GLAUCONY IN FLYSCH DEPOSITS AT THE FRONT OF THE MAGURA NAPPE NEAR FOLUSZ (POLISH OUTER CARPATHIANS)

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Abstract: The most significant textural, mineralogical and chemical data are presented for green grains from deposits of lower part of the Magura Beds and the Menilite Beds near Folusz. The analyses indicate that the most frequent glauconitic facies is granular and the grains are K-rich glauconitic mica with high Fe_2O_3 content - they represent evolved and highly evolved stages of glauconitization. These data can be the basis for discussion on depositional environment and the origin of parent material of the studied beds.

Key words: glaucony, mineralogy, Magura Beds, Menilite Beds

Introduction

In the Carpathian flysch there is quite large number of formations containing green grains which resemble glauconite. This mineral is useful, on account of its special properties, in different fields of geological science. It can, for example, be a possible tool for sedimentologic interpretation of marine deposits, stratigrafic correlation or radiometric dating (Amorosi, 1996).

Unfortunately, the investigations of green grains occurring in the Polish Carpathians are very poorly developed. In general, geologists regarded them as glauconites in most cases without examination their mineralogical and chemical character. The preliminary result of the mineralogical and chemical investigations of glaucony from the sandstone and madsone of the Magura Beds were presented by Koszowska and Leszczyński (2001).

This paper presents the results of mineralogical and chemical analyses of several samples of green grains from flysch deposits of the marginal zone of the Magura Nappe and its foreland (the Jasło Nappe). They can be the basis for discussion on geological conditions of origin the deposits containing them.

Geological setting

The study area is situated in the Polish Outer Carpathians near Folusz. Four representative samples were collected from two cross-sections exposed along Kłopotnica stream. One of them is situated in the marginal, northern part of the Magura Nappe (Siary subunit) and the other in the area at its front regarded as the Jasło Nappe (Koszarski and Koszarski, 1985; Koszarski, 1999). Although, because of its very complicated tectonic there are many differences in opinions on geology of this area (see: Szymakowska, 1966; Jankowski, 1997).

Two samples were collected from sandstones of the Magura Beds and the other two from the Menilite Beds (sandstone and limestone). Both formations are Lower Oligocene in age.

Methods of investigations

The collected samples were separated using the following methods: glaucony-bearing rocks were disaggregated, submitted to magnetic separation, heavy-liquid fractionation, purification by ultrasonic cleaning, and finally handpicking.

The main properties (morphology, mineralogy and chemistry) of green grains were studies by applying: optical microscopy, scanning electron microscopy (SEM-EDS) and XRD of oriented powder samples.

Results of investigations

Physical properties

The colour, density, morphology and internal structure of green grains were examined in detail. The green grains occur mainly in size range of 0,1 – 0,5 mm. They are mainly dark-green in colour (light coloured grains represent only few per cent of each sample). They exhibit considerable variety in morphology. Most frequent glauconitic facies type is granular, but the diffuse type was also identified. Among the morphological types the most representative are (according to Triplehorn, 1966): spheroidal –ovoidal (30-40% in each sample) with smooth surface, mammillated, tabular-discoidal and irregular shape are also observed, rarely composite pellets and pellets resembling internal cast of foraminifers are present.

The electron microscopy observations allow to distinguish two types of microstructure (according to Wiewióra and Łącka, 1979):

- "honey-comb" microstructure, observed in grains with smooth surface,
- random aggregates of flakes, which are characteristic for grains showing porous, coarse surface interpreted as an effect of abrasion and transport.

Mineralogy

The mineralogical characteristic was mainly based on powder mounts. X-ray diffraction investigations on untreated and glycolated oriented samples were made for defining the mineralogical type of green grains and the amount of expandable layers.

Investigations reveal that the grains of each sample represent glauconitic mica. The content of expandable layers, which is the main criterion for defining glauconitic species, is relatively small (less than 10%) - the procedure for defining illite/smectite interstratifications proposed by Środoń (1984) was used in the case of studied gluconites.

Short distance *d* between the (001) and (020) peaks on diffractograms (see: Odin and Matter, 1981; Odin an Fullagar, 1988) indicates high potassium content in the structure of studied glauconitic material. It also indicates that the grains consist of well-ordered glauconites.

Chemistry

Chemical analyses of the grains confirm their glauconitic nature. The calculated chemical formula does not differ significantly from the others presented in previous references (Tab. 1). The $Fe_2O_{3Tot.}$ content of the studied glaucony is high (up to 29%). The K_2O content, which is directly related to the content of expandable layers and provides information about the maturity of glaucony (as documented by Burst, 1958; Hower, 1961; Odin and Matter, 1981 and others), is also very high – more than 7%.

The composition (high K_2O content) and structure (*d* spacing, shape and intensity of peaks on XRD diagrams) indicate that the studied material represents the last stages of glaucony evolution. Glauonite from sandstones of the Magura Beds and sandstones and limestones of the Menilite Beds are evolved and highly-evolved. The same stage of evolution is characteristic for materials from embedding mudstones of the Magura Beds (Koszowska and Leszczyński, 2001).

Conclusions

The deposits hosting glaucony were formed by gravity-flow processes in an environment that was poorly suited to glauconitization. This suggests that the glauconitic grains were redeposited.

According to the model proposed by Amorosi (1996) glaucony of each sample is considered to be allochthonous. Nevertheless, more investigations are required to state if the glaucony is detrical (extrasequential) or parautochthonous (intrasequential).

The features of glaucony in individual sample indicate that the composition of grains is similar. They represent similar maturity and morphological types. Therefore, the genetic relationship between green grains is really possible (the maturity of glaucony may be used as an index for correlation with putative sources – Amorosi, 1996).

The results presented provide some new information on the origin of glauconite-bearing deposits in the studied area. Further detailed mineralogical and sedimentological investigations are needed to better understanding of the origin of glauconite-bearing sediments in the units of the Polish Outer Carpathians and to provide more adequate interpretation of origin of these units.

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Tab.1. Chemical formula of studied glaucony compared with data from previous references.

Author	Number of analyses	Formula
Presented work	14	$(K_{0,74}\ Ca_{0,05})_{0,77}$ $(Al_{0,31}\ Fe3+_{tot1,37}\ Ti_{0,01}\ Mg_{0,41})\ (Si_{3,51}\ Al_{0,50})\ O_{10}(OH_2)$
Smulikowski (1954)	60	$(K_{0,67}\ Ca_{0,08}\ Na_{0,08})_{0,83}$ $(Al_{0,40}\ Fe3+_{1,05}\ Fe2+_{0,17}\ Mg_{0,41})\ (Si_{3,66}\ Al_{0,34})\ O_{10}(OH_2)$
Turnau-Morawska et al. (1975)	1	$(K_{0,70}\ Ca_{0,09}\ Na_{0,01})_{0,80}$ $(Al_{0,76}\ Fe3+_{0,79}\ Fe2+_{0,15}\ Mg_{0,31})\ (Si_{3,64}\ Al_{0,36})\ O_{10}(OH_2)$
Odom (1984)	6	$(K_{0,76}\ Ca_{0,03})_{0,79}$ $(Al_{0,39}\ Fe3+_{1,10}\ Fe2+_{0,18}\ Mg_{0,35})\ (Si_{3,62}\ Al_{0,38})\ O_{10}(OH_2)$