GEOME 2
Manuscript received: January 30, 2000
Accepted: June 14, 2000

Geologica Macedonica, Vol. **14**, p. 21–24 (2000)
SSN 0352 – 1206
UDC: 553.9.06 (497.7)

Original scientific paper

THE ROLE OF ORGANIC MATTER IN THE EVOLUTION OF COAL DEPOSITS IN THE PELAGONIAN BASIN (REPUBLIC OF MACEDONIA)

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A b s t r a c t: It is an unassailable fact that the organic matter, its genetic and post genetic developments, conditioned by the specific conditions of sedimentation and governed by the intensity of geodynamic processes of sedimentation environment, are the primary factors that influenced the development of coal deposits. However, the characteristics that define the Pelagonian basin as an outstanding geomorphologic horst-anticlynorum form within the regional morphostructural structures, also include the active role of the organic mass, as reflected by the intensity of the geochemical and biochemical processes, whose nature requires appropriate study, analysis and determination, the afore mentioned items are the major goals of the paper.

Key words: Pelagonian basin; organic matter; coal; macerals

INTRODUCTION

The Tertiary Pelagonian basin occupying an area of 1500 km^2 is situated in the south part of the Republic of Macedonia. Its south most part is situated in neighbouring Greece. It developed as an individual geotectonic unit within regional geotectonic structures: the Vardar zone in the east and Western Macedonian mountains in the west all representing parts of the inner Dinaric belt.

Two phases are distinguished in the tectonic development of the Pelagonian crystalline mass: the Precambrian and Postcambrian. The Precambrian tectonic phase is characterized by the development of plicative structures that gave the Pelagon the shape of an anticlynorum, whereas during the Postcambrian phase it separated as an individual horst in which, owing to the intensity of radial tectonics, the Pelagonian and the Mariovo Pliocene basins were formed during the last phase of the geotectonic cycle. The Pliocene limnic structures and terraces reach the altitude of 1000 meters. As a result, the amplitude of neotectonic vertical movements in the area amounts from 700 to 800 meters.

The Pelagonian basin is an area of positive geomorphological form divided into two parts: the Bitola and Prilep valleys. The part in the area of Bitola reaches 800 m in depth, whereas the maximum depth of the Prilep valley amounts to 300 meters.

The sedimentation processes in the Bitola and Prilep valleys are different and conditioned, first of all, by the geodynamic processes, the depth of the basin and the manner and intensity of sedimentation.

In the Prilep valley facies of sands and sand clays formed as a result of fast and shallow sedimentation can be found. In the Bitola valley, besides sands and clay sands, fine grained materials (slate, alevrolite) as products of normal sedimentation can also be found.

The Pliocene limnic complex which, according to paleontologic analyses is distinguished as Middle to Upper Miocene, is of particular importance to the development of the organic matter and coal deposits.

Based on the members present in the lithologic composition two superimposed facies can be distinguished: lower and upper facies, each of them with their own characteristics.

The lower facies comprises the basal part of the Pliocene sediments and starts with sedimentation of transgressive material composed of gravel and gravel sands. This lithologic member is overlain by layers and interbeds of grey-green sands, sandy clays, coal layers and alevrolites. A characteristic feature of the facies is its rhythmic sedimentation as well as its vertical and horizontal gradual wedging out. Alevrolites (either alevrolite or pelite) with quartz, feldspar, vermiculite and clay grains (of the montmorilonite and illite group)

are significant coal-bearing indicators since they always occur in the hanging wall of the coal. The diagenetic stage and the pronounced bedding classify them as slates.

Coal layers and interbeds are developed in the top parts of the cross-section. Since the coal formation in the basin bears almost the same characteristics, differences occur with regard to the thickness, lithofacial characteristics and structural-tectonic features owing to different climatic, geotectonic, hydrographic, hydrogeological and other factors.

The upper facies stratigraphically lies in the upper part of the Pliocene cross-section present as poorly sorted and stratified gravel, gravel sands and loams mainly of yellowish colour. The sedimentary complex of the basin ends with Quaternary sediments of Pliocene and Holocene age.

2. GENETIC MODEL FOR COAL-BEARING ABUNDANCE IN THE BASIN

Unlike other mineral raw materials, particularly metallic raw materials where the issue of genetic modelling has been given great attention, the genetic models of coal have not been sufficiently studied. The paper will present all factors regarding the issue in order to contribute to the studies of genetic models and their significance in the formation of coal deposits.

The complex relationships, which define the occurrence of parent material and its evolution to the final product – the development of coal is of particular importance to the profusion of coal in the basin. In this regard, mention must be made of the phases as follows:

– the origin of the organic matter and its transport (climatic-vegetation conditions for the development of sufficient phytogenic material, autochtonous-alochtonous);

– accumulation (physical-geographic conditions, manner of sedimentation, pH and eH factors of the medium, geotectonic conditions, transgression and regression processes, multi-phase accumulations and the development of coal-bearing formations);

– transformation of organic matter as one of the most specific factors in the evolution and how it is affected by the complex physical-chemical and geological factors that also govern the processes of humification, carbonification, diagenesis and metamorphism of coal.

Based on the afore-mentioned processes and factors, two stages can be distinguished each of them occurring in different time periods and conditions:

– the first stage is characterized by the accumulation of flora and the development of floor coal-bearing formation lying immediately on the palorelief (I and II floor horizon of the Živojno deposit) and

– the second stage conditioned the development of the hanging wall productive coal-bearing formation lying in the top most parts of the basal facies.

The vertical discontinuity in the evolution of these coal-bearing formations was initiated by the geotectonic conditions of the Pelagonian basin and was an essential factor in defining the physical-geographical environment.

Active geodynamic conditions in the basin provided the microclimatic changes that influenced the arrangement and abundance of vegetation, the extent of ascent and dissent of the area of accumulation, the transgression and regressions that conditioned transgressive settling of various sands and dusts in the top part of the floor and the development of marl-clayey facies (Fig. 1) in the hanging wall of the coal-bearing productive formation.

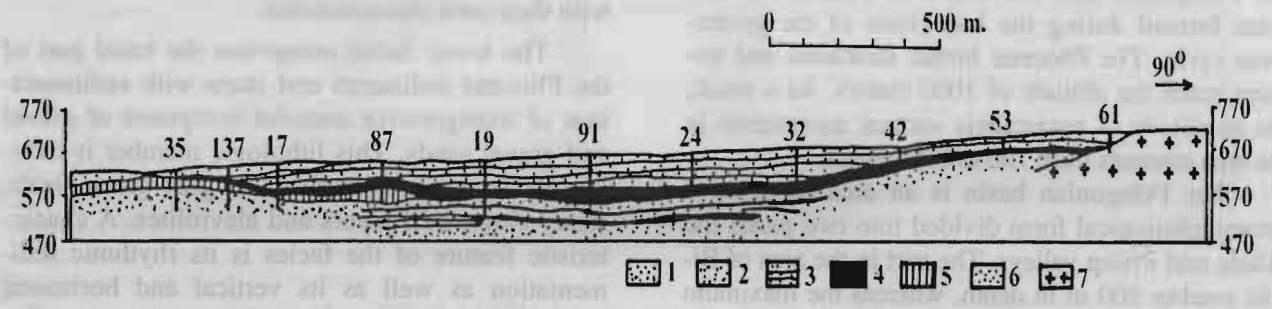

Fig. 1. Geological profile of the Suvodol deposit
1) Yellowish different grain sands and dusts. 2) Grey dusts and sands. 3) Greenish grey slates. 4) Coal seam. 5) Floor sands, dusts and coal slates. 6) Greenish floor sands and dusts. 7) Gneiss

The accumulation and decomposition of flora took place in the peat phase that led to the formation of peat. The humification process took place in biochemical and, most of all, microbiological conditions.

The covering of peat material by inorganic sediments of various compositions interrupted the activity of organisms. Owing to the accumulation of humic acids the medium became aseptic. The cease of microbiological activity initiated the physical-chemical processes in the peat mass. This activity started as a result of the high pressure, the catalytic influence of mineral admixtures and circulation of water mass.

During coal formation, the coal in the Pelagonian basin underwent a process of diagenesis in which peat changed into soft brown coal of the lignite type. During this diagenetic process a significant compression of the peat occurred along with water extinction accompanied by other chemical changes of reducing nature. Molecular association of humic acids, lepidoids and bituminous materials was activated, leading to release of gases from the organic matter such as carbon dioxide. In the initial phase, the process of metamorphism included the coal of I and II floor horizons in the Živojno deposit. This can be classified as the third group hard brown coals.

3. PETROGRAPHIC CHARACTERISTICS OF THE COALS

Heterogeneous organic materials comprising the predominant material in the formation of coal has several characteristics. The complex geochemical processes that took place during the formation of coal seams such as the processes of coal formation and carbonification developed a fairly complex-heterogeneous coal mass (Table 1). The study of this mass made it possible to determine the basic petrographic component parts of coal such as:

- the essential mass,
- the macerals and
- mineral admixtures

whose characteristics and nature have a great impact on the physical-mechanical and chemical characteristics of the coal.

Table 1

Petrographic analysis of coal from the Suvodol deposit

Macerals and minerals	Volume (%)
TEXTINITE	23.5
ULMINITE	36.5
ATRINITE	3.5
DENSINITE	4.0
GELINITE	9.5
LIPTINITE	3.0
INERTINITE	1.5
CLAY	17.0
PYRITE	1.5

The petrographic analyses carried out on coals in individual deposits in the Pelagonian basin indicate that:

- the percentage of mecerals (Fig. 2) such as textinite and ulminite (50–59%) predominates in the coals providing the coals a pronounced xylite feature,
- organic materials comprise 70–85% of the coal mass,
- the degree of reflection (Fig. 3) huminite/fusinite amounts to 0.28%, which is a characteristic of lignite coals.

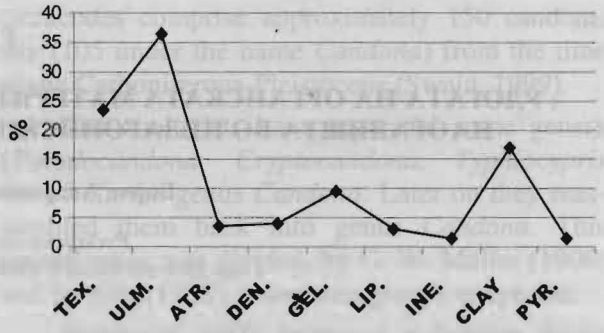

Fig. 2. Graphical presentation of the al petrographic compounds of coal in the Suvodol deposit

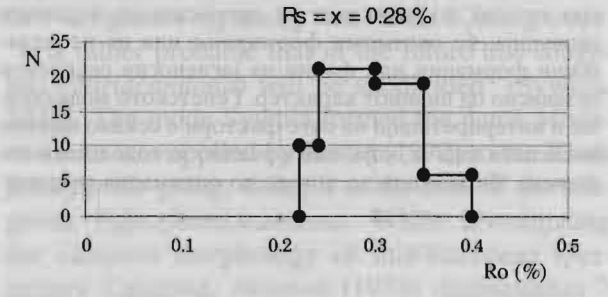

Fig. 3. Reflection of the huminit of coal in the Suvodol deposit

Regarding the fact that coal will be rationally used in near future, it is necessary to better define its petrographic composition and characteristics. The study should throw more light on the issue of the chemical changes and petrographic features of coal formed in thermal processes.

4. CONCLUSION

The organic matter was the dominant factor in the formation of coal deposits. The processes of its evolution determine whether or not it will develop coal formations or facies of coal sediments of any kind. Genetic modelling and interoperation of all factors is a complex task that could lead to a good interpretation and reconstruction of all natural processes governed by a number of factors and individual processes and its transformation into coal.

Unravelling this issue demands systematization and classification as well as interperation of all possible genetic data obtained during numerous complex investigations and examinations.

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Резиме

УЛОГАТА НА ОРГАНСКАТА МАТЕРИЈА ПРИ ФОРМИРАЊЕТО НА ЈАГЛЕНОСНИТЕ НАОЃАЛИШТА ВО ПЕЛАГОНИСКИОТ БАСЕН (РЕПУБЛИКА МАКЕДОНИЈА)

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Клучни зборови: Пелагониски басен; органска материја; јаглен; мацерали

Неоспорни се констатациите дека улогата на органската материја при формирањето на наоѓалиштата на јаглен претставува примарен и основен фактор којшто, во зависност од процесите на нејзината еволуција, ќе овозможи формирање или не на јагленосни формации или фации на јагленосни седименти независно од нивниот карактер. Генетското моделирање и интерпретација на сите фактори е секако најкомплексната задача, која, ако е реално методолошки поставена, би можела до доведе до оптимална реинтерпретација или реконструкција на сите природни процеси диктирани од големиот број на комплексни фактори, кои учествуваат во поедини процеси на нејзината трансформација во јаглен.

За решавање на овој проблем секако неопходна е потребата од систематизација (класификација) и интерпретација на сите можни генетски информации кои се последица на голем број комплексни истражувања и испитувања, кои се одвиваат или планираат во рамките на бројни научни дисциплини.