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Verification of structural control on landforms in the transition zone between Pannonian Basin and Eastern Alps

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INTRODUCTION

Steep, rectilinear slopes are frequently considered as being controlled by structural elements. A number of studies automatically take the linearity of landforms as prove for structural, most frequently fault control. However, this logical but not unequivocal conclusion needs careful verification, because divers geomorphic process alone can also result in straight valley sides, river stretches etc. Structural control on such landforms can be difficult to prove, because of poor outcrop conditions, and the lack of adequate surface and subsurface data sets. It is particularly true for landforms within the Pannonian Basin, central Europe, which offers poor outcrops for both geological and geomorphological analyses, landforms are vegetated and sometimes anthropogenetically modified.

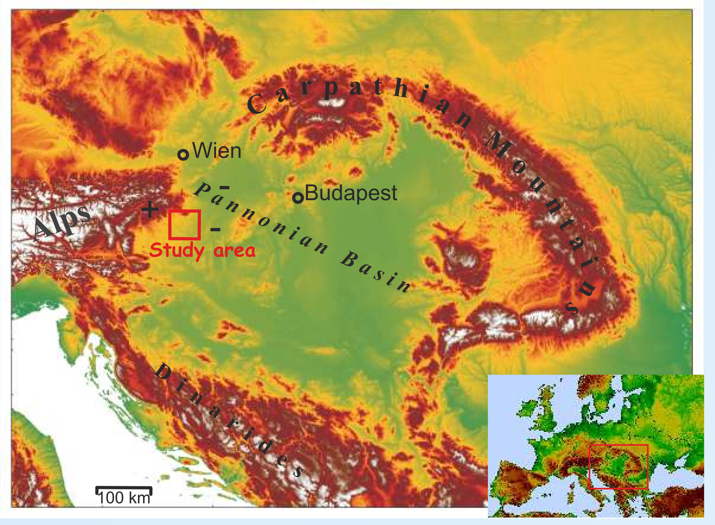


Fig. 1: The location of the study area

The investigated study area is situated in the transition zone between the still uplifting Eastern Alps and the subsiding Little Hungarian Plain (Joó 1992), bordered by Lafnitz (Lapincs), Répce (Rabnitz) and Rába (Raab) rivers (Fig. 1 and Fig. 2).
The contrasting forcing of the regions of differential uplift created a distinctive surface morphology of typically low relief that has a characteristic drainage network pattern as well.

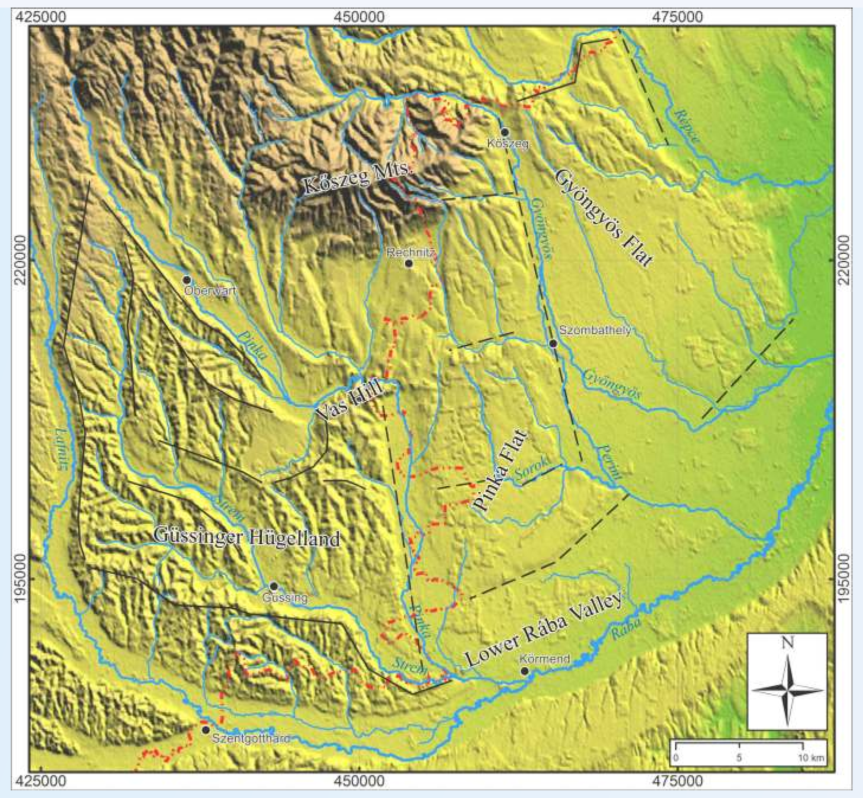


Fig. 2: General morphology of the study area, with unit names and highlighted scarps

The hilly area is mostly covered by Miocene sediments (Fig. 3). The mesoscale geomorphological units of the study area are influenced by the uplifting metamorphic core complex of Kőszeg–Rechnitz Mountains (Tari – Horváth 1995), by the also metamorphic and relatively uplifting Vas Hill as well as by the subsiding grabens. There are two dominant flow directions alternating downstream. Valley segments are often bordered by steep scarps, which were identified by previous research as listric normal faults and grabens.

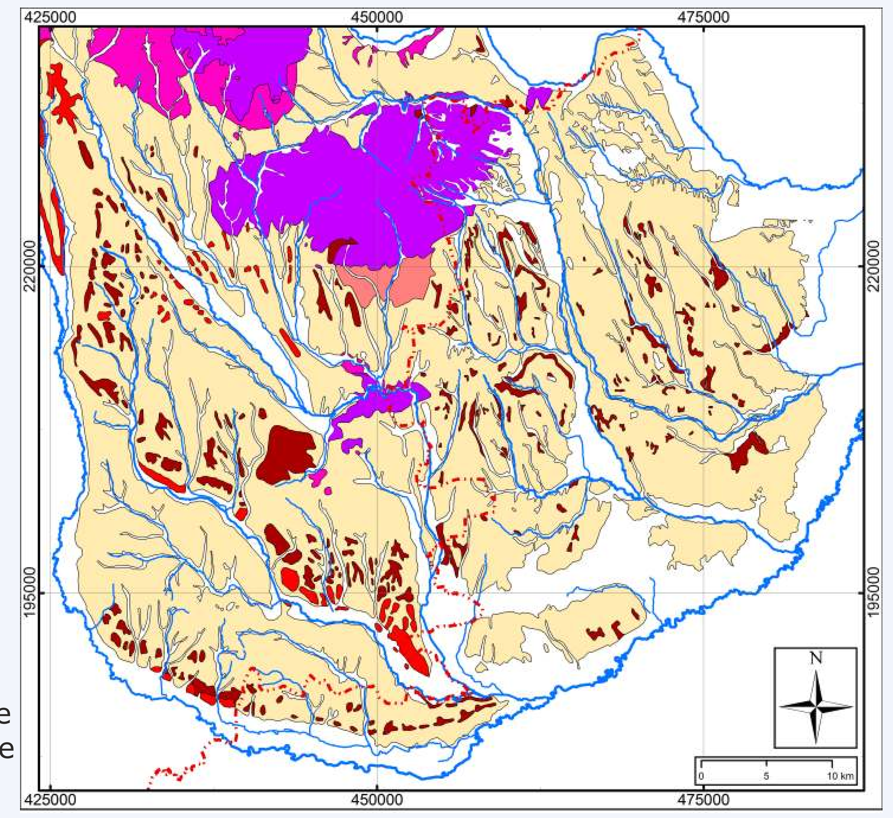


Fig. 3: Geology of the study area

CONCLUSION

All these data permitted to build a 3D model for a particular drainage anomaly located in the western Pannonian Basin, its transition to the Eastern Alps. The combined data set suggest that en echelon normal or oblique-normal faults controlled linear ENE trending segments of the Arany creek, which is almost perpendicular to the general flow direction. The en echelon faults could be part of a sinistral shear zone, which occur between the Rechnitz and Eisenberg windows of the Penninicum. If this fault was kinematically connected to others at the window's margin, their tectonic exhumation might have continued after the main early to mid-Miocene phase. The fault zone could be initiated in the late Miocene (Pannonian) around 9 Ma, and was active afterword. Exact timing of this deformation was not determined neither neotectonic activity proved. However, our study shows that the Late Miocene basin fill of the Pannonian Basin was deformed considerably. The other issue of our work is that the combination of diverse methods is useful, sometimes inevitable for checking the potential structural control and landform and landscape evolution.

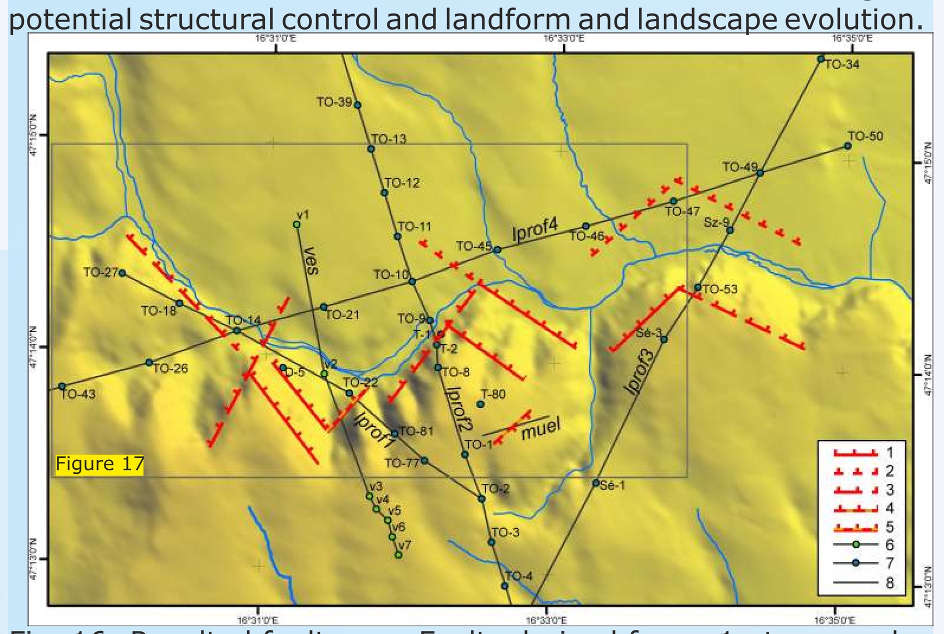


Fig. 16: Resulted fault map. Faults derived from: 1– topography, 2 – borehole data, 3 – topo. and boreholes; 4 – MUEL, 5 – VES, topo. and boreholes. 6–8 - VES, borehole & MUEL profiles

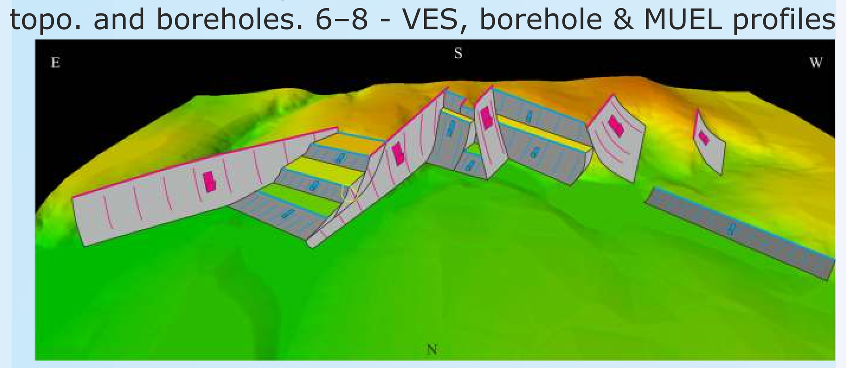


Fig. 17: 3D view of resulted fault planes

METHODS & RESULTS

Demonstration of structural control on a specific landform may involve variable methods and data sets. One successful example from the Pannonian Basin, Ruszkiczay-Rüdiger et al. (2007, 2009) used a complex surface and subsurface data sets (to infer structurally constrained landforms). In our study we partly follow this line of combined methodology, but use different subsurface and surface data sets. The success of the study of Ruszkiczay-Rüdiger et al. (2009) mainly depended on the availability of industrial seismic profiles. However, this is not the case in the presented study area. Instead of seismic data, we used other types of geophysical methods, namely 2D geoelectric tomography, 1D vertical electric sounding. Relatively dense network of shallow boreholes permitted the construction of cross sections and could be compared to geophysical data. Finally, surface fault-slip data was important for characterisation of fault geometry and fault kinematics.

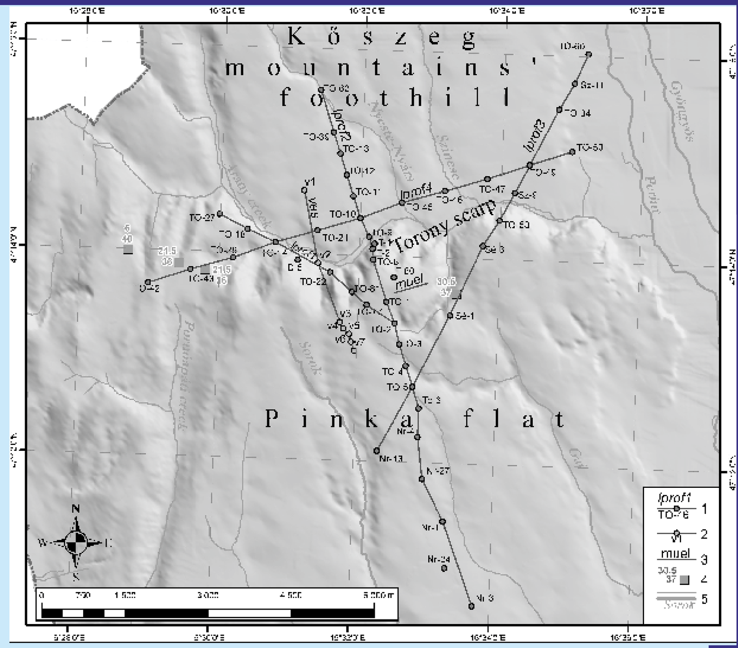


Fig. 4: Morphology of the scarp and investigated sections

During our field campaign, several geophysical methods were used to clarify some raised questions about Neogene landscape evolution of the wider area. Among them, 2D geoelectric tomography using multielectrode resistivity metre (MUEL, Fig. 6) and vertical electric sounding (VES, Fig. 5) were used to detect the geometry and possible ruptures of the underground layers (see sections on Fig. 4).

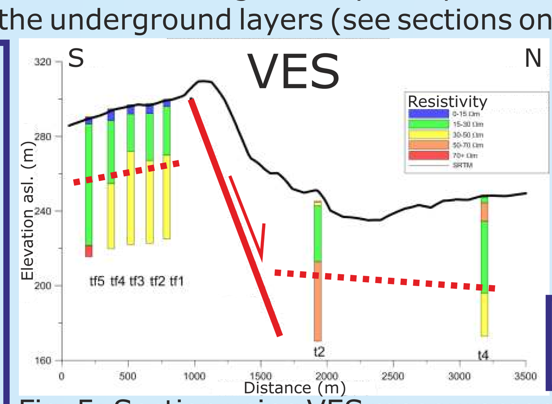


Fig. 5: Section using VES measurements

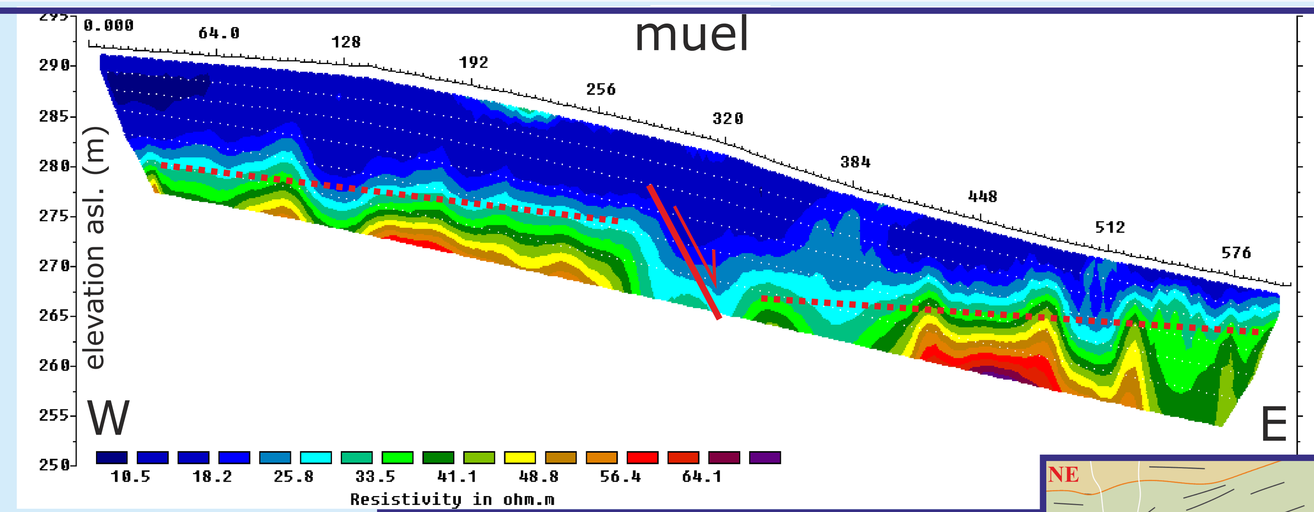
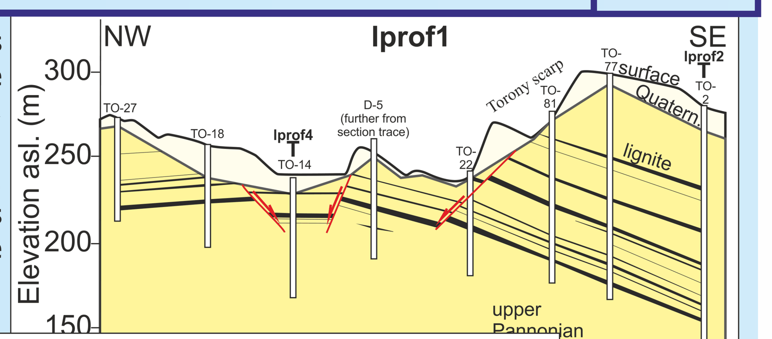
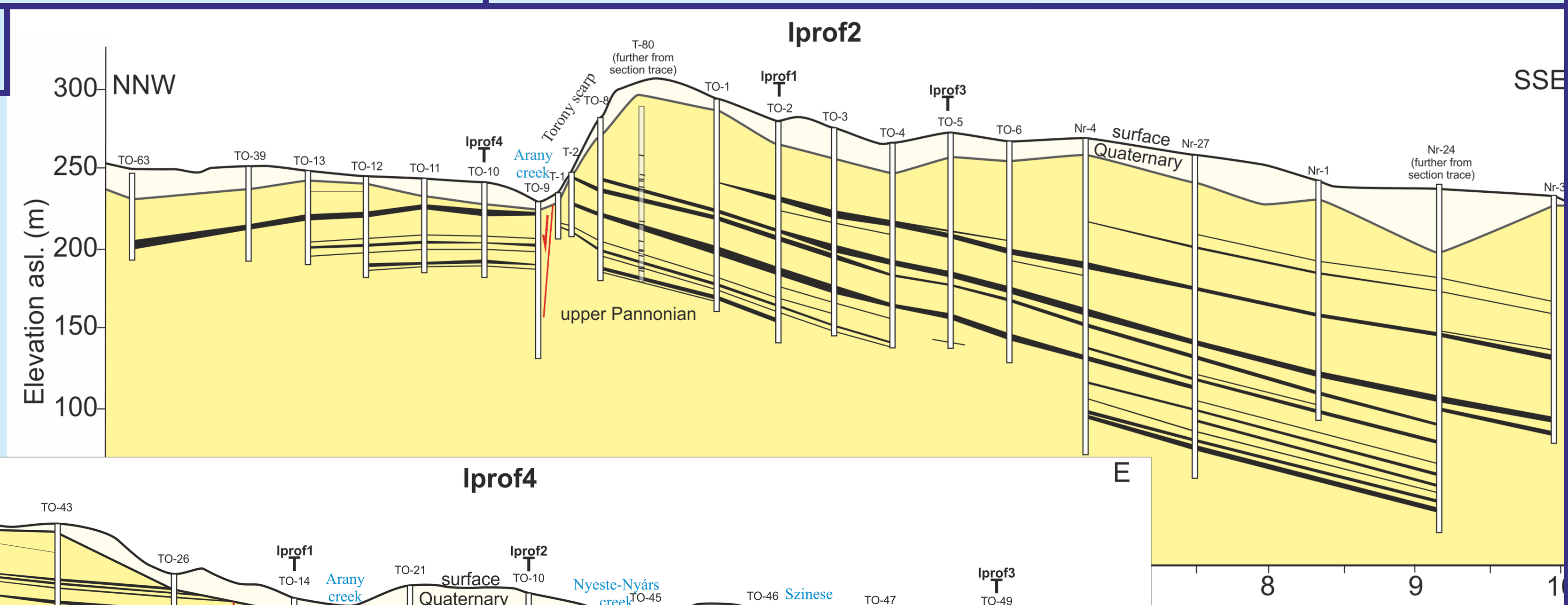


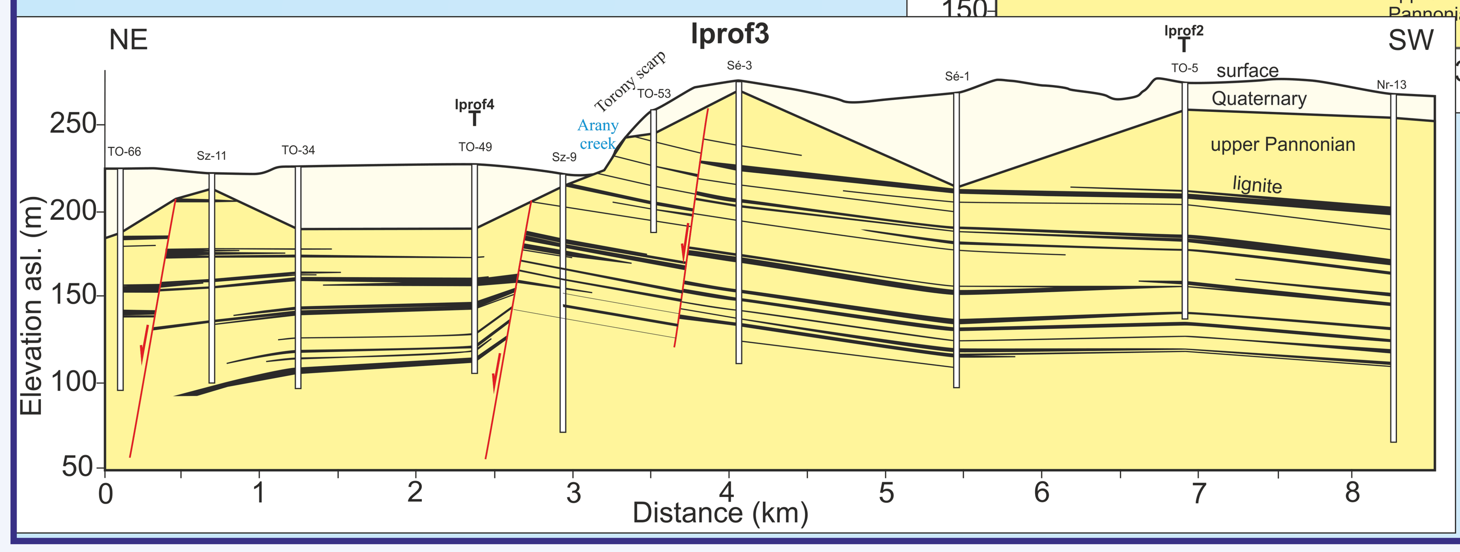
Fig. 6: Multielectrode section

Few outcrops permitted observations on brittle structures and provided information on potential larger-scale structures. In the close vicinity of the Torony slope, a sandpit exposes the Upper Miocene sequence, silt, organic-rich clay and cross-laminated sand. Several sets of faults and joints affected the poorly consolidated sediments.

Study area is surveyed by densely drilled (2-300 m) boreholes deepened due to the underground lignite reserves. The borehole data is freely accessible at the Hungarian Geological, Geophysical, and Mining Database.
Entire lithology of the boreholes along designated profiles (Fig. 4) were gathered. In our section profiles only the lignite layers and the margin between Pannonian and Quaternary are represented for clearer view.







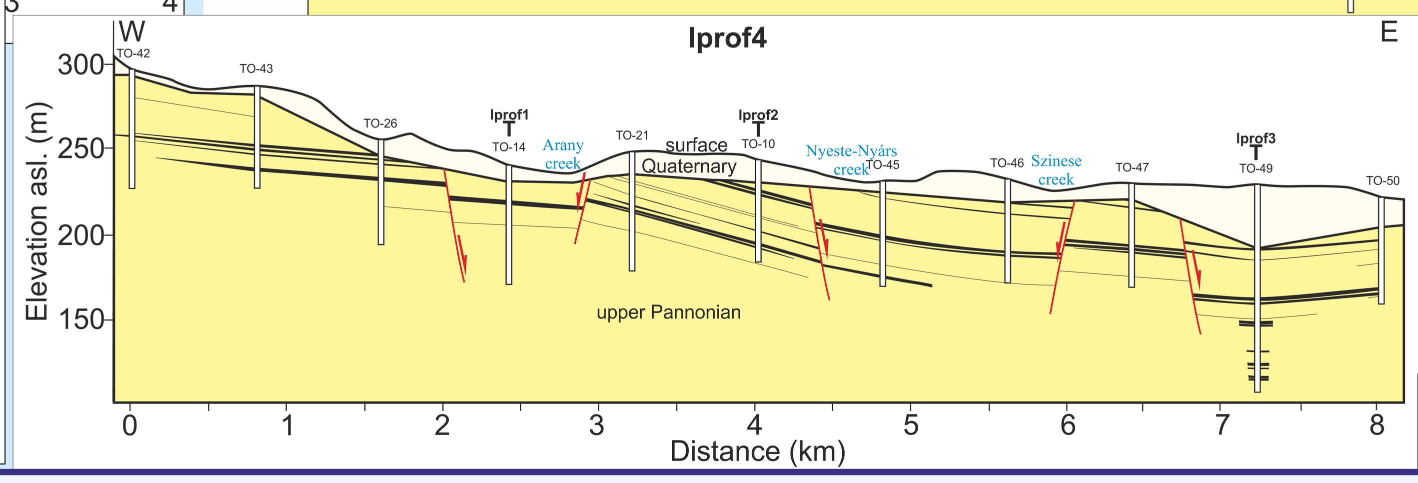


Fig. 7-9: Sections using borehole data

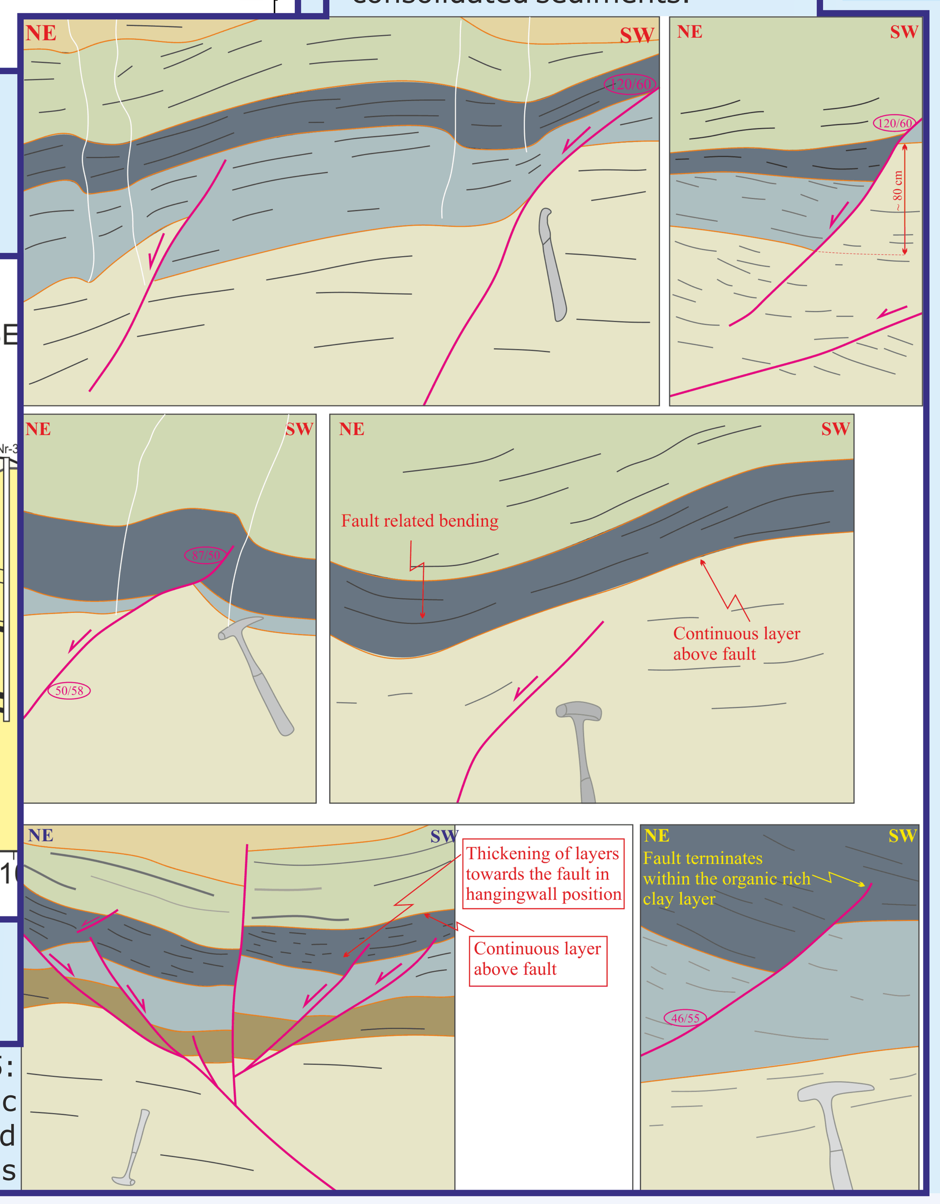


Fig. 10-15: Schematic view of field observations

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