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Late Miocene - Quaternary shortening and wrenching dominated groundwater flow in the central part of the Mid-Hungarian Mobile Belt

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The Neogene-Quaternary Pannonian Basin (Central-Europe) is underlain by two Mesozoic-Paleogene tectonostratigraphic terrains, the northwestern ALCAPA (Alpine-Carpathian-Pannonian) and the southeastern TISZA separated by the neotectonic zone of the Mid-Hungarian Mobile Belt. Based on historical industry seismic data along the middle section of the Mid-Hungarian Mobile Belt, a structural analysis was carried out on a 100 km x 100 km area, between the Danube and Tisza rivers. The structural analysis focusing on the Late Miocene and younger sediments was supported by sequence stratigraphic interpretation of seismic, well log and core-sample data.

According to the seismic reflection pattern shortening related folding of the Upper Miocene sediments and uplifting is conspicuous in the north of the Mecsek Line. Mapping of key chronostratigraphic surfaces (sequence boundaries) and unconformities within the Upper Miocene – Pliocene sediments allowed of defining anticlines and synclines. Interpretation of fold axis distribution suggests that N-S and NW-SE directed shortenings alternate since the Late Miocene. The orientation of mapped Late Miocene faults are ENE-WSW and NE-SW. Fold systems near the main strike-slip fault zones can be characterized by en-echelon folding geometry. The overall Late Miocene – Pliocene fault pattern is dominated by wide left lateral wrench fault zones. The main wrench faults seem to be rooted in the Mesozoic-Paleozoic slices of the Pre-Neogene basement.

Additionally, large canyons incised into the Upper Miocene Pannonian Lake sediments have been recognised in the central part of the study area (Alpár area) along several seismic lines. The canyon system has a surprisingly large size for a lacustrine setting. The incision surface is connected to sequence boundary SB Pa-4 (6.8 Ma). This SB was considered to have been associated with significant base level fall due to shortening and uplifting. The canyon system is incised several hundred meters in the preexisting substrate, into an extremely (700-800 m) thick aggrading deltaic complex. The canyon system occurs at a large releasing bend and/or extensional duplex of the Paks-Szolnok strike-slip system, which was active as a sinistral wrench fault zone during the Late Miocene. The formation of the deep canyons was presumably generated by the interaction of a relative base-level fall, the reactivation and bending/duplexing of a strike-slip system precisely in the same area, and the large sediment supply carried by overfed rivers.

Furthermore, the identified sedimentary and structural build-up has a determining impact on the groundwater flow systems of the study area. Based on regional hydrostratigraphic, hydraulic and hydrogeochemical evaluation, two groundwater flow-domains were identified for the area: a gravity-driven meteoric "fresh" water (TDS: 0.42-2.5 gL-1) domain, and a deeper over-pressured domain of saline water (TDS: 10-38 gL-1). Upwelling of the saline and over-pressured groundwater into shallower strata, even near to the ground surface is primarily possible along the identified fault zones. The rate of pressure dissipation and dilution of water principally depends on the depth of the Pre-Neogene basement, and the heterogeneity of the Neogene basin fill, which is a function of fault density as well. In some parts of the study area where the Pre-Neogene basement is located in a relative shallow depth (about -500m asl), and the Neogene aquitards are relatively thin and heterogeneous, around basement originated conduit faults highly pressured saline waters can appear even in shallow depths, while on the ground surface soil and wetland salinization can be observed. In other words, in this special geological situation of the research area a hydraulic short-cut can materialize across the whole Neogene succession in that otherwise only a slow diffuse fluid movement is possible.

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