Structure of the Podhale basin – new insights from seismic data interpretation

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Interpretation of seismic and well data from the Podhale basin was completed within the international TOPO-EUROPE Programme, that addresses the 4-D topographic evolution of the orogenic belts and intra-plate regions of Europe through a multidisciplinary approach linking geology, geophysics and other methods. TOPO-EUROPE consists of 10 projects, with Thermo-Europe as one of them. The Thermo-Europe project aims to test alternative mechanisms for the potential coupling of climate and tectonics at various scales across Europe. This will be achieved through improved documentation of the rates and distribution of erosion during the Neogene and through modelling the tectonic response to this signal of erosion. Within Thermo-Europe project 8 Individual Projects (IP) and 3 Associated Projects (AP) are distinguished.

For the IP 8 Thermo-Europe project "Mechanisms of uplift and erosion in the Carpathian thrust wedge and foreland basin" three main study areas have been identified: Carpathian foredeep basin, High Tatra Mts. (Inner Carpathians) and the Podhale Basin. Within the Podhale basin, main research goal is to explain time and space relationship between the basin inversion, mountain uplift and sedimentation.

The Carpathian thrust belt consists of three main tectonostratigraphic domains: the Inner Carpathians (including the High Tatra Mountains and the Podhale basin), the Pieniny Klippen Belt and the Outer Carpathians (with their outernmost unit formed by the compressionally deformed foredeep deposits) flanked to the north by the mostly undeformed Carpathian foredeep basin.

The Podhale basin is a part of a larger structure called Central Carpathian Paleogene Basin. It is interpreted by some authors as forearc basin. The Paleogene sedimentary infill of the Podhale basin consists of two different complexes. The older one is up to 100 meters thick and consists of Eocene limestones, the so-called Nummulite Eocene. It is almost completely covered by the Upper Eocene-Upper Oligocene flysch series (shales and sandstones), up to 3000 meters thick. The Podhale basin is situated between the Tatra Mountains in the South and the Pieniny Klippen Belt to the North. In the South, the flysch beds dip northward at low angle, in the central part of the basin they are almost horizontal, and only along its northern limb the Paleogene succession is strongly folded, sometimes even vertical. Such basin-scale geometry is a result of Tertiary activity of large strike-slip fault zone that forms boundary between the Podhale basin and the Pieniny Klippen Belt. Numerous transverse faults active in Middle Miocene cut the Podhale Paleogene succession, i.e. the Bialy Dunajec fault zone (located in the central part of Podhale basin) and Bialka fault zone (located in the eastern part of Podhale basin).

Various studies have been carried out within the Podhale basin. Most of them were based on field structural and stratigraphic studies, coupled with analysis of well data. Since late 1970' geophysical methods have also been used to study this area. Recently completed reinterpretation of 2D (acquired in 1970' and 1980') and 3D (acquired in 1990') seismic data, calibrated by several deep boreholes, provided new insight into certain aspects of structure and geological evolution of the northern part of the Podhale basin, adjacent to the Pieniny Klippen Belt. Podhale flysch infill (Zakopianskie and Szaflarskie beds) seems to unconformably rest on deformed Mesozoic substratum, equivalent to the Tatra nappe system. This might suggest early Paleogene initial minor uplift of the Tatra region to the South. To the North, Paleogene flysch series together with their Mesozoic substratum seem to be upturned, and this large-scale geometry might be interpreted as caused by drag folding along steep, possibly strike-slip fault, bordering Pieniny Klippen Belt. It is also possible that lower part of the Paleogene infill (Szaflarskie beds) might have been deformed by south-verging thrust faulting and associated north-verging backthrusting. This might have been related to the Miocene regional strike-slip movements along the Pieniny Klippen Belt.