Early Carboniferous miospores from Novachene Borehole, Central North Bulgaria

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Abstract. The paper presents the results of palynostratigraphic studies of Carboniferous rocks from Novachene Borehole. The age determination is based on miospore ranges from the Upper Tournaisian to the lower-middle part of the Visean. The identified microflora includes the following taxa: Retispora lepidophyta, Verrucosisporites nitidus, Schopfites claviger, Raistrickia clavata, Crassispora trichera, Diatomozonotriletes saetosus and Lycospora pussila.

Introduction

Novachene Borehole was drilled in 1987. The project involves the search of oil and gas in the Moesian Platform of North Bulgaria (Fig.1). At depth of 3418 m the deepdrilling penetrates terrigenous coal-bearing rocks and ends at 4000 m. The borehole provides for the first time the possibility for investigation of the coal sediments outside the Dobrudja Coal Basin. All data available about the lithology, the coal substance and the stratigraphy of the Novachene Borehole are compiled in the article of Nikolov et al. (1990). The sediments contain considerable amounts of pyroclastic material and in some intervals the rocks grade into sandstones, tuff-sandstones, tuff-shales and siltstones. The coal is mainly claroduritic, duroclaritic or duritic. The fossil macroflora found in the borehole show that the sediments within the interval 3614-3616 m are of Late Visean-Earliest Namurian age and those within the interval 3617-3706 m correspond to the middle-upper part of the Visean. Dimitrova (1993) reported about a miospore assemblage recovered from a number of samples from Novachene that was identified as Middle Visean. Due to the lack of material available for laboratory treatment to the present moment, the interpretation of the data needs to be further specified and completed. The present study was compiled after sampling additional rock material from the fifth core-interval (Fig. 1), as well as from levels beneath it.

The results presented in the article are gathered from the data obtained from samples of core intervals and the coreless interval at 3450.00-3645.00 m.

The determined miospore associations from the Novachene Borehole submit a question for discussion about the data published in the above mentioned article by Nikolov concerning...
the established age and the time correlation with Irechek and Mogiliste Formation from the Dobrudja Coal Basin.

Miospore analysis

The miospore assemblages were recovered from 16 out of 17 macerated samples. The spores are preserved to various degrees and most of them are easily determinable. In view of the fact that materials of such a presumed age were observed and determined for the first time on the territory of Bulgaria, the author of the present article has used as a main source of reference some publications about miospore associations of a similar age by Playford (1962, 1978), Utting et al. (1989), Higgs et al., (1988), Clayton (1971), Sullivan (1968), Bycheva and Umnova (1992), Turner et al.(1995).

The biggest part of the studied samples belongs to the second and fifth core-intervals (Fig. 1).

The oldest Carboniferous sediments were recovered at 3645 m. This sample is from a coreless interval and it consists of argillites. The type of the miospore association is determined mainly by the presence of the following species: Retusotriletes cf. planus, Heterotriletes sp., Verrucosisorites nitidus, Verrucosisorites bulliferus, Retispora lepidophyta, Tumulispora cf. rarituberculata, Auroraspora macra, Corbulispora cancellata, Knoxiosporites literatus, Grandispora sp., Densosporites spp., Raistrickia corynoges. Two specimens of Lophotriletes cristifer occur. This species does not occur in the overlying sediments. Characteristic only of this assemblage is the presence of Tumulispora and Retispora lepidophyta.

Eight of the samples belong to the fifth core-interval: 3614.00 m; 3614.80 m; 3615.40 m; 3616.50 m; 3617.50 m; 3619.00 m; 3619.30 m; 3620.00 m.

The biggest variety of species is registered in the assemblages obtained from samples from 3619.00 and 3619.30 m.

The miospore association is characterised by the presence of the following species: Aurora­spora macra, Diatomozonotriletes saetosus, Verrucosisorites nitidus and Knoxiosporites litera­tus. As a part of the assemblage occur also Raistrickia corynoges, Spelaeotriletes pectinosus, Corbulispora cancellata, Crassispora trichera and Densosporites spp. Only at 3619.00 m and 3620.00 m can be found Raistrickia clavata together with some common representatives of the genus Convolutispora. To the same core-interval belong also the samples from 3615.50 and 3617.50 m. The dominant taxa are: Convolutispora usitata, C. labiata, C. vermiiformis, Knoxiosporites literatus and Spelaeotriletes pectinosus. A peculiarity is the increased quantity of Schopfites claviger (14 specimens) and Stenozonotriletes coronatus. Only in these samples single representatives of Dictyotriletes cf. submarginatus and Murospora intorta occur.

In the fourth core-interval there are two samples: 3552.00 and 3552.10 m. Both samples were macerated together due to the lack of rock material. This miospore assemblage could be distinguished from the other samples by the common occurrence of Retialites sp. and Diatomozonotriletes saetosus. Only in this association can be found many specimens of the taxa Monilospora, Euryzonotriletes sp., Trematozonotriletes variabilis, Reticulatisporites peltatus, Densosporites anulatus, Convolutispora labiata, C. cerebra, Densosporites anulatus, Crasszonotriletes canaliculatus, Knoxiosporites cinclus, Apiculiretusispora multisetae, Trilobozonotriletes incisotrilobus, Waltzispora sp. The miospore assemblage obtained from 3550 m is from coreless interval and comprises the following species: Trilobozonotriletes incisotrilobus, Densosporites anulatus, Knoxiosporites literatus, K. rotatus, Crassispora trichera, Convolutispora cf. circumvalata, C. labiata, Retialites radforthii, Lophotriletes sp., Tetraptorina sp., Waltzispora planiangulata, Leiotriletes ornatus, Murospora sublobata, M. margodentata.

From the third core-interval, two samples are examined. At 3501 m occur single specimens of Waltzispora planiangulata, Grandispora echnata and Convolutispora cf. circumvalata. The species Crassispora trichera and Schop-
fites claviger continue to occur in this miospore assemblage. The appearance of Lycospora is specific for this assemblage and distinguishes it from the others. Very abundant in species is the sample recovered from 3496.70 m. The variety of miospore assemblages is determined by the presence of the following taxa: Densosporites variomarginatus, D. variabilis, Monilospora triungensis, Anaplicatissporites conicus, Convolutispora cerebra, C. mellita, Calamospora spp., Verucoisporites nitidus, Reticulatisporites cancellatus, Lophotiriletes densus, Stenozonotriletes perforatus, Spinozonotriletes uncutus, Densosporites sp., Acanthotriletes sp., Punctatisporites punctatus, Murospora spp., Triquirites grandis, Leiotiriletes ornatus. The species Schopfites claviger is absent from this assemblage.

In the second core-interval the two examined samples from 3460.50 m and 3465.00 m border on tectonic zones which explains the presence of numerous torn plant remainders. The taxa found are a repetition of a part of the previous two assemblages: Densosporites spp., Triquirites grandis, Leiotiriletes tumidus, Punctatisporites glaber, P. punctatus, Convolotispora sp. New for this miospore association is the appearance of the species Raistrickia nigra and Crassispora aculeata. There are also single representatives of Lycospora pusilla.

Immediately above the second core-interval, the sample from 3450 m, represents a restored miospore assemblage, including the species Tricidarisporites balteolus, Schulzospora cf. campiloptera, Chaetosphaerites spp., Lycospora pusilla, Raistrickia nigra, Convolutispora planimuricata, Rotaspora spp. The genus Tripartites is completely absent from this assemblage.

Palynostratigraphy

In the sediments of the Novacheene Borehole were found stratigraphic levels from the Moesian Platform unstudied until now. The only publication that shows the presence of the Lower Carboniferous out of the boundaires of the Dobrudja Coal Basin belongs to Cnacoc (1976). His data were obtained from Gomotartsi Borehole through a conodont analysis. To the present moment, on the territory of Bulgaria, well studied are only the miospore assemblages from Carboniferous sediments from the Dobrudja Coal Basin (Late Visean - Westphalian D). The taxonomical content of the miospore assemblages from Novacheene can be compared only with the results from Konare and Belgun Formations (Dimitrova, 1993). Comparisons and the correlations are possible only in the interval 3450-3550 m (Fig. 2) from the Novacheene Borehole. The biggest part of the common species compose the content of sample 3450 m: Raistrickia nigra, Lycospora pusilla, Schulzospora sp. and Rotaspora sp.

The common species from the second core-interval are similar to some miospores from Konare and Belgun Formations (Dobrudja Basin): Leiotiriletes tumidus, Punctatisporites glaber, Densosporites anulatus, Convolutispora labiata, C. cerebra, Raistrickia nigra. This assemblage from the Dobrudja Coal Basin was proved to be of Late Visean age (Dimitrova, 1993). The results are comparable to the spore content from the second core-interval from Novacheene.

All the other levels form the third to the fifth core-intervals and the samples from coreless intervals cannot be correlated with the palynological data from the Dobrudja Basin.

The taxonomical peculiarity of the species (Pls. I, II) determines the stratigraphical position of the miospore assemblages from the Novacheene Borehole and makes them comparable to the general divisions from Western Europe (Clayton et al., 1977) and Western Europe and the Russian Platform (Owens et al., 1978). Well studied are the ranges of some of the following index-species: Verrucosissporites nitidus, Raistrickia corynoges, R. clavata, Speleotiriletes preitosus, Crassispora trychera, Schopfites claviger, Lycospora sp., Retispora lepidophyta. The species listed above are important for the associations of the Carboniferous biozones CM, PU from the Westeuropean subdivision (Clayton et al., 1977). The established age is Tn 3/ V 1-2.

According to the miospore analysis, the boundary between Late Devonian and Early Carboniferous can be defined between the two zones LN and PC introduced by Loboziak (in Loboziak et al., 1994) which also includes the appearance of Schopfites cf. claviger and Crassispora trichera.

Some species from the fourth core-interval in the Novacheene Borehole are similar to the Middle Visean miospore associations from the Russian Platform (Бычева et al., 1985): Crassizonotriletes variabilis, C. canaliculatus, C. macroduplicatus, Euryzonotriletes sp., as well as Densosporites.

As a result of the correlation between the miospore assemblages from Poland and Great Britain, Turnau (in Clayton and Turnau, 1990) established the following species as typical for the zone CL for West Pomerania miospore zonation: Tumulispora rarituberculata, Raistrickia clavata, R. corynoges, Knoxiospores literatus, Schopfites claviger. The established age is
PLATE I

Early Carboniferous miospores from Novachene borehole. All figures × 700.
1. *Triquitrites* cf. *grandis*; depth 3460.50 m.
2. *Anapiculatisporites concinnus* Playford; depth 3496.70 m.
3. *Triquitrites marginatus* Hoffmeister, Staplin and Malloy; depth 3645.00 m.
4. *Schophites claviger* Sullivan; depth 3617.00 m.
5. *Crassispora* cf. *trichera* Neves and Joannides; depth 3619.00 m.
6. *Convolutispora vermiformis* Huques and Playford; depth 3619.30 m.
7. *Crassispora trichera* Neves and Joannides; depth 3619.00 m.
8. *Murospora intorta* (Waltz) Playford; depth 3617.50 m.
9. *Reticulatisporites cancellatus* (Waltz) Playford; depth 3496.70 m.
10. *Convolutispora planimuricata* Butterworth and Spinner; depth 3450.00 m.
11. *Leiotriletes ornatus* Ichchenko; depth 3496.70 m.
12. *Punctatisporites glaber* (Naumova) Playford; depth 3696.70 m.
13. *Convolutispora usitata* Playford; depth 3696.70 m.
14. *Diatomozonotriletes saetosus* (Huques and Bars) Huques and Playford; depth 3619.30 m.
15. *Verrucosisporites nitidus* Playford; depth 3645.00 m.
16. *Crassizonotriletes canaliculatus* (Playford) Byvscheva; depth 3552.10 m.
17. *Knoxisporites literatus* (Waltz) Playford; depth 3619.00 m.
18. *Convolutispora labiata* Playford; depth 3615.50 m.

PLATE II

Early Carboniferous miospores from Novachene borehole. All figures × 700.
1. *Retialetes* sp.; depth 3552.00 m.
2. *Raistrickia clavata* (Huquesbard) Playford; depth 3620.00 m.
3. *Retusotriletes* sp.; 3645.00 m.
4. *Monilospora* sp.; depth 3552.00 m.
5. *Grandispora* sp.; depth 3501.00 m.
6. *Rugospora* sp.; 3645.00 m.
7. *Vallatisporites verrucosus* Huquesbard; depth 3617.50 m.
8. *Concentricisporites? concentricus* Byvscheva; depth 3645.00 m.
9. *Heterotriletes* sp. 1 McGregor and Playford; depth 3645.00 m.
10. *Tumulispora* cf. *rarituberculata* (Luber) Playford; depth 3645.00 m.
11. *Retispora lepidophyta* (Kedo) Playford; depth 3645.00 m.
12. *Lophotriletes cristifer* (Luber) Kedo; depth 3645.00 m.
13. *Tetraptorina* sp.; depth 3552.00 m.
14. *Lophotriletes* sp.; depth 3552.30 m.
15. *Monilospora triungensis* Playford; depth 3552.00 m.
16. *Corbulispora cancellata* (Waltz) Bharadwaj and Vencatachala; depth 3645.00 m.

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**Borehole Novachene**

<table>
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<tr>
<th>Core Interval</th>
<th>Samples Depth, m</th>
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**Miospore Taxa**

- *T. cf. rarituberculata*
- *R. lepidophyta*
  - *V. nitidus*
  - *R. clavata*
  - *S. claviger*
  - *C. trychera*
  - *C. cf. circumvalata*
  - *K. literatus*
  - *Crassizonotriletes sp.*
  - *Euryzonotriletes sp.*
  - *T. incisotrilobus*
  - *M. triungensis*
  - *Murospora sp.*
  - *Lycospora pusilla*
  - *C. aculeata*
  - *R. nigra*
  - *Schulzospora sp.*
  - *Rotaspora sp.*

**Age Zone**

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<th>T3 Upper + V1-2</th>
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<tr>
<td>NV</td>
<td>PC + CM</td>
<td>CM + PU</td>
<td>PU</td>
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**Miospore Zones**

*W. Europe – Clayton et al., 1977*
In the same article Clayton assumed that the disappearance of *Tumulispora* from the sediments of the British Isles determines the boundary between the zones PC and CN. All species which are included in the zonal scheme Clayton, Turnau’s (1990) publication, represent a part of the miospore assemblage from the interval 3614 — 3645 m from the Novachene Borehole.

**Conclusion**

The miospore assemblages recovered from the majority of the examined samples (exceptions are those from the second core-interval and above the second core-interval) show the presence of the species *Verrucosisporites nitidus*, which tentatively determines the stratigraphical importance of the miospore assemblage. The morphological discussion about the description of the index-species and its synonymy, based mainly on the size of the basal diameter of verrucae, was given by Turnau et al. (1993). The authors have used material from different Carboniferous localities: West Pomerania (Poland), LL-CM Biozones; from Ireland, LN Biozone; from Russian Platform, Belarus and Russia, LE and LN Biozones.

The first appearance of the species *V. nitidus* was identified by Playford (1964) and was related to the Turnourian Horton Group from Eastern Canada. The species *V. nitidus* is considered in Northwest Europe to be an important zonal species.

The information about the taxonomy and the stratigraphical significance of the species *V. nitidus* reveals that its presence in the miospore assemblages from the Novachene Borehole is extremely important for the correlation of the sediments from this borehole with other analogical localities in Europe. The age of the miospore assemblages from different core and core-intervals is determined by species with considerable stratigraphical importance, such as: *Tumulispora cf. rarituberculata* (3645 m); *Raistrickia clavata* (3619 — 3620m); *Schopfites claviger* (3501 — 3617,50m); *Lycospora pusilla* (3465 — 3501 m). The taxa listed above characterise the biozones VI, PC, CM and PU from the generalised zonal scheme for Western Europe (Clayton et al., 1977).

From the analysis of the miospore associations and the stratigraphical distribution of the single species the following conclusions can be made:

1. The age of the sediments from Novachene in the interval 3501-3645 m, including the distribution of the species *V. nitidus*, was established as Tn2/Tn3 — V1-2.

2. The appearance of the taxa *Schulzospora* and *Rotaspora* in the sample from 3645 m gives also information about the Visean age in the Novachene Borehole. A peculiarity is the complete absence of the genus *Tripartites*.

3. The sediments in the interval 3465-3550 m can be correlated with parts of the Belgun and Irechek Formations (Dobrudja Coal Basin).

4. For the first time on the territory of Bulgaria were registered miospore assemblages from Early Carboniferous age.

5. It remains an open question whether there was a spatial relation between the Novachene Borehole and the Dorudja Coal Basin during the Visean.

**APPENDIX**

List of taxa recorded in the present study

<table>
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<th>Taxon</th>
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<td><em>M. margodontata</em> Beju, 1970</td>
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