicted on the basis of a theoretical tectono-morphological model, based on sedimentological observations and tectonic data, as well as analogues for basin evolution with similar stress fields.

The tectonic model implies two phases of uplift of the Apusen Mountains source area during the Late Neogene and Quaternary, which was strongly controlled by the evolution of the subduction zone along Eastern Carpathians. During the Pliocene and Early Pleistocene, due to continent-continent collision, a compressional stress field was operating in the East Carpathians region that resulted in thrust-driven uplift of the Apusen Mountains (*Figure 2*) and formation syn-sedimentary trap at the western margin of the mountain chain. For this phase transverse drainage is envisaged, characteristic for actively uplifting orogens, whose

sediments have been captured in the thrust fault bounded syn-sedimentary trap, parallel to the mountain front. In addition to capturing the sediments of the transverse rivers, this trap favoured the development of axial drainage, and sediments were transported from northeast to study area, also inferred from micro-mineralogical data of detrital heavy minerals (THAMÓ-BOZSÓ et al. 2007)

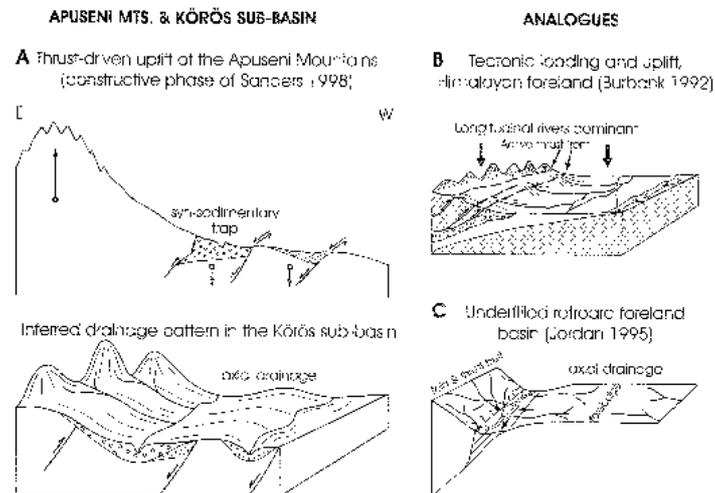


Figure 2. Geotectonic model for the thrust-driven uplift of the Apusen Mountains (after THAMÓ-BOZSÓ et al. 2002).

The second phase of uplift of the Apusen Mountains was characterized by an erosion-driven, isostatic uplift (Figure 3) due to the relief of the compressional stress field resulting from the waning collision. As a result the trap ceased to be active and was filled up rapidly by the sediments of the transverse rivers, and also allowed the spread of alluvial fans over the basin to the west. This is indicated by the occurrence of SE transport directions in the boreholes at about 1,95 Ma ago, which also gives the timing for the tectonic processes.

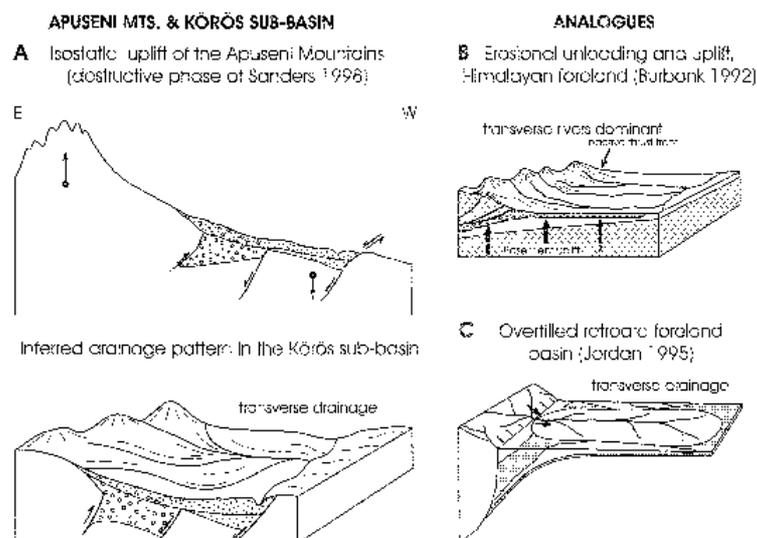
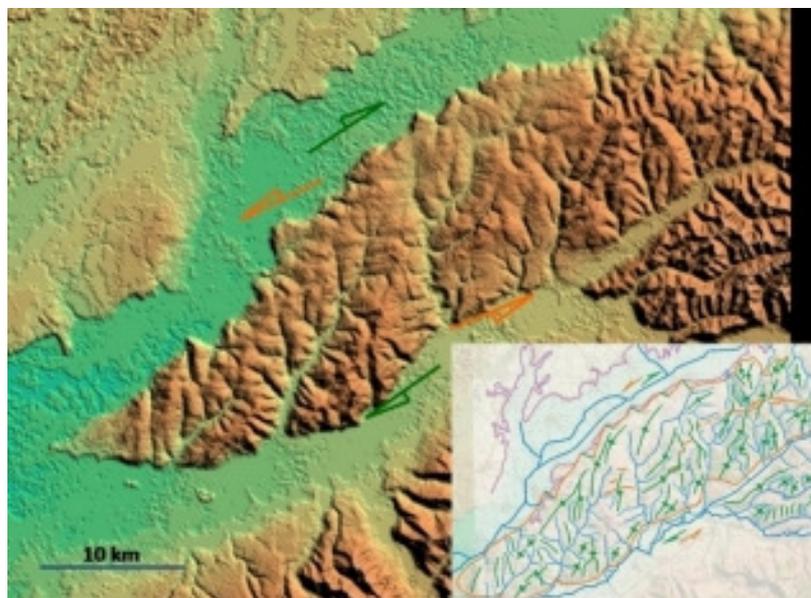


Figure 3. Geotectonic model for the isostatic uplift of the Apusen Mountains and reactivated strike-slip faults on the eastern part of the Great Hungarian Plain (after THAMÓ-BOZSÓ et al. 2002).

### 3. PLEISTOCENE STRATIGRAPHY AND NEOTECTONIC PROCESSES ON THE ÉRMELLÉK REGION

Microtectonic measurements and OSL dating on the source region of Ér-, and Berettyó-rivers. The other studied area is situated east from the Great Hungarian Plain and northwest from the Transylvanian (Apusen) Mountains, close to the source region of Ér- and Berettyó-rivers. These rivers carry sediments into the Körös subbasin, which river network evolution was investigated earlier by sedimentological, morphological, and tectonical methods complemented with OSL dating and heavy mineral analysis. These investigations were extended to northeast, into the valleys of Ér- and Berettyó-rivers.

Our micro- and morphotectonic measurements show that there are two phases of deformations. The older was generated by a NE-SW compression, which caused left lateral strike slips. The younger was generated by WNW-ESE compression and caused right lateral transpressions, which seems to be active till now. The network of the tectonical lines is very similar to those, analysed from seismic sections of the Körös subbasin (*Figure 4*).



*Figure 4. Active tectonic zone in the eastern part of the Hungarian Great Plain. The older ENE-WSW direction sinistral (Middle and Late Pleistocene) and the younger dextral (Late Pleistocene – Holocene) shear zone in the Ér-valley. The Érmellék region connected to the Mecsek-alja Line, which is the most important tectonic zone.*

Pleistocene sediments are represented by fluvial sand and gravel, eolian sand, loess and paleosoils with about 15-20 m thickness on the study area. They are covered by some m Holocene redeposited silty sand, silty clay, and peat sediments in the Ér river valley. Loess, fluvial and eolian sand samples were collected for optically stimulated luminescence dating and heavy mineral analysis. During the OSL measurements on quartz various tests suggest that the samples are suitable for age determination. The equivalent dose of the samples has wide range between 8 and 106 Gy, in 1.2-4.5 m depth. Usually the loess has higher dose rate (1.5-2.3 Gy/ka) than the fluvial and eolian sands have (0.8-1.6 Gy/ka). The estimated OSL depositional ages of the loess samples are about 25, 39, 44, and 54 ka. Fluvial sands deposited about 40-42 ka ago, eolian sands formed about 5 and 10 ka BP. Fluvial sands were found in the Great Hungarian Plain with similar ages and more or less similar heavy mineral composition. Probably they are the sediments of the same river, the ancestor of Tisza river.

According to the earlier OSL and TL dating similar old loess and eolian sand sediments occur in different part of Hungary (Figure 5).

Based on new OSL age data the older neotectonic movement in the study area took place till 40 ka, while the younger movements started after 40 ka BP. We concluded that these tectonic movements had important allogenic control on the development of river dynamics of the Great Hungarian Plain.

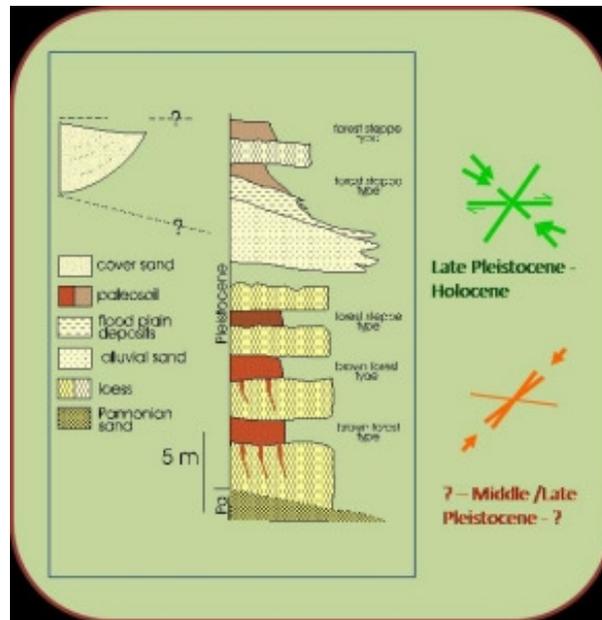


Figure 5. Pleistocene sediments of the Érmellék region with the two Quaternary tectonic phases.

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