

# FORE—MAGURA ZONE IN THE POLISH SECTOR OF THE OUTER CARPATHIANS

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**Abstract:** The Fore-Magura Zone occurs in the Outer Carpathians between the Magura and Silesian nappes. It consists of several tectonic units of which sedimentary successions have been deposited in the same Dukla Basin. Lithostratigraphic differences of individual units depended of lateral facies changes characterised by morphology and dynamic evolution of the basin. The Dukla Basin connected in the Cretaceous with the Magura Basin was individualised and transformed during the Paleogene time.

**Key words:** Fore-Magura zone, Late Cretaceous, Paleogene, Polish Flysch Carpathians

## **Introduction:**

The Outer Carpathian sedimentary basins are characterised by marked lateral facies changes that highlight complex paleogeography, where deep subsiding basins (trough) were separated by shallow or even emergent geanticlinal structures – ridges. From the south to north the following main sedimentary basins and ridges, each with distinctive lithostratigraphic succession, are identified: the Magura Basin, the Dukla Basin, the Silesian Ridge, the Silesian Basin, the Subsilesian Ridge, and finally the Skole Basin. In the troughs and basins usually enormous sequences of flysch type sediments were deposited, the thickness of which approach up to a few thousands meters. As a result of intense Neogene orogeny the sediments filling the basins were folded and detached from their substrate and several uprooted nappes were created that reflect the original configuration of the basins. During folding and thrusting the main nappes have been partly differentiated and subdivided to smaller tectonic units.

The Fore-Magura Zone (after Książkiewicz, 1956) includes a group of tectonic units which are folded and thrust one upon another. They are tectonically covered by the Magura Nappe that has been turned from south, and all together are thrust over the Silesian Nappe. Sedimentary successions of respective units of the Foremagura Zone have been deposited in the Outer Carpathian part of geosyncline, north of the sedimentary area of the Magura succession, and south of the Silesian Ridge (Cordillera) which

bordered the Silesian Basin from south and separated it from southern widespread sedimentary basins.

### **Units of the Fore-Magura Zone:**

The Dukla Nappe (Ślączka, 1970) is the largest and most important unit of the Fore-Magura Zone. It crops out on the surface in the eastern sector of the Polish and Slovak Outer Carpathians and in Ukraine. It comprises several imbricated folds plunging toward the west below the Magura Nappe, which covers it almost completely in the western sector. Towards the west, together with facies changes the Dukla Nappe passes into the Obidowa-Słopnice Nappe (Cieszkowski et al., 1981a, b) and Grybów Nappe. These two units are known only from the tectonic windows formed in the Magura Nappes and from wells. The Grybów Nappe is overthrust onto the Obidowa-Słopnice Nappe. Both have been encountered in several deep wells below the Magura Nappe in the Rabka - Nowy Targ area (Obidowa IG-1, Chabówka 1) and Limanowa – Słopnice area (e.g. Słopnice 1, Słopnice 20, Leśniówka 1). Between these areas the units in question are partly outcropping in the Mszana Dolna tectonic window, but Grybów Nappe is known also from several tectonic windows, which most of them is located between Limanowa and Grybów. The Obidowa-Słopnice Nappe has been documented in the deep wells located SE of Żywiec (Sól 1) and in Western Slovakia (Oravska Polhora 1). In Eastern Slovakia (Zboj 1) it has been found beneath the Dukla Nappe.

Obidowa-Słopnice Nappe is consisting of a flat lying and gently folded limbs of a “recumbent” fold. There is a question, how does the connection between the Dukla and Obidowa-Słopnice look like under the cover of the Magura Nappe. It could be either the continuous passage, or thrusts and/or diagonal faults could separate these two tectonic units. The Grybów Nappe is a strongly folded and thrust stake fold. The Dusina zone, distinguished in Ukraine as the innermost subunit of the Dukla Nappe, could be an eastern equivalent of the Grybów Nappe.

Innermost unit of the Fore-Magura Zone, called Jasło Nappe (Koszarski & Koszarski 1985, Koszarski 1999) has been distinguished in the surroundings of Gorlice and Jasło. This folded and imbricated unit has been crossed over the Grybów and Dukla nappes, and in the Jasło-Gorlice area is overthrust onto the Silesian Nappe. For a long time it has been supposed to be a northern-most zone of the Magura Nappe, that forms two tectonic peninsulas there.

In front of the Magura Nappe two outer units are located. These are the Fore-Magura Unit s.s. (Książkiewicz 1956, 1977) and Michalczowa Unit (Cieszkowski 1992). The first of them extends in the area between Żywiec and Koniaków, whereas a second one occurs north of Nowy Sącz. They both directly overthrust the Silesian Nappe. Everyone is tectonically complicated and consists of a few tectonic slices.

### **Paleogeography, basin evolution and correlation of strata**

All the sedimentary successions of the tectonic units of the Fore-Magura Zone were deposited in the same Dukla Basin. This basin evolved in the Cretaceous and was transformed during the Paleogene. Up to the end of the Late Cretaceous and beginning of the Paleogene it was connected with the Magura Basin. The connection is marked by the development of the Inoceranian beds, which occur in the Magura Nappe, and in almost all the units of the Foremagura Zone, as well. In the Paleogene a new ridge (Grybów Ridge) was uplifted. It bordered the Dukla Basin from the south, and separated it from the Magura Basin during the Eocene and Oligocene.

Though lateral facies changes differentiated lithostratigraphy of the sedimentary successions, the development of deposits allows to correlate individual units of the Fore-Magura Zone. As it was noticed above, during the Senonian and Palaeocene time the facies of the Inoceranian beds was widespread in the Dukla Basin almost everywhere. Then in the Dukla and Obidowa-Słopnice successions the fans the thick-bedded Cisna Sandstones have been formed. This facies is diachronic. On the west, in the sedimentary area of the Obidowa-Słopnice succession arrived in the Early Senonian, and in the Dukla succession area on the east it is noticed from the Late Senonian. The Palaeocene shally flysch facies of the Majdan beds from the Dukla succession could correspond to the Obidowa beds from the Obidowa-Słopnice succession, which are developed as the mudflows with pebbles of exotic rocks, interbedded occasionally by the sandstone turbidites. The Palaeocene facies of the Bukovec Velky widespread mainly in the Dukla Unit in the East Slovakia is known from Obidowa-Słopnice Nappe too.

When the Dukla Basin had been individualised in the Eocene, the sedimentary successions of the Dukla and Obidowa-Słopnice nappes developed in the central part of it. High rates of subsidence marking the depocenter resulted in high thickness of the Hieroglyphic beds in both discussed units. It ranges from 800 m up to more than 1000 m. Then the sedimentary area of the Jasło Succession was yet connected with the Magura Basin. In the southern part of the Dukla Basin sedimentation of the Grybów Succession

took place. In the northern part, sedimentary successions of the Fore-Magura s.s. and Michalczowa units were developed. Their Palaeocene and Eocene sediments are more or less condensed, and dominated by the red or variegated shales and/or marls. These shales and marls were deposited in more or less shallow part of Dukla Basin in the area connected with its northern slope.

At the end of the Eocene and at the beginning of the Oligocene, the Silesian Ridge partly collapsed and wide connection between the Dukla and Silesian basins was opened. The deposits of the Menilite and Krosno beds filled both these basins. The Oligocene sequence commences in all basins of the Outer Carpathians (except of the Magura Basin) with dark brown bituminous shales of the Menilite beds. But, in many places of the Dukla Basin, especially in the Obidowa-Słopnice sedimentary area, and in the southernmost zone of the Silesian Basin as well, the sedimentation of so called "black Eocene" facies took place. This facies, also characterised by presence of sediments with dark shales, had preceded deposition of the typical Menilite beds and is represented by the Rdzawka beds with fans of the thick-bedded Zboj Sandstones. Its thickness ranges here from 600 m to about 1000 m. The Rdzawka beds consist mainly of the thin- and medium bedded flysch with siliceous sandstones and black shales. The Zboj Sandstones are developed as medium- and coarse-grained siliceous sandstone and fine conglomerates, often with intercalations of mudflow and debris-flow like deposits. In the Dukla and Grybów nappes the Rdzawka beds occur occasionally, here and there with single layers of the Zboj-like sandstones.

The Oligocene sequence commence in all basins, which were situated north Magura Basin, with the Menilite beds that consist of brown bituminous shales, cherts and siliceous marls and sporadic sandstone complex in their lower part. But, in many places of the Dukla Basin, especially in the Obidowa-Słopnice sedimentary area, the sedimentation of so called "black Eocene" facies took place. This facies is also characterised by presence of dark-coloured sediments with. The Rdzawka beds with fans of the thick-bedded Zboj Sandstones, Late Eocene and Early Oligocene in age, represent it. The Rdzawka beds had preceded or partly replaced deposition of the typical Menilite beds. The Menilite Beds of the Dukla Basin are very characteristic. There, in the sedimentary areas of Dukla and Grybów successions the lower part of the bituminous shales turbiditic Sub-Cergowa and Sub-Grybów marls developed. Locally, beneath of them the thick-bedded Mszanka Sandstones underlie. Within the chert horizon the Cergowa beds, sandstone and/or shale facies forms a complex widespread in the Dukla basin. Within the Menilite beds of the

Fore-Magura Zone occur limestone levels (Wola Łużańska, Michalczowa, Koniaków, and Skalnik limestones) rich of organodetrritic material, that consists mainly of *Lithothamnium* and bryozoan remnants. The alimentation centre of this material was shelf that surrounds the Silesian and Grybów ridges (cf. Golonka et al., 2002: this volume). Those are the Wola the Menilite beds are overlaid by the Krosno beds developed as light-coloured calcareous sandstones and marly shales.

Mentioned above wide connection between the Dukla and Silesian basins is marked by presence of facies typical for Dukla succession in the innermost part of the Silesian Nappe (cf. Ślącza 2000). The Mszanka and Cergowa sandstones and Tylawa Limestone horizon are known from there. Also Rdzawka beds with Zboj Sandstones occur in the innermost part of Silesian Nappe. In some places within these beds the olistostrom sequences are present.

The main stages of folding and thrusting of the Outer Carpathians took place in the Miocene. A number of features of the Fore-Magura Zone units complement some interesting tectonic events of the Outer Carpathians" evolution. For instance, it is apparent that the last stage of the thrusting of the Magura Nappe and of units of the Fore-Magura Zone took place in the early Sarmatian (Cieszkowski 1992). Then, the Silesian and Subsilesian nappes overthrust by the Magura and Fore-Magura units, were already completely folded, strongly eroded and thrust together upon Miocene deposits that feel the Carpathian Foredeep. It happened after the Late Badenian – Early Sarmatian transgression of the Miocene sea, while the transgressive deposits covering flysch of the Outer Carpathian units had been just faulted and eroded.

## References

- Cieszkowski M., 1992: Michalczowa zone: a new unit of the Fore-Magura Zone, Outer Carpathians, South Poland. *Kwart. AGH, Geologia*, 18, 1-2: 1-125.
- Cieszkowski M., Durkovic T., Jawor E., Korab T. & Sikora W., 1981a: A new unit in the Polish and Slovak Flysch Carpathians. *Carpatho-Balkan Geol. Assoc.*, 12 Congr., Bucharest, 1981. Abstracts:118-120.
- Cieszkowski M., Durkovic T., Jawor E., Korab T. & Sikora W., 1981b: Geological interpretation of the Obidowa-Słopnice tectonic unit in the Polish and Slovak Flysch Carpathians. *Carpatho-Balkan Geol. Assoc.*, 12 Congr., Bucharest, 1981. Abstracts: 272-274.

- Koszarski A., 1999: The Jasło Nappe *versus* the Gorlice beds. A controversy at the front of the Magura Nappe in the Jasło-Gorlice region. (Polish Middle Carpathians). *Geologica Carpathica* 50: 153-154.
- Koszarski A. & Koszarski L., 1985: Marginal zone of the Magura Nappe and its relation to lower units. In: Koszarski L. ed.: *Geology of the Middle Carpathians and Carpathian Foredeep. Guide to Exc. 3. Carpatho-Balkan Geol. Assoc., 13 Congr., 1985. Cracow, Poland: 216-224.*
- Książkiewicz M., 1956: Geology of the Northern Carpathians. *Geol. Rundsch*, 45: 396-411.
- Książkiewicz M., 1977: The tectonics of the Carpathians. In: W. Pożaryski, ed.: *Geology of Poland V, IV Tectonics. Warszawa: 476-720.*
- Ślącza A., 1980: Geology of the Dukla Unit. *Inst. Geol. Prace* 63: 1-97.
- Ślącza A., 2000: Dukla unit a key between a western and eastern Carpathians.: *Geol. Vereinigung e.V. 90<sup>th</sup> Ann. Meeting & Geol. Soc. Austria Meeting 2000. Geology 2000. Vienna, April 14-17, 2000. Abstracts. Terra Nostra. Schriften der Alfred-Wegener-Stiftung 2001/1: 109.*
- Golonka J., Cieszkowski M., Rajchel J. & Ślącza A., 2002: Paleogeography of the algae-bearing Jurassic-Paleogene limestones and sandstones in the Polish Outer Carpathians. This volume.

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