Neotectonics of the Pannonian Basin

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New data and reinterpretation of old observations shed light on a very exciting and largely overlooked problem: the tectonic evolution of the Pannonian basin from the beginning of Pliocene to recent time. This period is distinct from the Miocene, which saw the extensional collapse of Alpine orogenic wedges, and the formation of the Pannonian basin system. We think that a new tectonic regime characterised by an increase of intraplate stress (neotectonic phase) was established at about 5 to 4 Ma and has continued up to the Present.

Our tentative model for the neotectonic evolution of the Pannonian basin suggest that desiccation of the Mediterranean sea during the Messinian caused a remarkable water level fall in the Pannonian Lake. It was associated with a tectonic uplift of the basin, and a hot-dry clima, which resulted in desert-like conditions in the former lake areas. Intensive erosion has started mostly in western part of the basin (Transdanubia) and continued up to the Recent. This led to a major erosional gap and tectonic discordance at the top of Pannonian strata, which is locally overlain by late Pleistocene to Holocene loess in a thickness of a few to less than 60 m. In contrast, at the western part of the basin (Great Hungarian Plain) subsidence renewed due to intraplate stress increase, and terrestrial red clays are interfingering with lacustrine and fluviatile deposits up to a thickness of 1000 m. Over here, the base of Quaternary is a paraconformity suggesting practically continuous sedimentary record with a cyclicity most probably controlled by the Milankovitch climatic cycles. High-resolution seismic data offer the first spectacular evidence that folding and/or faulting occurred during this neotectonic period, and locally faults active during the late Pleistocene and possibly even the Holocene can be present.

Contemporary stress partitioning in the Polish Western Carpathians

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In the Polish part of the Western Carpathians and the Carpathian Foredeep, recent horizontal stress direction was determined by mean of breakouts analysis method for four boreholes. Breakouts are compressive failures of the borehole wall which cause its elongation perpendicular to the maximum horizontal stress (S_{Hmax}). Long breakouts profiles give unique opportunity for continuos observation of stress direction changes with depth. Breakouts were detected with Six-Arm Dipmeter (SAD) and borehole televiewer (CAST) and processed with SPIDER program.

In the well PL 19 (located in the westernmost part of the Polish Carpathian Foredeep), S_{Hmax} direction changes from NNW for Devonian to NW for Precambrian basement. There are local deviations of stress direction in the vicinity of the fault zone which cuts Devonian rocks. NWN to NW direction of S_{Hmax} is corroborated by numerous breakouts analysis from neighbouring Czech side of the foredeep basin [Pavel Peska - WSMDB] but any stress partitioning has not been mentioned.

Borehole PL 35 is located in the Magura Nappe in the Carpathians, near Zywiec. Here, S_{Hmax} has different orientation for different structural levels. Mean breakouts direction within the flysch nappes indicates NNE S_{Hmax} orientation (similar stress direction was constrained by poor quality data from PL 32, located in the westernmost part of the same nappe). In the Miocene and Devonian autochthonous basement of PL 35 compression has NNW direction while within the short section of Precambrian metamorphic basement it changes towards NW. Therefore, three detached geodynamic levels could be differentiated in this well profile. Small scale deviations of stress orientation were also observed within Devonian interval. Tectonic examinations of the drill core shows, that the set of steeply dipping strike-slip faults is responsible for small scale stress reorientation.

In the well PL 34 which is located in the central part of the Polish Carpathians, and penetrated both Carpathian nappes and the autochthonous Permo-Mesozoic basement, S_{Hmax} trends N-S while in the deeper Carboniferous and Devonian fundament single breakouts indicate NW compression.

At the moment, three other boreholes from this region are under investigations.

Generally, in the westernmost part of the Polish Carpathians, from the deepest autochthonous basement upwards, S_{Hmax} direction rotates from