SEQUENCE STRATIGRAPHY OF THE COAL BEARING OTTNANGIAN (?) - KARPATHIAN SEDIMENT SERIES IN THE EAST BORSOD BASIN (N-HUNGARY)

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Abstract: We have performed the sequence analysis of the coal bearing Miocene series of the East Borsod Basin. We could separate 25 parasequences (5th order cycles), four 4th order cycles and one 3rd order cycle. The latter can be regarded as an eustatic cycle parallel with TB2.2 of Haq et al. (1988), the 4th order cycles were determined by tectonic events. Simultaneous interpretation of the available paleontological data and the eustatic curves prove the Karpathian age of the series.

Key words: sequence stratigraphy, Miocene, Karpathian stage, Borsod Basin, coal

Introduction

In the East Borsod Basin a siliciclastic sediment series was accumulated during the Lower - Middle Miocene, within shallow marine paleoenvironments, with five enclosed paralic coal seams (V, IV, IIIa-III, II, Ia-I). In the western and central part of the basin its thickness is 100 - 200 m, while in the east it is more than 300-400 m. A detailed sequence stratigraphic analysis has not been performed yet. Now the comparative analysis of the logs of more than 150 boreholes was carried out to reconstruct vertical and horizontal structure of the sediment series (Fig. 1).

Parasequences, parasequence sets, the order of the accumulation

The parasequences were formed by shallow marine siliciclastic masses controlled by tidal currents and waves (WAGONER et al. 1990), indicating the appearance of off-shore, foreshore and lagoonal paleoenvironments. The most important sediment characteristics are shown on Fig. 2., which reflect lateral and vertical connections of the facies belts within a given parasequence.

We were able identify 25 parasequences (Fig. 3 and 4). Transgressive character is well detectable in the whole series but basin environments became dominant only in the 17th parasequence.

Sediments of the initial transgression (parasequences from 1 to 5) filled up local depressions of the unevenly dissected paleosurface. The first general progradation in the 6th parasequence led to formation of coal beam IV in the East Borsod Basin. A transgression can be detectable indicated by Ostrea-beds above coal beam IV. Within the aleuritic facies of the 7th, 8th and 9th parasequences there are polyhaline mollusc associations indicating shallow sublittoral environments (e.g. Dgy-366, 220, 222 m, BOHN-HAVAS 1983, T-66, BOHN-HAVAS 1985).

The next transgression is detectable at the 10th parasequence, with aleuritic facies enclosing a polyhaline mollusc association (e.g. Dgy-366 291,7-296,7 m, 296,7-301,5 m, BOHN-HAVAS 1983). The 12th, 13th, 14th, 15th and 16th parasequences form an aggradational parasequence set with the coal beams III, IIIa and II.

Transgression became determinative within the 17th parasequence forming a transgressive sand bed just above coal beam II and thick aleuritic beds with poly- and euhaline macro- and microfauna (e.g. KORECZ-LAKY 1958, 1985). A progradation started within the 18th and 19th parasequences forming the coal beams Ia and I.

A transgressive sand bed above coal beam I indicates a further transgression with progradations in the 20th, 21**st**, and 22**nd** parasequences. The last transgression is in the 23**rd** parasequence followed by progradations in the 23**rd**, 24th and 25th parasequences. Fauna data indicate the dominance of euhaline environments.

Hierarchy and genetic interpretation of cycles

The whole series can be regarded as the transgressive period of a 3rd order cycle, in which the transgressive character became dominant in the 17th parasequence, which is presumably the boundary between the transgressive and early highstand systems tracts of the 3rd order eustatic cycle.

The most important transgressions divide the series into four well separable 4th order cycles. The first contains parasequences 1-6 with a long transgression and a fast progradation, the second contains parasequences 7-16 with transgressions and progradations changing into aggradation on its top. The third cycle is introduced by a transgression (17th parasequence) followed by progradation changing into aggradation (18th and 19th parasequences). The fourth has also been started by a strong transgression (20th parasequence). These 4th order cycles divide the 3rd order eustatic cycles into semicycles reflecting periodical fast increase of accumulation space, which may have been the consequence of tectonic development of the basin indicating at least three tectonic events in the region. The periodical increase of depth may have been in connection with the tectonic subsiding of the basement.

The separated parasequences (25) were presumably formed by 5th order cycles, which may have been caused by the climatic changes of Milankovic, iniciated by oscillation of the Earth's orbital factors (precession). The fact that the 5th order cycles are well detectable in the series proves a rather intensive accumulation and important lateral movement of facies belts according to sea-level changes reflecting an elevated swell-status of the area during the sedimentation.

Cronological consequences

A few years ago the coal bearing series was regarded as an Ottnangian series, but malacological (Rzehakia socials - BÁLDI 1976) and micropaleontological (Sütõ-Szentai in Radócz 1983, Sütõ-Szentai 1994, 2000) data indicate Carpathian age (CICHA et al. 1967) for at least a part of the series. Although its exact age is not cleared yet, the upper part of the series is Carpathian (Radócz 1987).

The Ottnangian and Carpathian stages of the Miocene are characterised by two (Bur-3, Bur-4) of the glacioeustatic sea-level changes evidenced by isotopic data (ABREAU AND HADDAD IN VAKARCS 1997 p. 157). The Ottnangian - Carpathian age range from 19 m.y. to 16,2 m.y. and the boundary of the two stages is at 17,2 m.y. The whole series can be divided into 25 parasequences and considering the genetic model of the parasequences (5th order climatic cycles), they represent 24 000 y. per parasequence. As the average thickness of the parasequences is not more than 20 m, the sedimentation rate is not more than 100 cm/1000 y, so the accumulation time of the whole series is not more than 600 000 y.

Considering that the whole series represent only one 3rd order cycle that is why there is no sequence boundary indicating eustatic regression within the coal bearing series, and considering that the upper parts of the sequence have Carpathian age, the 3rd order cycles can be correlated mainly with the Bur-4 eustatic event (TB2.2 in HAQ et al. 1988).

This is in good agreement with the appearance of 4th order cycles, which are well detectable because of the very sensitive sedimentary conditions (important facies drifting due to the sea-level changes). These cycles reflect tectonic events that can be led back to the Styrian orogenic phase parallel with Bur-4 eustatic cycles. The 4th order cycles are in good correlation with those detected by the sequence stratigraphic analysis of the Kladzany Formation having similar age in the East Slovakian Basin (VASS et al. 2000).

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Figure 1 Boreholes exploring Salgótarján Lignite Formation

Figure 2 Horizontal and vertical connections between facies belts of an upward coarsening parasequence

Figure 3 Sequence stratigraphic model of the Karpathian coal bearing sediment series in the East Borsod Basin

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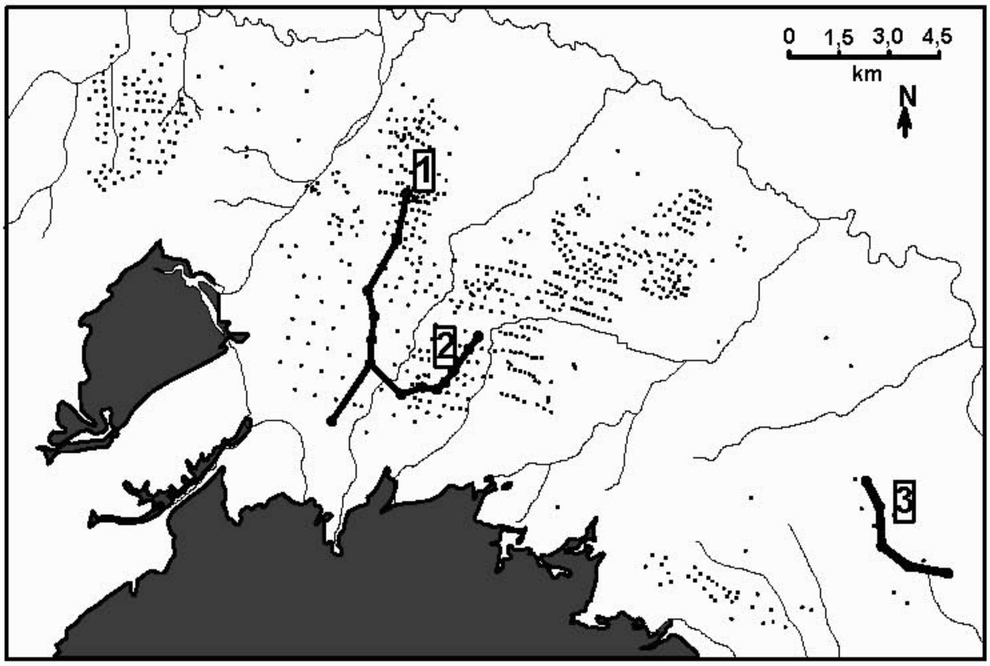

Figure 1 Boreholes exploring the Sarmatian series and the direction of the sections

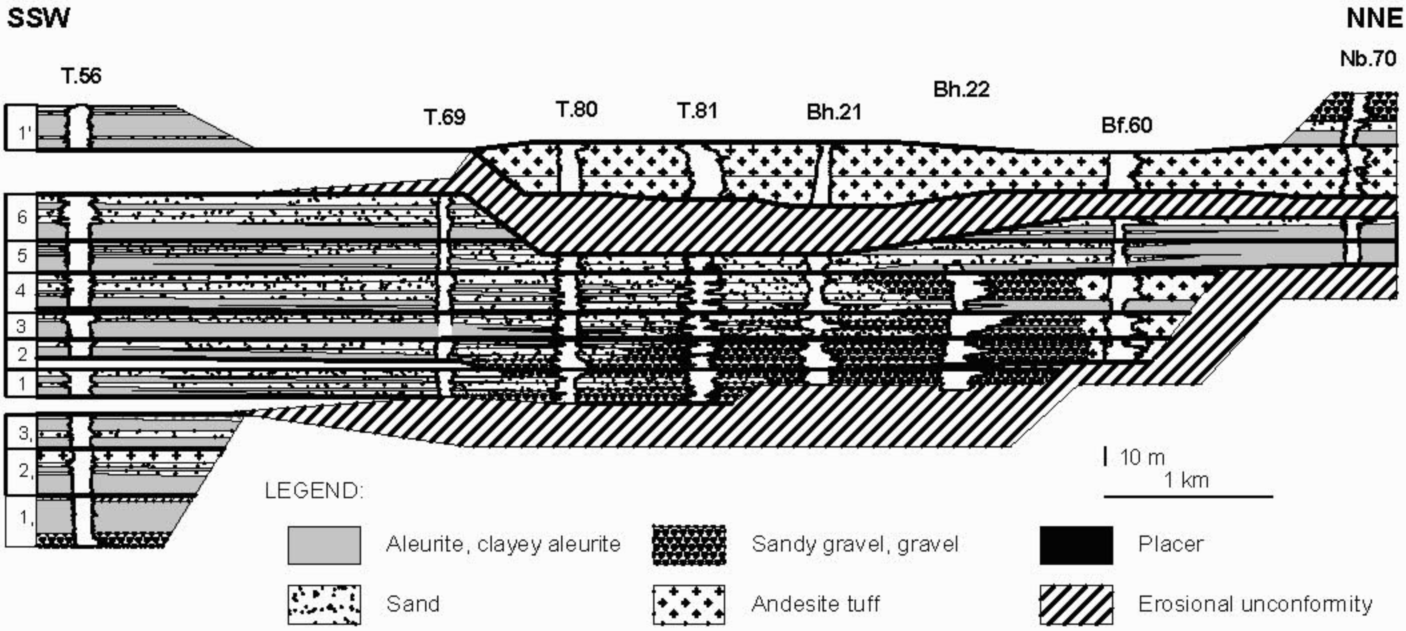

Figure 2 Spatial distribution of the facies belts along section 1
(for its diretction see Fig. 1)

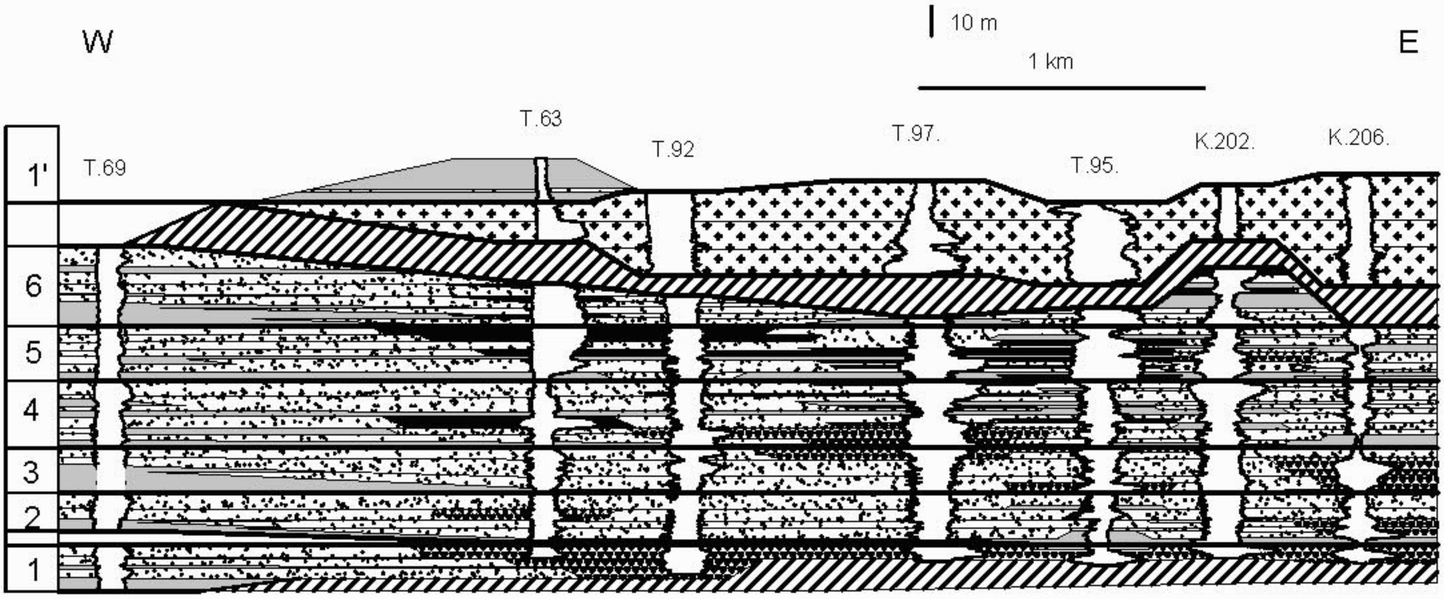

Figure 3 Spatial distribution of the facies belts along section 2
(for its direction see Fig. 1, for legend see Fig. 2)

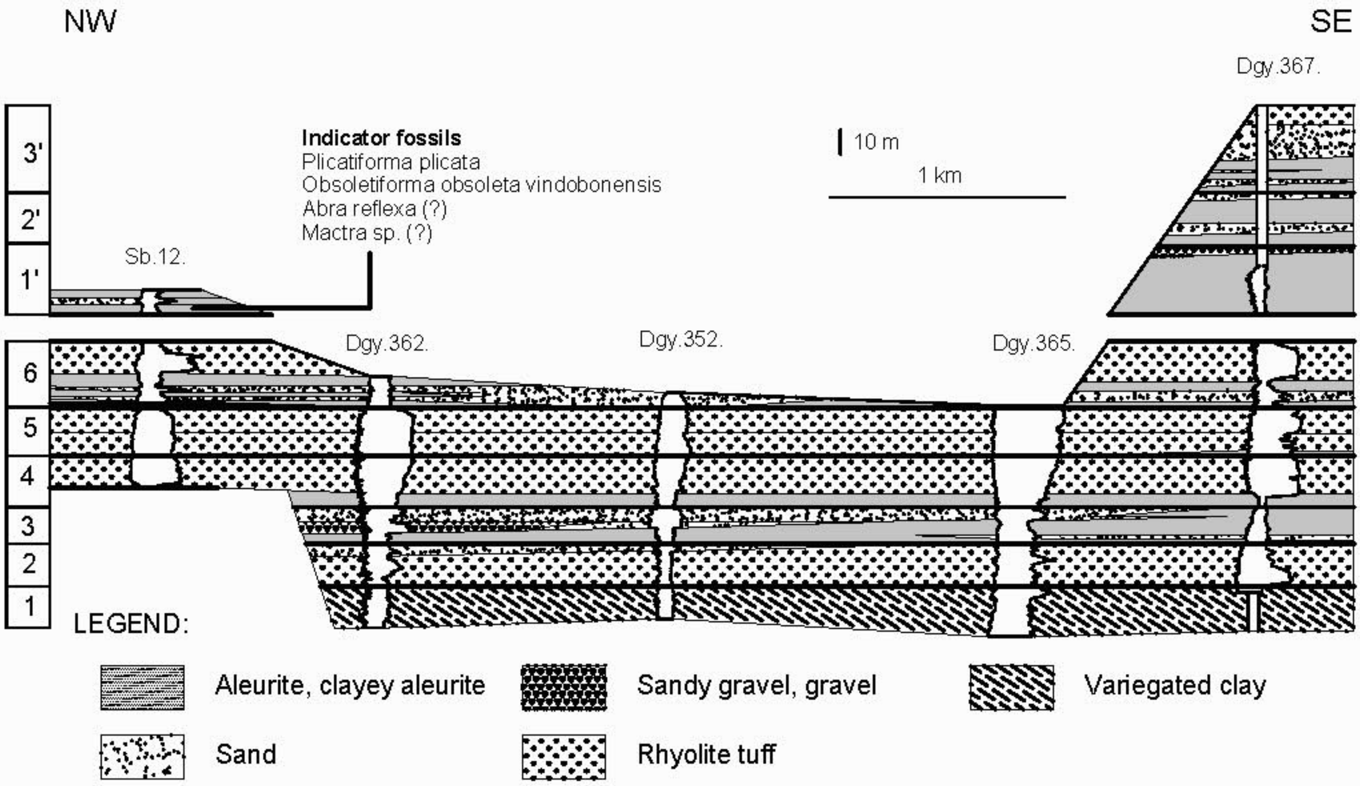

Figure 4 Spatial distribution of the facies belts along section 3
(for its direction see Fig. 1)