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**MARLS OF THE SUB-SILESIA UNIT (FLYSCH CARPATHIANS)
– PRELIMINARY PETROGRAPHIC COMPARATIVE STUDY**

INTRODUCTION

When compared with sandstones and shales, marls are the least known component of the Carpathian Flysch. The marls are defined as calcareous rocks of predominantly pelitic character, massive or showing slabby/flaggy parting. They are distinguished among sandstones and shales in all tectonic units of the Flysch Carpathians. They are differing in colour, compactness, grain size and sedimentary structures. Marls are particularly common within Upper Cretaceous series of the Sub-Silesian unit. Apart from two dominant Upper Cretaceous (mainly Campanian) marly facies: variegated Węglówka Marls occurring eastward of the Dunajec and grey Frydek Marls containing volcanic blocks described westward of this river, marly rocks of various lithologic character are also locally reported to occur. They are both older and younger than Campanian in age. Among them, there are hard, yellowish, locally spotted rocks called the Jasienica Marls and whitish, hard Żegocina Marls. Detailed study of mineral composition of these rocks tends to define their position in petrographic classification and to determine their origin, what can contribute to the reconstruction of evolution of geologic structure of the Flysch Carpathians.

SAMPLES DESCRIPTION

The Węglówka Marls (Campanian-Maastrichtian) were profiled and sampled in the Węglówka tectonic semi-window, whereas those of the Frydek type (Campanian-Maastrichtian) and the Żegocina marls (early Campanian) in the Żegocina tectonic window. Besides, the Jasienica Marls (Senonian) were sampled in the Jasienica tectonic window.

The Węglówka marls are red, green and variegated. All these varieties are soft, sand-free, often bioturbated, massive or showing flaggy parting. Green, spotty colouration in reddish marls is observed around fine fecal pellets, several to a dozen mm in size. Within marly beds there occur loaf-shaped beige phosphate concretions, up to about 10 cm in size, locally replaced by anhydrous and hydrated iron oxides. In Narębski's opinion their origin is related to submarine volcanic phenomena, producing gases enriched in fluorine.

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Marls of the Frydek type are grey-bluish, soft, arenaceous, containing mica flakes and showing coarse parting. They contain intercalations of grey, horizontally laminated, micaceous, calcareous sandstones and andesite exotic pebbles, several cm in size.

Żegocina marls are white, locally greenish, very hard, poorly arenaceous, structureless and horizontally laminated, locally convoluted. Within their beds siliceous concretions and hornstone intercalations are observed.

Jasienica marls are light beige in colour with subtle yellow or distinct dark-grey spots (bioturbations), hard, showing more or less visible horizontal lamination, locally slightly wavy, marked by a change of colour intensity. Their thin beds are separated by stripes of beige-coloured calcareous shales.

PETROGRAPHY

As follows from the results of these studies, quantitative mineral composition of all the marly facies of the Subsilesian unit studied is very similar. They differ in quantitative proportions at three main mineral components: carbonates, minerals of silica group and clay minerals (Table 1). Their compactness results just from this diversity.

Table 1. Average proportions of main mineral components of the marls studied (wt.%)

Marly facies	Component		
	Carbonates	Minerals of silica group	Clay minerals
Węglówka Marls (17 samples)	20	5	75
Frydek Marls (5 samples)	10	20	70
Jasienica Marls (11 samples)	40	10	50
Żegocina Marls (10 samples)	75	5	20

Micas (muscovite and biotite) and feldspars are subordinate components of marls. Moreover, the Węglówka and Frydek Marls contain some iron minerals: oxides (hematite) and hydrated oxides (red Węglówka Marls). Besides, there also occur sulphides (pyrite), often oxidized (green Węglówka and Frydek Marls). The iron content, expressed as Fe_2O_3 , amounts to about 4 wt.%.

The content of carbonates, minerals of silica group and clay minerals is taken into account in classification of rocks combining the properties of carbonate, clay and silica rocks and of sandstones. The estimation of systematic position of marls requires determinations of origin of these components.

ORIGIN OF THE MAJOR MINERAL COMPONENTS OF THE MARLS

Carbonates are represented by biogenic calcite and, in traces, by diagenetic dolomite.

Calcite occurs in the form of bioclasts and fine plates, as well as moldic microsparite. Biogenic calcite is differently preserved and occurs mainly in foraminiferal chambers or their fragments and as coccolites.

Fine-platy calcite is dispersed among clay minerals and is resembling them in morphology. In marls enriched in carbonates, foraminiferal chambers are filled with microsparite.

Individual rhombohedral dolomite crystals are dispersed in clay-calcite matrix.

Minerals of silica group are generally represented by low-crystalline biogenic silica and grains of detrital quartz. The former comes from dissolved sponge spicules and is fine-platy, similarly as clay minerals. Detrital quartz grains are, but rarely more than 0.1 mm in size.

Clay minerals are represented mainly by smectite mineral, locally with subordinate kaolinite admixtures, as well as by minerals of mica and chlorite groups. The first mineral shows specific features ascribed to volcanogenic smectites. It is dioctahedral, rich in magnesium mixed layer smectite/illite (the content of swelling layers is more than 80%), showing low charge (ca. 0.30), relatively high temperature of decomposition of structure (about 700°C) and cornflake-like micromorphology.

ORIGINAL DEPOSITIONAL COMPONENTS OF THE MARLS

Homogeneity of mineral composition of the marls indicates a similar source of their components. As follows from the present author's studies the initial components of marls were mainly nannofossils (foraminifers and coccolites), sponge spicules, and pyroclastic material being the source of clay minerals. Similar sediments are reported to occur e.g. in the Atlantic and the Pacific oceans. Apart from the nature of clay minerals, the occurrence of biotite flakes also indicates the presence of pyroclastic material in the marls studied. The content of detrital quartz grains in marls is variable what is related to energy of environment of their sedimentation.

CONCLUSIONS

The current investigations have shown that the studied marls of the Sub-Silesian Unit are the products of diagenese of volcanogenic clay-bearing, nannofossil oozes (Żegocina Marls) or nannofossil-volcanogenic clays (Jasienica Marls). The Węglówka Marls originated from nannofossil- and spicule-bearing volcanogenic clays or similar deposits containing silt and sand admixture (Frydek Marls). Actually they represent a continuous series of rocks from calcareous claystones (Węglówka Marls), sometimes arenaceous (Frydek Marls), up to marls (Jasienica variety) and marly limestones, locally arenaceous and silicified (Żegocina Marls). The difference in their compactness depends mainly on the content of carbonates.

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