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NEW DATA ABOUT THE MIRKOVO FORMATION FROM THE AREA OF CHELOPECH VILLAGE, SOFIA DISTRICT

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ABSTRACT. The study presented the results from the specialized lithological and lithofacial investigations of four drills that crossed the Mirkovo Formation north-west of Chelopech Village, Sofia district. The Mirkovo Formation (Santonian-Campanian) is build up mainly by red limestone with rare intercalations of polymictic matrix- and grain-supported breccia and breccia-conglomerates. The limestones are mainly allochemic and micritic, medium to fine grained. Together with the allochemic and bioclastic component in them, most often forming detachable levels, it is presented classtic and pyroclastic ones, the last one represented by llitho- and vitroclasts, plagioclases and biotite. With similar levels are connected load-cast structure with various amplitude and frequency, flint concretion development and changes of the color of the rocks – from saturated red to reside to light-green and whitish. The obtained results permit to be specified the character and the peculiarities of the lower and upper boundary of the unit. Also stratigraphic subdivision of the unit is developed.

НОВИ ДАННИ ЗА СТРОЕЖА НА МИРКОСКАТА СВИТА В РАЙОНА НА С. ЧЕЛОПЕЧ, СОФИЙСКО

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РЕЗЮМЕ. Изследването представя резултатите от специализирани литоложки и литофациални изследвания на 4 сондажа пресичащи Мирковската свита СЗ от с. Челопеч, Софийско. Мирковската свита (сантон-кампан) е изградена предимно от червени варовици с редки прослои от полимиктови наситени и ненаситени брекчи и бракчо-конгломерати. Варовиците са предимно алохемни и микритни, средно- и дребнозърнести. Наред с алохемната и биокластичната компонента в тях, формирайки най-често обособени нива, присъства кластична и пирокластична такава, последната представена от лито- и витрокласти, плагиоклази и биотит. С подобни нива са свързани тектстури на натежаване и проникване с различна амплитуда и гъстота, развитие на кремъчни конкреции и промяна на цвета на скалите – от наситено червен към резидав и белезникав. Получените резултати позволяват уточняване на характера и особеностите на долната и горната граница на единицата. Разработена е и стратиграфска подялба на единицата.

Introduction

With its lithology the red limestone of the Mirkovo Formation (Santonian-Campanian) is among the convenient and often used lithostratigraphical and lithofacial marker levels in Upper Cretaceous succession in western and central Bulgaria. Despite of this some aspects of its characteristics are not well studied yet.

The unit is introduced as "Мирковская свита" by Moev and Antonov (1976). In the previous investigation in the area the rocks of the Formation are described as "second horizon of the Senonian" (Nikolaev, 1947), "third horizon of the Mastrichtian" (Vrablianski et al., 1961), "clayey-limestone suite" (Moev et al., 1975f) and Mirkovo Formation (Moev and Antonov, 1978; Yolkichev, 1993c; Cheshitev et al., 1995; Zhelev et al., 1999f).

The prospecting drilling program of Balkan Mineral and Mining (BMM) EAD in the area of Chelopech syncline, with which special permission this study is published, realized in the period of 2006-2007 year and includes part of the type area of the unit as well, gives good opportunity to be collected and analyzed new data about the lithology and the structure of the Mirkovo Formation in Western Bulgaria.

The aim of this study is to present the results obtained from the specialized lithofacial study of the Mirkovo Formation in four drillings and several outcrops in the eastern part of Chelopech syncline, structure that is build up mainly by Upper Cretaceous (Turonian-Maastrichtian) sedimentary and volcano-sedimentary rocks, and is situated just NW of Chelopech village, Sofia district.

Material and methods

The paper is based on the results of the specialized lithofacial studies of core material from four drillings, situated in the northern limb and the eastern centrycline of the Chelopech syncline (Fig. 1). The core material is storied in the core-depository of BMM EAD in Chavdar village, Sofia district. The calculation of the true thickness of the units is based on the structural data given by BMM EAD as well as on National Geofund materials (Zhelev et al., 1999f). During the macro-

scope study of the core materials were recognized, studied and described lithologica and lithofacial types under application of standard abbreviation code that correspond to the content, texture and structure of the protolith. Aiming the facilitate using the core column graphs, the vertical scale of the lithological column in the graphs as well as in the text correspond to the drilling data (depth from the surface) but no to the real thickness of the units. The field grain-size characteristic of the clastic and the carbonate rocks is based the developed by Friedman and Sanders (after Miall, 1990, Table 2.1) standard scale. The description of the mixed clastic-carbonate rocks is based on the classification scheme proposed by Sultanov (1980). The field color description of the rocks in the section is based on the *Rock-Color Chart* (1991).

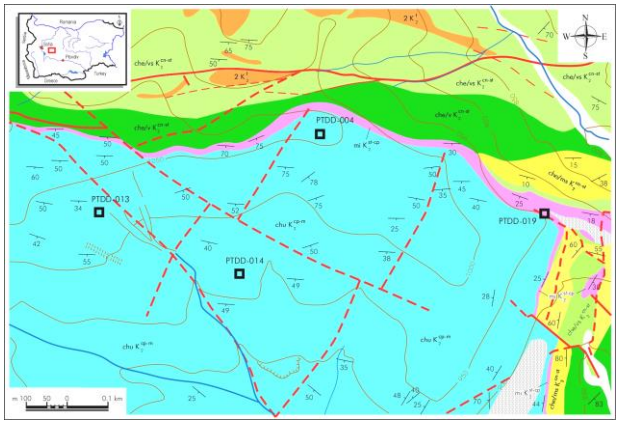

Fig. 1. Schematic geological map of the studied area position of the studied and sampled during this investigation drillings (on the base of data given by BMM EAD and after Zhelev et al., 1999). *Abbreviations*: 2 K_2^t – sandstone suite; Chelopech Formation: che/v K_2^{cn-st} – volcanogenic package; che/vs K_2^{cn-st} – volcano-sedimentary package; che/ms K_2^{cn-st} – mica-sandstone package; mi K_2^{st-cp} – Mirkovo Formation; chu K_2^{cp-m} – Chugovitsa Formation

Lithological characteristic

The Mirkovo Formation is built up by variegated, mainly red limestone intercalated by beds of polymictic breccia-conglomerate. The unit was established in all four drillings. Its thickness varies: in drilling PTDD-004 – about 16 m (interval 32-85 m); in drilling PTDD-013 – 21 m (interval 132-156 m); in drilling PTDD-014 – about 58 (?) m (corresponding with interval 150-217 m); and in drilling PTDD-019 – 18 m (interval 9-41 m).

The main lithological varieties, that give the face of the Formation, are the limestone. Significant part of it is colored in different tones of the red, but reseda to whitish in color is also observed. In the sequence dominate the micritic and allochemical medium- and fine grained limestone. Biomorphic and bioclastic varieties are also established. About the 60-70% of the volume of the biomorphic limestone is built up by fossils – mainly foraminifera (in some places up to 95%) and in less degree fragments of mollusk, crinoids, ostracodas etc. The structure of the bioclastic limestone also is dominated by ostracorda and foraminifera fragments. Characteristic feature for biomorphic, as well as bioclastic component, is the development of hematitization. Not so rare the shells completely are filled by hematite colored calcite.

Besides with allochemical and bioclastic component, in the limestones are established also clastic and pyroclastic ones. The clastic component is presented mainly by quartz, muscovite and lithites. The lithites are presented by volcanic and carbonate rock fragments. The volcanic rock fragments are angular to well rounded, medium as chemical content, fresh to altered in different degree. On some fragments are visible thin limonite and/or hematite crusts. Plagioclase, biotite, amphibole and glauconite are also established. The pyroclastic component is presented by litho-, crystallo- and vitroclasts, plagioclase (Fig. 2e) and biotite (Fig. 2f), the last one mainly dark brown. While the pyroclastic plagioclase often is sericitised, the biotite, even very rare, is mainly fresh. In some place the pyroclastic component, mainly with psammitic size, forms detachable bodies – beds and lenses that alternate with the limestones. In other cases the limestone is enriched by mainly fresh andesite fragments with size from 2-3 to 60-80 cm (Fig. 2b) that could from matrix supported breccia and breccia-conglomerates. While in drilling PTDD-014 similar coarse grained bodies are observed mainly in the lower part of the Formation, in drillings PTDD-004 and PTDD-019 they are established in whole volume of the unit.

The characteristic feature of the lowermost of the Formation is the abundances of *Inoceramus* detritus. This is accompanying with increased amount of pyro- and epiclastic psammite and psephitic component in the limestone that leads to forming of mixed rocks, as well as to more nodular structure. Some Inoceramus fragments enrichment, but not in the same degree, is established in different levels inside the unit volume. Mainly the matrix is micritic and fine grained irregularly grained calcite.

Between the 10th and 12th m over the unit base is established flint, most often as nodules, and rarer as irregular in from bodies (Fig. 3). Its color vary from medium red (5R 5/4) to light greenish-grey (5G8/1), but are observed nodules in which the color is changing from to core to their periphery (Fig. 2c).

The main part of the volume of the unit is presented by thin to medium bedded limestone. Predominates medium-, fine- to very fine nodular, fine laminated and rarer massive structure. Beside, even rarer, are observed also cross-bedded and flaser structure (Fig. 3). In some places the irregular distribution of the bioclastic and clastic component leads to forming of spotty structure. On different levels in the rocks of the unit are recognized surfaces of local erosion.

In several levels, enriched by pyroclastic (rarer epiclastic) component, load cast structures with different amplitude and saturation are observed (Fig. 2d, 3). As a rule around of these structures some change of the color of the rocks is observed – usually from saturated red to rezida-colored and beige.

Even only in isolated cases, in the rocks of the Mirkovo Formation could be observed bioturbation, mainly vertical ones and with small (about several cm) amplitude. It was established also syn-sedimentary deformations, probably slumping folds, which, probably, are result of gravitation-slumping event with local affect. On the base of data connected with the availability of foraminifera fossil fauna in the rocks of the Mirkovo Formation (Moev, Antonov, 1978) and fossil limy nanno-plankton (Zhelev et al., 1999) is accepted that chronostratigraphical range of the unit is part of Santonian and Campanian stage of Upper Cretaceous series.

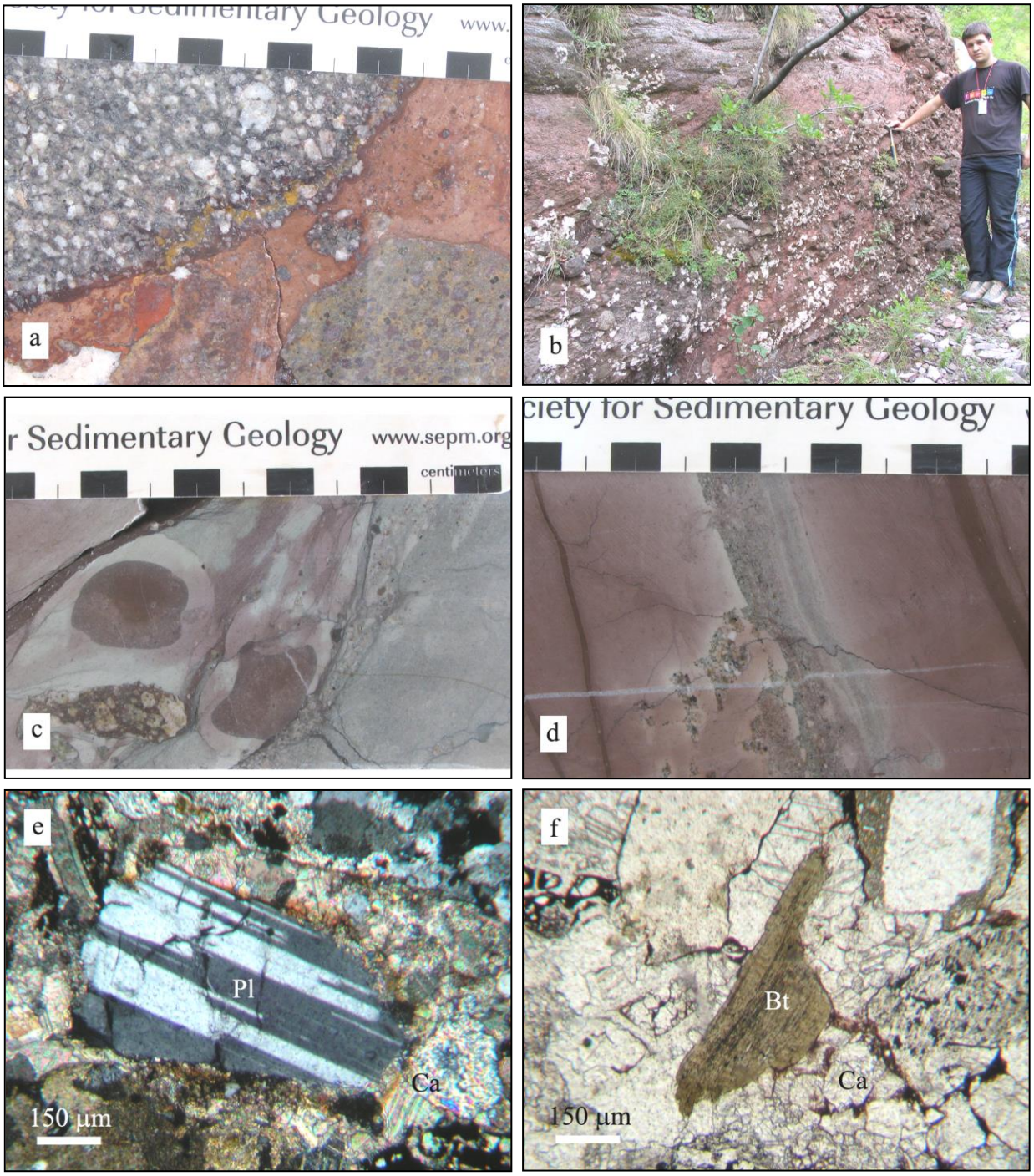

Fig. 2. Macro- and microphotographs of characteristic lithologies and structures for the Mirkovo Formation: a – andesite fragment (upper part of the photo) with 3-4 mm thick hematite crust. The other clasts are volcanic clasts are relatively fresh. The matrix contains fragments of Fe-oxide crusts with zonal structure as well, (PTDD-004, 84 m, base – left end of the photo); b – progradational large scale cross-bedding on the base of the unit (lower half of the picture) that is enriched by volcanic fragments and Inoceramus detritus, (western slope of Vozdol); c – zonal colored flint nodules, one of them partially includes volcanic epiclatst, covered by rezida-colored. In the right part of the photo limestone bed enriched with pyroclastic materials, (PTDD-014, 202 m, base – left end of the photo); d – micritic limestone with thin tuffose bed that has graded bedding and load casts on the bottom. Around the lower contact of the pyroclastic bed and the load cast structure some "discoloring" of the dark-reddish limestone is observed, (PTDD-014, 185 m, base – left end of the photo); e – very fresh pyroclastic plagioclase among calcitic matrix, (+ N, PTDD-004, 55 m); (f) – fresh pyroclastic biotite among calcitic matrix, (II N, PTDD-004, 55 m). Abbreviations: Bt – biotite; Ca – calcite; Pl – plagioclase

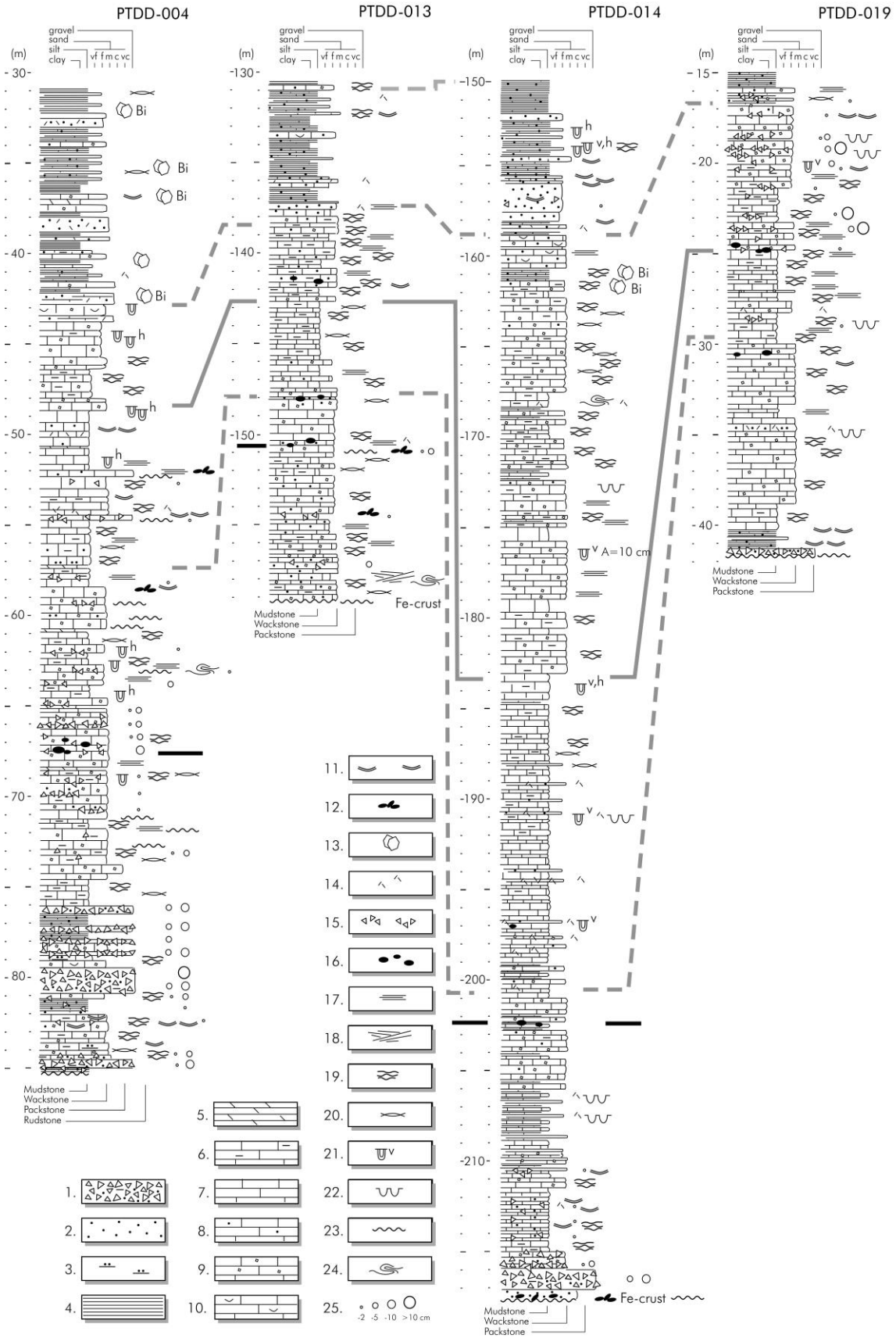

Fig. 3. Lithofacial and stratigraphical columns of the Mirkovo Formation: 1 – breccia-conglomerate; 2 – sandstone; 3 – siltstone; 4 – claystone; 5 – marl; *limestone* (6-10): 6 – micritic; 7 – clayey; 8 – allochemical; 9 – bioclastic; 10 – sandy; 11 – bioclastic (Inoceramus); 12 – intraformational rock fragments; 13 – enrichment of terrigenous mica; 14 – pyroclastic; 15 – extraformational rock fragments (volcanic); 16 – nodules (flint); *structures* (17-24): 17 – parallel lamination; 18 – mesoscale cross-bedding (trough and low-angle); 19 – nodular, all types; 20 – flaser; 21 – bioturbation, upper index – vertical (*v*) and horizontal (*h*), amplitude (*A*); 22 – load casts; 23 – erosional surface; 24 – average rock fragment size. Boundaries: *upper dashed grey line* – upper boundary of the Mirkovo Formation; *lower dashed grey line* – lower boundary of the micrite interval; *black line* – correlative level with intensive development of flint concretions

Discussion and conclusions

Among the problems with the distinguishing and the correlation of the Mirkovo Formation in the studied area is the identification of its boundaries.

The obtained log and the surface data reveals the accretion character of the sedimentary architecture of the psephitic-dominated coarse to very coarse grained epiclastites from the uppermost parts of the volcano-sedimentary package of the Chelopech Formation (Fig. 2b) as well as lowermost part of the Mirkovo Formation. Also the last one is characterized by strongly enrichment with Inoceramus debris that form 2.5 m thick package.

The lower boundary of the Mirkovo Formation is described usually as sharp lithological, in some places with data for erosion and with features of prolongate subaeral exposure – uneven, oxidised and carbonatised residual crust. Such crusts divide the polymictic medium to very coarse grained breccia-conglomerate from the upper part of the Chelopech formation from the Inoceramus and clastic enriched base of the Mirkovo Formation. On the other hand, features connected with development of oxidation crust, result of prolongate subaeral exposure, however, are observed in some levels inside the situated stratigraphicaly bellow the Mirkovo Formation volcano-sedimentary package of the Chelopech Formation as well. Beside this, again there, could be observed some reworked and re-sedimented product of such processes. Because of this, their use as marker of the lower boundary of the Mirkovo Formation has to be done very carefully and taking in account all peculiarities of the section.

The realized field studies reveal the existence of lateral replacement of epiclastites from the uppermost part of the Chelopech Formation by the limestones of the Mirkovo Formation as well, where could be seen some features of progradation, accretion (Fig. 2b) and syn-sedimentary deformation.

Other specific feature of the lower boundary of the Mirkovo Formation is connected with the fact that the uppermost levels of the volcano-sedimentary package of the Chelopech Formation are built up by sandstone and matrix- to grain-supported breccia-conglomerates, mainly with blue-purple color. In the sedimentology of the clastic rocks similar colors are connected with sedimentary profiles that have been affected by prolongated intensive oxidation or paleosol forming processes.

In the studied area the upper boundary of the Mirkovo Formation, those with the terrigenous rocks of the Chugovitza Formation, is gradual transition interval in which the definitive features of the one of the units gradually replace those of the other one. In all studied drillings there are mainly very fine to fine-grained terrigenous and mixed rocks, in most cases colored in red or variegated tones. Other its specificity of this interval, established during this study, is the presence of fresh volcanogenic biotite in it.

In this part of the section of the Upper Cretaceous, Moev and Antonov (1978) nominated, and Zhelev et al. (1999f) mapped about a 140 m thick package of predominantly fine laminated, grey claystones and marls that contain varying amount of psammite-silty component, that they named the Voden Member of the Chugovitza Formation. According to them this unit occupies lowermost part of the Formation. Generally, part of the characteristic of the described above transitional interval (the presence of fine grained clastic rocks) correspond with the properties of the Voden Member, but, from the other hand, they contrast to its color and the appearance of psammitic materials. This, as well as its small thickness, not allows its nomination as specific, independent unit that could be steady recognized and traced in the field.

Despite the seemingly monotonous lithology (red colored limestone) the rocks of the Mirkovo Formation gives good opportunity for more detail inner subdivision. Mainly this is the composition of the rocks. On this base the unit could be divided into three intervals (packages). The lower and upper one of them are characterized by stabile and significant attendance of allochemical component in the limestone, while in the middle one predominates mainly micritic limestone (Fig. 3). The thickness of these intervals vary. The thickness of the upper allochemical limestones package is in the range from 3.9 to 20.8 m, those of the middle micritic limestone package – from 4.5 to15.6 m; and those of the lower allochemical limestones package – respectively from 9.5 to 14.7 m.

More detail study of the core material allows in some extend the clarification of the stratigraphic position of the flint concretion in the profile of the Mirkovo Formation as well. The collected data reveal that they appear in levels where it was established some enrichment of pyroclastic component (Fig. 3). Because of this they are developed in several levels, but one of them – those that is situated about 10-12 m above the base of the unit, is mostly pronounced (Fig. 2c). Similar connection could be interpretated as diagenetic expression of the increased amount of SiO_2 in the rocks that is indirect result of the enrichment with pyroclastic.

Other manifestations of the levels that contain fresh volcanic materials are the appearance of greenish and the pile coloring of the limestone. This connection could be observed also in several parts of the unit as forming solitary, isolated, very thin intervals, as well as forming intervals with thickness over 15 m, in which, because of its very frequent development, this greenish coloring is part of the general face of the rocks (Fig. 2c, d).

Other peculiarity of the Mirkovo Formation is the presence of solitary rock fragment or breccia-conglomerate bodies that are build up by gravelites to coarse grained pebbly and cobble, containing some small blocks, that are dominated by volcanic materials. In two of the drillings – PTDD-004 and 014, they give the face of the lowermost part of the Formation (Fig. 3). In the other two drillings their amount is significant less, but in drilling PTDD-019, they dominate also in the uppermost parts of the unit. In the outcrops along the western slope of Vozdol valley, situated almost nearly of this drilling, however, the breccias-conglomerate are present as in the uppermost as well as in the lowermost part of the Formation (Fig. 2b). From one hand this area is strongly tectonized, that's why it may exist some fold or fault generated repetition of the profile of the unit. From the other hand, however, this fact could be interpreted as very fast (short) changeability – laterally and vertically, of these breccia-conglomerates, supposition, completely supported by the data from drilling PTDD-013.

Appearance the volcanic fragments in different form are observed in the rest part of the unit profile also, as well as in the transitional interval to the Chugovitza Formation.

The origin of these breccia-conglomerate bodies is strongly discussional. The main part of the participated in them volcanic rock fragments is fresh. They are included into micrite limestone matix in which there are not visible any evidence of syn-sedimentary deformations, result of horizontal transport, that's why, in most of the cases the rock fragments „float" among this matrix. Thus described features suppose eruptive (syn-volcano) transport of these materials. In support of similar thesis is the appearance of fresh pyroclastic material on many levels of the unit, fact that was already discussed according to the possible origin of the greenish colors of the rocks. The absence of the impact structure in the limestone, from the other hand, directs the connection of the origin of these coarse bodies with the processes that have leaded to forming of epiclastites.

The solving of similar problem is possible only through broader field investigations. Also realization of similar investigations could assist the clarification of the chronostratigraphical range of the activity of the volcanism in the area.

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