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THE GEOLOGY AND ABUNDANCE OF GREY SLATES IN THE EASTERN PARTS OF THE PELAGONIAN TERTIARY BASIN

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Abstract: The specific conditions in the evolution of the Pliocene sedimentary complex in the eastern marginal parts of the Pelagonian basin created favourable conditions for the development of large amounts of grey slates in the top part of the coal-bearing formation. This indication encouraged the present authors to carry out investigations on their genesis and define their abundance. The paper also presents the methods applied during the investigation, the results and the possible recovery of the raw material.

Key words: geology; grey slates; mineralogy

INTRODUCTION

The Pelagonian Tertiary basin which covers an area of 1 500 km² is situated in the south of the Republic of Macedonia. The southern parts of the basin are situated in the Republic of Greece.

In terms of its structural-tectonic regional geologic setting, the basin (defined as Pelagonian horst-anticlinorium (Arsovski, 1960) is characterized by pronounced complexity. This ascertainment is due to the fact that the basin developed as an individual geotectonic unit within specific regional structures. They were the Vardar zone in the east and the western Macedonian mountains in the west representing part of the inner Dinaric belt.

Of particular interest to the development of the Pelagonian depression (Fig. 1) was the Pliocene period which created the conditions for the formation of large sedimentary complexes of grey slates.

Large number of vertical structures were activated during the Pliocene as a result of the intensity of radial tectonics creating favourable conditions for the development of the Pelagonian depression which served as sedimentary-lacustrine environment over the history (Izmajilov, 1965).

The complex analyses carried out on the Pliocene complex led to several conclusions:

- that it is present in the eastern parts of the Pelagonian basin, being eroded in other parts of the basin;

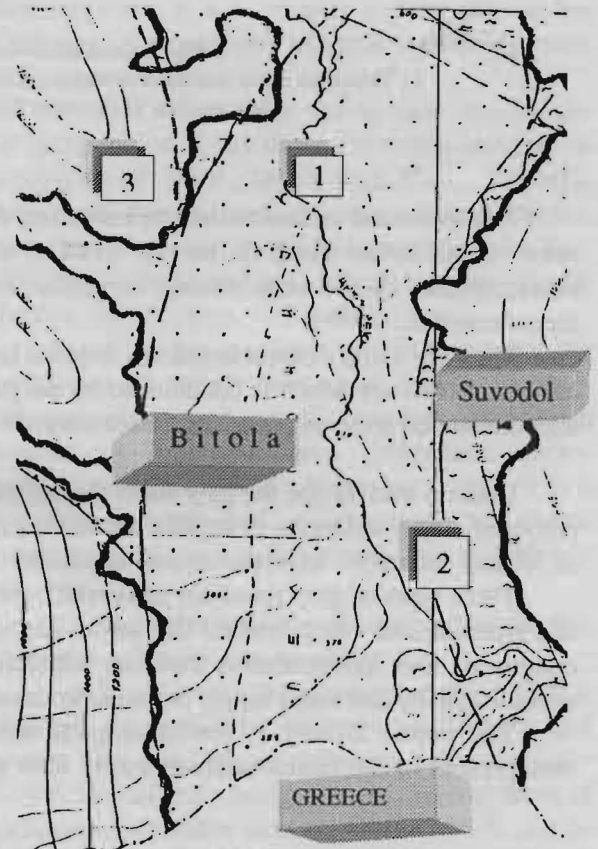


Fig. 1. Schematic presentation of the Bitola part of the Pelagonian basin. 1) Quaternary. 2) Pliocene, grey slates. 3) Marginal part. 4) Sampling site.

- in terms of the paleorelief its stratigraphic position is transgressive and discordant;
- that in the Pliocene sedimentary complex a basal facies, a coal-bearing producing facies, clayey-marly and sandstone one are clearly defined.

The size of the clayey-marly facies, estimated at several billion tones, increased the interest to further investigate and eventually excavate the mineral raw material.

GEOLOGICAL CHARACTERISTICS OF GREY SLATES

The stratigraphic location in the Pliocene sedimentary complex is an indication that the raw material can be expected in a permanent place, concordantly deposited in the top part of the coal-bearing producing facies. The grey slates occur on

the surface in a large area in the eastern marginal parts of the Pelagonian basin (PK Suvodol, Vranjevci, Brod - Gneotino as far as the Greek border) (Fig. 2).

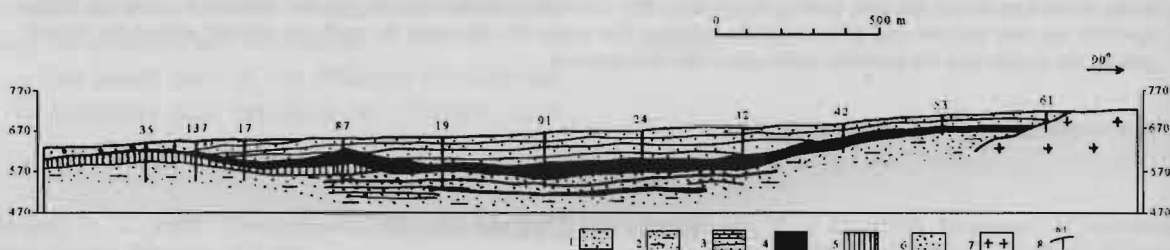


Fig. 2. Geological cross-section of the Suvodol deposit.

- 1) Yellowish sands and dusts of various sizes.
- 2) Grey dusts and sands.
- 3) Grey clays.
- 4) Coal layer.
- 5) Coals clay.
- 6) Greenish floor sands and dusts.
- 7) Gneiss.
- 8) Drillhole

The structural-tectonic characteristics and the value of individual elements are the result of the characteristics of the coal-bearing formation and the paleorelief.

They are mainly characterized by explicit layering and cleavage which is conditioned by the parallel orientation and concentration of mica minerals.

Under a microscope the grey slates display properties of clayey sediments of explicit alevrolitic-pelitic affinity and micro- to crypto-crystalline structure.

Three types of grey slated are determined: greyish, greenish and white formed due to the specific conditions and sedimentation medium, structural-tectonic activity and water supply in the environment.

The pelitic affinity of the lithological members present in the facies makes possible their ge-

netic determination. Notably, their occurrence depends on the geotectonic and hydrodynamic nature of the sedimentation medium.

The analysis of the mineral composition of the grey slates make possible a provisional determination of the presence of some volcanic dust which allows to call them tripelites. This is also supported by the fact that the eastern marginal part of the Pelagonian basin is in close proximity to the Mariovo volcanic area. These observations, no doubt, should be proved by further investigations and examinations.

One of the characteristics of the grey slates is their abundance in plant residues whose volume and preservation had an effect on the sedimentation process.

QUALITATIVE CHARACTERISTICS OF GREY SLATES

Determination of the granulometric composition is one of the basic goals in the determination

of the abundance of the raw materials of sedimentation affinity.

Table 1

Granulometric analysis of grey slates

Particle size μm	Amount %
+ 63	3.50
63–50	10.80
50–30	8.80
30–10	15.90
10–5	17.80
– 5	43.30

Analysis of the amount of individual fractions (Table 1) indicated that 96.50 % of the material consists of fraction below 63 μm showing that the grey slates are characterized by fine dispersion due to the specific nature of the sedimentation medium, whose intensity and sedimentation took place in quiet conditions over long periods of time. The high fineness results in the explicit hydroscopy (of up to 45 %).

In nature the grey slates contain high percentage of moisture reaching up to 74%, the volumetric weight in moisture state amounting from 12.7 to 15 kN/m^3 , whereas in dry state amounting to 6 kN/m^3 . The specific mass ranges from 23 to 25 kNm^3 .

The amount of SiO_2 of up to 61.41 % and Al_2O_3 of 14.6 % (Table 2, Fig. 3) classify the grey slate as non-metallic mineral raw material of aluminosilicate nature.

Table 2

Chemical analysis of grey slate

Parameter	Amount %
SiO_2	61.41
Fe_2O_3	6.76
Al_2O_3	14.60
TiO_2	0.02
CaO	2.14
MgO	2.72
Na_2O	0.80
K_2O	1.21
g.z	10.30

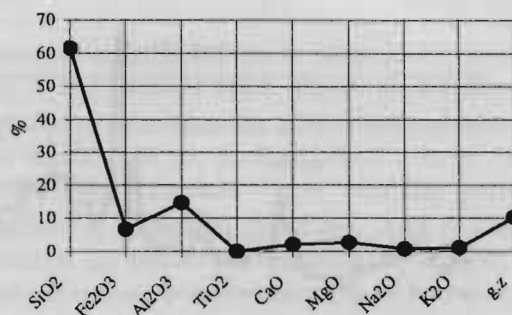


Fig. 3. Graphic presentation of contents of individual oxides

The chemical analysis (which according to Bolenbah makes possible an estimation of the mineralogical composition of any mineral raw material) classifies the grey slates as a mixture consisting of 7.15 % potassium feldspar, 6.76 % sodium feldspar, 30.36 % clayey matter, 11.63 % ($\text{CaO} + \text{MgO} + \text{Fe}_2\text{O}_3$) and 38.06 % free, mainly amorphous, SiO_2 .

The results obtained indicate that the grey slate (tripolite) is not virtually a slate material but a mixture of amorphous material containing some 30% clayey.

In order to precisely define their mineralogical composition X-ray diffractometric analyses in conditions of 38kV, 18mA with CuK_{α} /Ni rays, differential-thermal and thermogravimetric analyses were carried out in the laboratories of the Faculty of Technology and Metallurgy in Skopje (Jančev, 1996), (Figs. 4, 5 and 6).

Based on the results it was inferred that the grey slates are mainly built up of amorphous material, and only a small part of crystalline phase which consists of illite-hydromica, orthoclase, microcline, plagioclases and amorphous quartz. It is a complex mineralogical composition that causes overlapping of some diffractive lines of different minerals.

Based on the analysis of overlapping the following conclusions can be drawn:

– reflection with the intensity of $d = 3.33 \text{ \AA}$ is obtained for both illite-hydromicas, feldspar and quartz. Chlorites, whose reflection amounts to $d = 7.19 \text{ \AA}$ undoubtedly being present, overlap those of kaolinite whose value amounts to $d = 7.16 \text{ \AA}$, can be an indicator of kaolin presence. However, the absence of other intense kaolin reflections ($d = 2.49 \text{ \AA}$, $d = 2.338 \text{ \AA}$, $d = 2.288 \text{ \AA}$) confirm the illite-hydromica affinity of the clay.

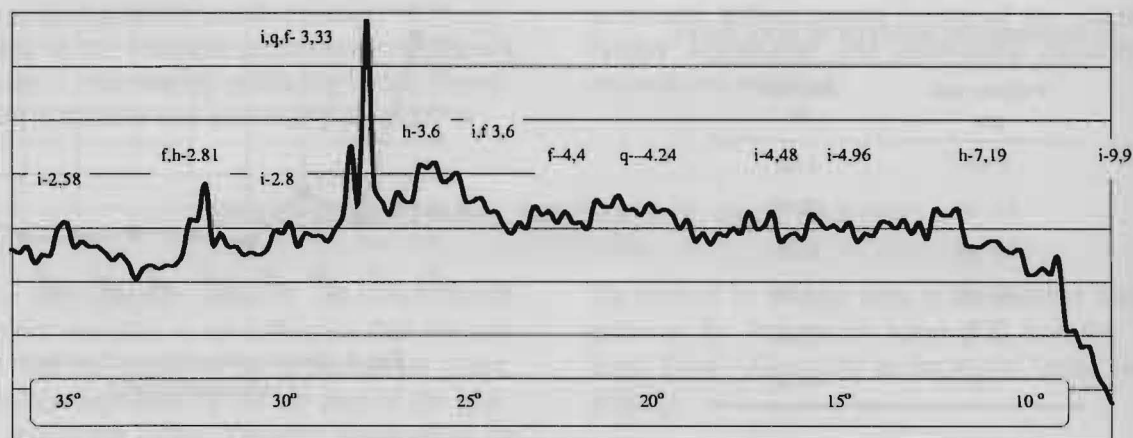


Fig. 4. X-ray diffractometric analysis
i - illite (hydromica), q - quartz, f - feldspar, h - chlorite

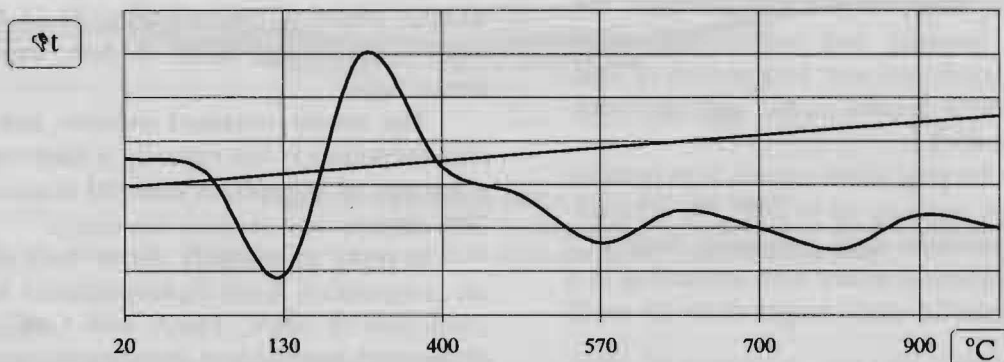


Fig. 5. Differential thermal analysis

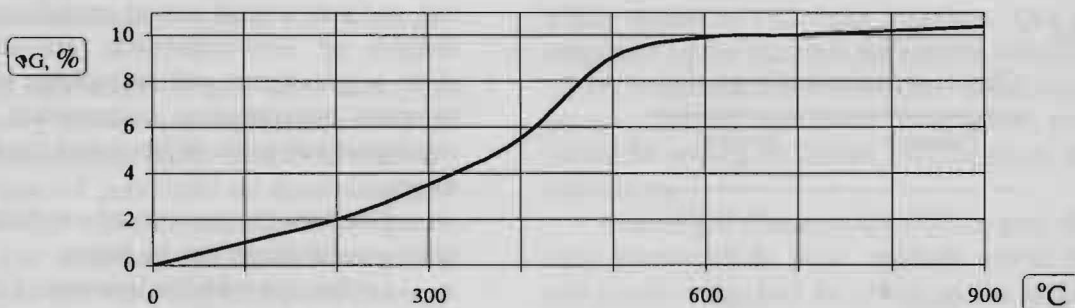


Fig. 6. Thermogravimetric analysis

The thermogravimetric analysis records the presence of exothermal effect, with maximum at 300 °C, indicating the development of oxidation process or

burning of organic materials present in the grey slates. This was also proved by microscopic examinations which yielded the cyclotella type of diatoms.

TECHNOLOGICAL PROPERTIES AND POSSIBILITIES OF ITS USE

The specific nature characterizing the grey slate was the reason for complex investigations in order to define its properties and the possibilities of its use.

When drying the material at 105 °C, the volume weight does not exceed 800 kg/m³, whereas dried at 600 °C to 600 kg/m³ it displays high tenacity (Sapunov et al., 1975). The material heated to 960 – 1050 °C resembles good quality baked brick

whose volumetric weight is 30 to 35 % lower than that of the ordinary brick. Based on the aforementioned characteristics the grey slates can be used as raw material in the production of a large number of building materials (light building parts and aggregates, insulation materials, filler in chemical industry, as pozzolana additive to cement, as a dryer-desiccant component parts in hydroscopy of materials etc.

CONCLUSION

The analysis of the slate-marly facies in the Pliocene sedimentary complex of the Pelagonian basin displays the specific nature of evolution in the basin.

According to their affinity the authors can come to the following conclusions:

– the clayey-marly facies is a good indicator of the evolution and the presence of the coal-bearing formation in the basin,

– grey slates contain good properties of a non-metallic raw material of complex mineralogical composition present as amorphous matter and clayey substance of specific physico-mechanical characteristics,

– the qualitative determination of the grey slate in terms of individual parameters and technological properties point out the possible valorization which should become the subject of further investigations and examinations.

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Резиме

ГЕОЛОШКИ И КВАЛИТАТИВНИ СПЕЦИФИЧНОСТИ НА СИВИТЕ ГЛИНЦИ ВО ИСТОЧНИТЕ ДЕЛОВИ НА ПЕЛАГОНИСКИОТ ТЕРЦИЕРЕН БАСЕН

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Клучни зборови: геологија; сиви глинци; минералологија

Анализата на глиновито-лапоровитата фација во плиоценскиот седиментен комплекс на пелагонискиот

басен непосредно ги определува специфичностите на нејзиниот развој и развојот на басенот во целина.

Со оглед на нивниот карактер и интерес, а во функција на предметниот труд, би можеле да се истакнат следните согледувања:

– Глиновито-лапоровитата фација претставува непосреден индикатор за развојот и егзистенцијата на јагленосната формација во басенот.

– Производ на фацијата се сивите глинци, кои од квантитативно-квалитативен аспект ги поседуваат сите атрибути на една многу интересна и специфична неметална минерална суровина со комплексен мине-

ралоски состав, претставен со аморфна материја и глиновита супстанција и со специфични физичко-механички особини.

– Квалитативната дефинираност на сивиот глинци е изразена преку вредностите на поединечните параметри и технолошките својства кои ја условуваат неговата реална потенцијалност за адекватна валоризација, што треба да биде предмет на понатамошни истражувања и испитувања.