

Structure of the eastern part of the Varín sector of the Pieniny Klippen Belt – unravelling the puzzle

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The studied area occurs in the borderland of the Kysuca and Orava regions in northern Slovakia, west of the N-S trending “Zázrivá sigmoid”, between the villages of Lysica, Terchová and Zázrivá. The area was mapped already in 1930-ies by Andrusov (1938) and later by Haško & Polák (1979). The latter authors distinguished the Klippen Belt (PKB) units, namely the Kysuca and Orava, which are overlain by the Manín Nappe (nowadays correlated with the Klape Unit). The area is dominated by the highest mountain of the entire PKB – the Pupov Hill (1090 m a.s.l.) composed of Senonian marls and calcareous turbiditic sandstones correlated with the Klape Unit (Pupov Beds – Potfaj ed., 2003). The southern, W–E trending margin of the PKB is followed by imbricated lenses of the “peri-Klippen Paleogene” (Gosau-type, Paleocene–Middle Eocene Myjava-Hričov Group).

We performed detailed geological mapping, structural analysis and biostratigraphic investigations for foraminifers and dinoflagellates of various, mostly shaly and marly formations. Relying on the current concept of the PKB structure (Plašienka et al., 2012; Plašienka & Soták, 2015), we have distinguished three main Oravic tectonic units – the Šariš Unit (Plašienka & Mikuš, 2010), Subpieniny and Pieniny units (Uhlig, 1907) from bottom to top with various, partly differing successions and formations, and two nappe units of possibly Central Carpathian (Fatric) provenance – the Klape and Orava units. Overstepping post-nappe formations are represented by the Gosau-type Senonian Pupov Fm. and Lower Paleogene Myjava-Hričov Group.

The extraordinarily complex structure of this PKB part can be characterized as a synclinorium with almost all beds and successions overturned and steeply N-dipping. In general, the Oravic units are mostly rimming the PKB along its northern and southern margins, while the Klape and Orava nappe units occur in the centre and at the eastern part, respectively. The latter are associated also with the Senonian deposits of the Pupov Fm. However, there are numerous exceptions from this scheme and some formations sometimes occur in a very strange position. In consequence, our tectonic interpretation can merely be a preliminary one reflecting the present state of knowledge.

The Šariš Unit is only represented by fragments of its succession, e.g. by the Middle Jurassic “Black Flysch” and radiolarites (Szlachtowa, Opaleniec, Sokolica and Czajakowa fms) and variegated shales and sandstones of the Upper Cretaceous Malinowa Fm. Some

characteristic members, like the calcareous flysch of the Jarmuta-Proč Fm., have not been recognized. Due to close lithological and spatial relationships to the Middle Jurassic formations, we associate the Lower Jurassic quartzitic sandstones occurring on the Jedľovinka Hill with the Šariš Unit, too.

The Czorsztyń Succession, as a typical representative of the Subpieniny Unit, crops out in patches along the northern PKB margin. Czorsztyń-type blocky klippen are mostly formed by Middle-Upper Jurassic sandy-crinoidal and red nodular limestones surrounded by Aalenian black shales and Upper Cretaceous variegated marlstones of the Púchov facies (e.g. Kopččky near Lutiše, Holešova skala, Janíkov vrch, Erdúsky kostol – see Jamrichová et al., 2012). The “transitional” Czertezik Succession is represented by one small klippe near Zázrivá village (Haško, 1976).

The Pieniny Unit is composed of the deep-water Kysuca Succession – its prolongation from the westerly located “Kysuca Gate” type area (Rochovica and Brodno klippen – see e.g. Michalík et al., 2009 and references therein). In the investigated area, the incomplete and dismembered succession lacks Jurassic members and consists of Lower Cretaceous bedded cherty limestones (Pieniny Fm.) and spotted marly limestones of the Fleckenmergel facies (Kapušnica and/or Tissalo Fm.), followed by the Cenomanian–Santonian, upward coarsening-and-thickening synorogenic sequence of dark-grey marly shales, siliciclastic turbidites and bodies of conglomerates and pebbly mudstones containing also the “exotic” material (Snežnica and Sromowce fms, respectively).

The Orava Unit (Haško, 1978) is also a deep-marine succession, but with some special members (e.g., the Adnet Fm.) and with flysch sedimentation starting already during the Albian. According to Mahel’ (1990), it likely represents a frontal element of the Krížna nappe system incorporated in the PKB. It builds two large klippen in the easternmost part of the area (Kozinec and Havranský vrch hills), separated by a distinct WNW-ESE trending dextral fault, named here as the Ráztoky Fault.

The Klape Unit consists mostly of thick prisms of mid-Cretaceous terrigenous flysch deposits that overlie the Kysuca Succession in the western part of the area. It is not to be excluded that a long stripe of klippen with Lower Cretaceous cherty limestones north of Lysica village, having been interpreted as a window of the Kysuca Unit, also belongs to the Klape Unit.

The up to thousand metres thick Pupov Formation occupies the central position in the PKB synclinorium and consists of several members. The lower part is composed of Coniacian–Santonian calcareous turbiditic sandstones with marly intercalations, followed by Campanian grey and variegated marlstones. The uppermost part is composed of probably Maastrichtian shallow-water gritty sandstones used as a sharpening stone. Although not definitely clear, we consider the Pupov Fm. as an element of the post-thrusting, wedge-top basins associated with the Gosau Group (cf. Plašienka & Soták, 2015 and references therein).