Geophysical research of the Pieniny section of the Pieniny Klippen Belt in the eastern Slovakia

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A b s t r a c t : The studied area is situated in the Pieniny section of the Klippen Belt in the eastern Slovakia, near the village Jarabina. The aim of our research was to clarify its tectonic structure by combination of surface geological mapping and structural investigation with interpretation of the subsurface structure using various geophysical methods.
The detailed gravimetry was one of the applied geophysical methods. The gravity survey consists of the high accurate gravity profile measurements. These data have been processed into the Bouguer gravity anomalies. The interpretation is illustrated by geological–geophysical profiles, which show the lithological members and their density parameters. The influence of surrounding geological units is clearly observed in the southern and northern parts of the profile. They represent large sedimentary units (Central Carpathian Palaeogene Basin and the Magura Nappe, respectively), composed of low density rock masses. The rocks included in the Pieniny Klippen Belt (PKB) have a higher density and the graph of the Bouger anomalies creates an elevation above it. Consequently, the lateral limits of the PKB are relatively clear. The anomalies within the PKB are not so sharp, what results from small differences between the density values of its lithological members. Continuation of the klippen bodies from surface to the depth and their geometrical limitation was inferred by the density modelling. The computed graph line corresponds considerably to the klippen structures continuing to the depth, the bodies on the surface have only a weak effect.
It is also interesting to compare the density modelling results with results of the interpretations of the geoelectrical and seismic measurements, which were performed on the same locality, too. The method of vertical electrical sounding (VES) detects the variability of electric resistivity to the depth. It is indicative for the horizontal geological boundaries. The physical boundaries in the measured profile are nearly identical with the gravimetric ones. The boundary

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between sediments the Central Carpathian Palaeogene Basin and PKB, as well as the information about distribution of the klippen mantle are well comparable to results obtained by gravity measurements. The modeled sections are consistent with the geological interpretation of the anticlinal structure of layers of the Šaris unit and the thrust of the Subpieniny unit over the Šariš unit is also visible.

The seismic tomography was the third method used. It was applied only on a short part of the gravimetric profile, however (120 m). The velocity of the seismic waves depends on the petrophysical properties of subsurface sediments and generally increases from surface to the depth. Measurements of seismic tomography method allowed to allocate the subsurface areas of "packaging" formations (marlstones and claystones) and areas formed by solid limestone bodies. The highest values were found in the klippen bodies. Similar high seismic velocities were recognized also at the shallow subsurface depths (somewhere it was at the 3 m depth), which may be interpreted as hidden klippes.

There was made a large seismic investigation in the eastern Slovakia (MOŘKOVSKÝ et al., 1981). The seismic reflection profile 30/80 was measured about 13 km SE of Jarabina. It shows the situation in the depths up to 5 km. In the interpretation of this method we defined the northern and southern limit of the PKB to neighboring units and some fault structures in the area of PKB, which are likely related to movements in the transpression zone.

The mapping revealed the presence of three PKB units, arranged in a fold–overthrust structure. The modeled geophysical profiles coincide with the tectonic profile in the main features. The section-based, high-resolution geophysical methods combined with surface geological investigations brought results that are applicable for tectonic interpretations. They were also used for localisation of two short (200 and 140 m), but continuously cored boreholes that generally confirmed some features of the interpreted subsurface structure, at least up to these depths. In the drill wells JAR-1 and JAR-2, the upper parts are formed by the members of Subpieniny unit and the thick layers of the Šariš unit continue to the depth. Therefore the capability of such an approach for unravelling the structure of internally complicated zones, like the PKB, appears to be satisfactory and has been applied also in other PKB regions.

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