BALENI-1 BOREHOLE. NEW DATA ON THE UPPER NEOGENE SEQUENCE IN THE WESTERN DACIAN BASIN

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Abstract. Băleni-1, is the only deep borehole in the Dacian Basin area which was paleontologically continuously monitored during the drilling. The investigation of the Upper Neogene deposits, based mostly on cuttings data sampled every ten meters during the well drilling, evidences the stratigraphic and lithologic continuity of the Upper Meotian-Lower Dacian sedimentary succession in the western part of the Dacian Basin. The Late Meotian-Late Pontian lithology is very fine-grained and highly monotonous. Although transgressions affected the western Dacian Basin during the Meotian and Pontian time, these events did not introduce lithologic changes in the sedimentary sequences drilled at Băleni-1 site.

Key words: Paratethys, Dacian Basin, bio-stratigraphy, lithology

1. INTRODUCTION

Significance of data

Baleni-1 borehole is located in the north-east of the Mehedinţi County, the south-western part of Romania (Fig. 1), into an area corresponding to the westernmost part of the Dacian Basin. This Paratethys basin functioned as a shallow brackish sea since the Upper Sarmatian (*s.l.*) (about 11-10 Ma) until the Middle and Upper Dacian time (4.5-4.0 Ma).

Băleni-1 is one of the few boreholes in the Dacian Basin area which was paleontologically continuously monitored during the drilling. Although the well's geological survey relies heavily on cuttings data, this borehole provides additional data on the stratigraphic succession of the Mio-Pliocene deposits in the western Dacian Basin.

1.2. Methodology

The description of the lithology of the drilled deposits is based on logs and cuttings information.

The modern lithostratigraphic dating of the deposits drilled by the Băleni-1 borehole was one of the main targets of the operator and shall be presented in this paper. In order to reach this goal, a detailed biostratigraphic analysis was carried out on the cuttings sampled every ten meters during the well drilling .

Having the cuttings as the sole investigation material, it means that the identification of fossils relied on shell fragments. This is why many genera are referred to by the formula **aff**. **However there are unmistakable shell fragments. This is the case of** Amplocypris odessaensis whose shell morphology is unique, and so are „praebosqueti" or Pontoniella. The Chartochoncha shell fragments are recognized by its high costae with one or two ridges in between.

The primary results of the paleontologic and lithologic analysis of the Băleni-1 cutting samples are presented in the seven tables attached to the present paper.

1.3. Dacian Basin stratigraphic scale

During the Late Neogene restricted and variable communication existed between the individual water bodies of the Paratethys realm, leading, among others, to the increased endemic development of their fauna. This is why different stratigraphic scales were built up for each of the Paratethys basins.

The comparison of the Mediterranean and Dacian Basin chrono-stratigraphic scales as adopted in this paper, with magnetostratigraphic dating of Vasiliev *et al.* (2004) is presented in figure 2.

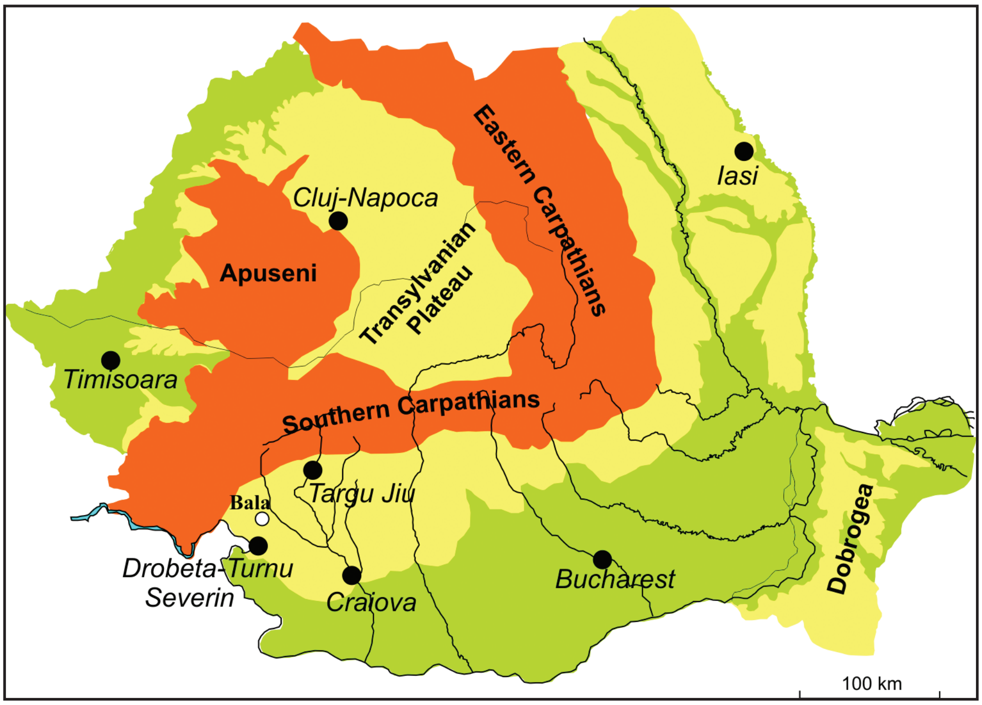

Fig. 1 Location of the Bala locality on the physical map of Romania. The Baleni-1 borehole was drilled in the vicinity of Bala locality

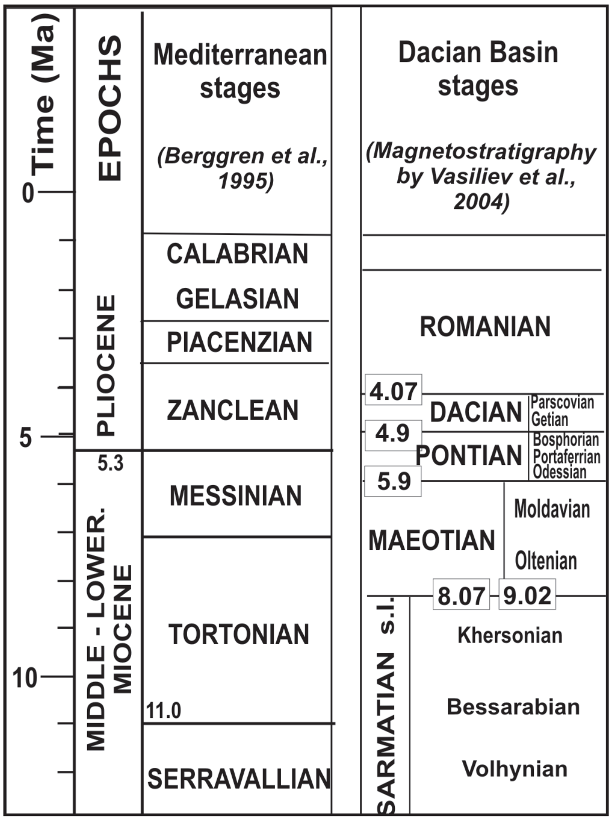

Fig. 2 Stratigraphic scale of the Dacian Basin correlated with the Mediterranean Basin scale

2. PRESENTATION OF DATA

The Maeotian/Pontian boundary is sharp and transgressive. With the Lower Pontian a new biological cycle began, and the Lower Pontian fauna is different from the Upper Maeotian fauna.

Being the first to occupy the new transgression areal in the Dacian Basin, the Lower Pontian (Odessian) ostracods community is rather restricted. This was the "spearhead" of the Pontian migration. Out of the 5 - 6 Odessian species none is exclusive for this substage. They continue during the Portaferrian and even during the Bosphorian. These species belong to the Pontian transgression and represent the most adaptable ones in the new, post-Maeotian biotope.

The Dacian Basin Portaferrian community already reached equilibrium and became comparatively reach, with many new genera and species absent during the Lower Pontian.

2.1. Baleni-1 stratigraphic sequence

In the 0 m and 1364 m drilled interval, the Băleni-1 borehole penetrated deposits belonging to the following temporal sequences, stages and substages:

Dacian – Lower Dacian – between 20 m and 80 m;
Pontian – Upper Pontian – between 80 m and 320 m;
– Middle Pontian – between 340 m and 520 m;
– Lower Pontian – between 520 m and 770 m;
Maeotian – Upper Maeotian – between 790 m and 835 m;
Sarmatian – Middle Sarmatian – between 840 m and 1000 m;
– Lower Sarmatian – between 1000 m and 1225 m;
Badenian – between 1230 m and 1364 m.

2.2. Biostratigraphy

Lower Dacian

The uppermost deposits cut at Băleni 1 location (between 20 m and 80 m) include frequent *Viviparidae* fragments (Table 1), a distinctive feature for some Lower Dacian sections in the western part of the basin. These deposits make up a coarsening upward unit, like all the Lower Dacian (Getian) sediments drilled in the western and central part of the Dacian Basin (Jipa *et al.*, 2007).

Pontian

The presence of the Upper Pontian *(Bosphorian)* is indicated by the following ostracod, molluscs and otolit fossils, recorded in the 80 m-320 m drilling depth interval: *Caspiolla geometica* Olteanu, *Amplocypris* aff. *odessaensis* (Ilitkaia), *Gobius pretictus*, *Ilyocypris* sp., *Amnicythere* sp. *Loxoconcha* aff. *schweyeri* (Suzin), *Didacna* sp., *Caspiocypris* aff *pontica* (Sokac), *Pontoniella* aff *acuminata* (Zalany), *Pseudocatillus pseudocatillus* (Barbot), *Gobius* sp., *Caspiolla* sp. (Table 2)

Table 1 Paleontological content of the Early Dacian deposits

Drilling depth	Cutting lithologic composition	Fossils	Remarks	Estimated age
0 -10 m	Quartzitic sands	-	-	-
10 – 20 m	Quartzitic sands, lamellar gypsum	-	-	-
2o – 30 m	Gray, fine clay, quartz granule	*Lymnocardium* (?)	fragments	-
30 – 40 m	Gray, fine clay	-	-	-
40 – 50 m	Gray, fine clays	-	-	-
50 – 60 m	Gray, fine clays	*Pseudocatillus* sp. (BV)	fragments	Dacian
60 – 70 m	Gray, fine clay	-	-	-
70 – 80 m	Fine clays	*Nitellopsis* sp. (Ch) *Viviparus* sp. (G)	Three oogons Fragments	Lower Dacian (Getian)
80 – 90 m	Gray, fine, micaceous clays	Large *Candonae* (0)	Fragments	Lower Dacian (Getian)

Table 2. Paleontological content of the Upper Pontian (Bosphorian) deposits

Drilling depth	Cutting lithologic composition	Fossils	Remarks	Estimated age
90 – 100 m	Gray clays	*Pseudocatillus pseudocatillus* (Barbot)	Umbonal zone of the juvenile shell	Upper Pontian (Bosphorian)
100 – 110 m	Gray clay	Mollusk (?)	Unclear fragments	
110 – 120 m	Gray clay	-	-	-
120 – 130 m	Gray clay	-	-	-
130 – 140 m	Gray clay	*Caspiolla geometica* Olteanu (0)	Adult, right valve	Upper Pontian (Bosphorian)
140 – 150 m	Gray clay	-	-	-
150 – 160 m	Gray clay	*Amplocypris* aff. *odessaensis* (Ilitkaia)	Large fragment,adult, left valve	Upper Pontian (Bosphorian)
160 – 170 m	Gray clay	-	-	-
170 – 180 m	Gray clay with coal fragments (10%)	*Gobius pretictus* (0t), *Ilyocypris* sp. (0)	Two otolits and one fragment of fresh-water ostracod	Upper Pontian (Bosphorian)
180 – 190 m	Gray clay	*Amnicythere* sp. *Loxoconcha* aff. *schweyeri* (Suzin)	Large fragments	Upper Pontian (Bosphorian)
190 – 200 m	Gray clay	*Didacna* sp. (BV), *Caspiocypris* aff *pontica* (Sokac) (0)	Large fragments	Upper Pontian (Bosphorian)
200 – 210 m	Gray clay	-	-	-

Table 2 (continued)

Drilling depth	Cutting lithologic composition	Fossils	Remarks	Estimated age
210 – 220 m	Gray clay	*Pontoniella* aff *acuminata* (Zalany) (0)	Fragments	Upper Pontian (Bosphorian)
220 – 230 m	Gray, fine clay	-	-	-
230 – 240 m	Gray clay	*Gobius* sp. (Ot)		Upper Pontian (Bosphorian)
240 – 250 m	Gray clay , coal fragments and quartz	-	-	-
250 – 260 m	Gray clay	*Caspiolla* sp. (0)	Fragment	Upper Pontian (Bosphorian)
260 – 270 m	Gray clay	-	-	-
270 – 280 m	Gray clay	-	-	-
280 – 290 m	Gray clay	*Bacunella* sp. aff B. *dorsoar-cuata* (Zalany) (0)	Large fragment	Upper Pontian (Bosphorian)
290 – 300 m	Gray clay	-	-	-
300 – 310 m	Gray clay	-	-	-
310 – 320 m	Gray clay , coal fragments	*Didacna* aff *subcarinata* (BV)	Umbonal fragment	Upper Pontian (Bosphorian)
320 – 330 m	Quartzitic sands with argileous cement	*Chartoconcha* aff *bayerni* (BV)	Shell fragment with specific ridges and costae	Upper Pontian (Bosphorian)
330 – 340 m	Gray, silty, quartz and coal frag-ments	-	-	-

The Middle Pontian *(Portaferrian*) deposits between 340m and 550m, yielded less definite paleontological content. Some *Didacna subcarinata* fragments, the complete valve of *Euxinocythere bosqueti* and one posible *Congeria rhomboidea* fragment suggests the presence of this substage (Table 3).

The Lower Pontian (*Odessian*) (550 m to 770 m drilling depth) is defined by characteristic and frequent ostracod valves as *Caspiocypris pontica, C. rakosiensis, Cypria tocorjescui and Lineocypris trapezoidea* (Table 4).

Upper Maeotian

The presence of the Upper Maeotian stratigraphic interval (790 m to 835 m) was established on the base of less frequent but characteristic ostracod fossils, *Candona ricca* and *C. danubiana* (Table 5). Other identified fossil remains are the following: *Candoniella* sp., *Candona danubiana* (Stanceva), the gastropod *Hydrobia* sp. and reworked Miocene foraminifers. *Cypria tocorjescui* Hanganu was also observed in the Maeotian cutting samples, probably due to drilling mud contamination.

No Lower Maeotian fossils have been found, although elsewhere this stratigraphic interval is usually be very rich in specific fossil content.

Sarmatian

In the interval (840 m and 1000 m) assigned to the Sarmatian (sensu lato, defined by Barbot de Marny, 1869) no Upper Sarmatian fossils were discerned. This is not surprising, as in the northern peripheral area the western Dacian Basin this stratigraphic interval mostly develops in a coarse grained, barren clastic facies.

Although ostracods, foraminifers and otolits are frequent, only the presence of the Midlle Sarmatian is indicated only by *Miocyprideis sarmatica,* a characteristic species (Table 6). The rest of the fauna (*Elphidium macellum, Aurila angularis, Xestoleberis laevis, Leptocythere plana*) certificate the Sarmatian sensu largo.

Amnicythere tuberculata and some *Ervilia* sp., *Mohrensternia* aff. *inflata* fragments could suggests the existence of the Lower Sarmatian deposits.

Badenian

The Badenian biotop is fully marine. Two identifiable coral fragments, *Heliastrea* sp and *Solenostrea* sp., certify the normal salinity marine environment (Table 7). The following marine foraminfers also occur: *Dentalina elegans*, *Globigerina triloba*, *Flexus plicatus*, *Discorbis* sp., *Uvigerina* sp., and mollusks as *Ostrea* (?) sp., *Dentalium* sp. All the identified foraminifers are characteristic fossils for the Badenian age.

Table 3 Paleontological content of the Middle Pontian (Portaferrian) deposits

Drilling depth	Cutting lithologic composition	Fossils	Remarks	Estimated age
330 – 340 m	Gray, silty, quartz and coal fragments	-	-	-
340 – 350 m		*Tyrrhenocythere* sp. (0)	Fragment	Middle Pontian (Portaferrian)
350 – 360 m	Gray clay	*Congeria* sp. ex gr. *C. rhomboi-dea* (BV)	Fragment	Middle Pontian (Portaferrian)
360 – 370 m	Gray clay	-	-	-
370 – 380 m	Gray clay	*Tyrrhenocythere* aff T. *filipescui*	Fragment	Middle Pontian (Portaferrian)
380 – 390 m	Gray clay	*Hydrobia aff spicula* (G), *Pontoleberis* aff. *altilla* (Stanceva) (0)	Juvenile shell and identifiable fragment	Middle Pontian (Portaferrian)
390 – 400 m	Gray clay	*Congeria* (?) (BV)	Fragments	
400 – 410 m	Gray clay	-	-	-
410 – 420 m	Gray clay	-	-	-
420 – 430 m	Gray clay, coal fragments and quartz	*Euxinocythere bosqueti* (Livental) (0)	Adult, right valve	Middle Pontian (Portaferrian)
430 – 440 m	Clay	*Viviparidae* (G)	Fragments	
440 – 450 m	Clay	-	-	-
450 - 460 m	Clay	*Camtocypris* sp. (0)	Fragment	Middle Pontian (Portaferrian)
460 – 470 m	Yellow silty, coal fragments	-	-	-
470 – 480 m	Yellow silty, coal fragments	-	-	-
480 – 490 m	Gray clay	-	-	-
490 – 500 m	Siltstone	-	-	-
500 – 510 m	Fine sands, argillaceous cement	*Pontoniella* sp. aff *P. excellentis* Olteanu (0)	Large, identifiable fragment	Middle Pontian (Portaferrian)
510 – 520 m	Gray, fine quartzitic clays	-	-	-
520 – 530 m	Gray, fine quartzitic clays	-	-	-
530 – 540 m	Clay	-	-	-
540 – 550 m	Clay	*Euxinocythere* sp. (0)	Fragment	
550 – 560 m	Clay	*Posodacnomya* sp. aff. *P. sturi* (Cob.) (BV)	Umbonal fragment	-
560 – 570 m	Gray clay	-	-	-
570 – 580 m	Clay, coal fragments, carbonatic concretions	*Melanopsis* sp. (?)	Fragments	-
580 – 590 m	Silstone, quartz particles, gneiss fragments	-	-	-
590 – 600 m	Silstone, quartz particles, gneiss fragments	-	-	-
600 – 610 m	Gray, fine clays	-	-	-
610 – 620 m	Gray clay	-	-	-
620 – 630 m	Gray clay, coal fragments	-	-	-
630 – 640 m	Gray clay, coal fragments	-	-	-
640 – 650 m	Gray clay	*Caspiocypris* sp., *Lineocypris trapezoidea* (Zalany), *Cypria tocorjescui* Hanganu (0)	Complete valves, identifiable fragments	Lower Pontian (Odessian)

Table 4 Paleontological content of the Lower Pontian (Odessian) deposits

Drilling depth	Cutting lithologic composition	Fossils	Remarks	Estimated age
500 – 510 m	Fine sands, argillaceous cement	*Pontoniella* sp. aff *P. excellentis* Olteanu (0)	Large, identifiable fragment	Middle Pontian (Portaferrian)
510 – 520 m	Gray, fine quartzitic clay	-	-	-
520 – 530 m	Gray, quartzitic clay	-	-	-
530 – 540 m	Clay	-	-	-
540 – 550 m	Clay	*Euxinocythere* sp. (0)	Fragment	
550 – 560 m	Clay	*Posodacnomya* sp. aff. *P. sturi* (Cob.) (BV)	Umbonal fragment	-
560 – 570 m	Gray clay	-	-	-
570 – 580 m	Clay, coal fragments, carbonatic concretions	*Melanopsis* sp. (?)	Fragments	-
580 – 590 m	Silstone, quartz particles, gneiss fragments	-	-	-
590 – 600 m	Silstone, quartz particles, gneiss fragments	-	-	-
600 – 610 m	Gray, fine clays	-	-	-
610 – 620 m	Gray clay	-	-	-
620 – 630 m	Gray clay, coal fragments	-	-	-
630 – 640 m	Gray clay, coal fragments	-	-	-
640 – 650 m	Gray clay	*Caspiocypris* sp., *Lineocypris trapezoidea* (Zalany), *Cypria tocorjescui* Hanganu (0)	Complete valves, identifiable fragments	Lower Pontian (Odessian)
650 – 660 m	Gray clay	-	-	-
660 – 670 m	Gray clay	*Bacunella* sp. aff *B. balcanica* (Zalany) (0)	Large fragment	Lower Pontian (Odessian)
670 – 680 m	Siltstone	*Cypria tocorjescui* Hanganu *Lineocypris trapezoidea* (Zalany), (0)	One complete shell	Lower Pontian (Odessian)
680 – 690 m	Black sandstone, carbonatic concre-tions, pyrite	*Cypria tocorjescui* Hanganu (0)	Three complete shells	Lower Pontian (Odessian)
690 – 700 m	Clays, quartz, calcopyrite	*Maeotocythere* sp. aff. *M. praebosqueti* (Livental) (0)	One complete carapaces	Lower Pontian (Odessian)
700 – 710 m	Gray clay, quartz, calcopyrita, calcitic particule	*Cypria tocorjescui* Hanganu (0)	Two complete carapaces	Lower Pontian (Odessian)
710 – 720 m	Gray clay	*Cypria tocorjescui* Hanganu, *Caspiocypris rakosiensis* (Me-hes), *Lineocypris trapezoidea* (Zalany)	Many complete valves	Lower Pontian (Odessian)
720 – 730 m	Gray clay	-	-	-
730 – 740 m	Gray clay	-	-	-
740 – 750 m	Gray clay	*Caspiolla lobata* (Zalany) (0)	Complete valve	Lower Pontian (Odessian)

Table 4 (continued)

Drilling depth	Cutting lithologic composition	Fossils	Remarks	Estimated age
750 – 760 m	Fine, micaferous clay, quartz, micaschist	*Cypria tocorjescui* Hanganu, *Caspiolla labiata* (Zalany), *Lineocypris trapezoidea* (Zalany), (0)	Complete valves	Lower Pontian (Odessian)
760 – 770 m	Gray clay	*Cypria tocorjescui* Hanganu (0)	Complete valves	Lower Pontian (Odessian)
770 – 780 m	Gray clay	-	-	-

Table 5 Paleontological content of the Upper Meotian deposits

Drilling depth	Cutting lithologic composition	Fossils	Remarks	Estimated age
760 – 770 m	Gray clay	*Cypria tocorjescui* Hanganu (0)	Complete valves	Lower Pontian (Odessian)
770 – 780 m	Gray clay	-	-	-
780 – 787 m	Gray clay	-	-	-
790 – 795 m	Silty, subanguar quartz elements	*Candona ricca* (Stanceva)	Complete valve	Upper Meotian
795 – 800 m	Silty, subanguar quartz elements	*Candona danubiana* (Stanceva)	Complete valve	Upper Meotian
800 – 805 m	Silty, subanguar quartz elements	-	-	-
805 – 810 m	Siltstone	-	-	-
810 – 815 m	Siltstone	*Reworked Miocene foraminifers*	-	-
815 – 820 m	Siltstone	*Hydrobia* sp. (G) *Candoniella* sp. (0)	Fragments	Upper Meotian
820 – 825 m	Siltstone			
825 – 830 m	Siltstone			
830 – 835 m	Siltstone	*Candona danubiana* (Stanceva) (0)	Complete valve	Upper Meotian
835 – 840 m	Siltstone, gneiss and micaschist fragments	-	-	-

Table 6 Paleontologic content of the Middle Sarmatian (Bessarabian) deposits

Drilling depth	Cutting lithologic composition	Fossils	Remarks	Estimated age
830 – 835 m	Silty	*Candona danubiana* (Stanceva) (0)	Complete valve	Upper Meotian
835 – 840 m	Silty, gneiss and micaschist frag-ments	-	-	-
840 – 845 m	Argillaceous sands, plant debris	*Sclerochilus* sp. *Hydrobia* sp.	Fragments	Middle Sarmatian (Bessrabian)
845 – 850 m	Argillaceous sands, plant debris	-	-	-
850 – 855 m	Argillaceous sands, plant debris	*Elphidium* sp. aff *E. macellum* (Fichtel&Moll)	Almost complete shell	Middle Sarmatian (Bessrabian)
855 – 860 m	Siltstone	-	-	-

Table 6 (continued)

Drilling depth	Cutting lithologic composition	Fossils	Remarks	Estimated age
860 – 865 m	Fine sand	-	-	-
865 – 870 m	Fine sand	*Miliolidae* (?)	Fragments	
870 – 875 m	Calcareous sand	-	-	-
875 – 880 m	Calcareous sand	-	-	-
880 – 885 m	Fine sand	*Triloculina* sp.A (F)		Middle Sarmatian (Bessarabian)
885 – 890 m	Calcareous sand	-	-	-
890 – 895 m	Argillaceous sand	*Textularia* sp. (F)	Fragment	Middle Sarmatian (Bessarabian)
895 – 900 m	Calcareous sand	-	-	-
900 – 905 m	Fine sand	-	-	-
905 – 910 m	Fine sand	*Aurila* sp. (O)	Fragment	Middle Sarmatian (Bessarabian)
910 – 915 m	Fine sand	-	-	-
915 – 920 m	Fine sand	-	-	-
920 – 925 m	Calcareous sand	-	-	-
925 – 930 m	Calcareous sand	-	-	-
930 – 935 m	Calcareous sand	-	-	-
935 – 940 m	Fine sand	*Miocyprideis sarmatica* (Zalany)	One complete valve	Middle Sarmatian (Bessarabian)
940 – 945 m	Fine calcareous sand	-	-	-
945 – 950 m	Fine calcareous sand	-	-	-
950 – 955 m	Fine calcareous sand	-	-	-
955 – 960 m	Marls	-	-	-
960 – 965 m	Fine sand and marl	-	-	-
965 – 970 m	Fine sand	*Xestoleberis* sp. aff *X. laevis* (Suzin) (O)	Complete valve	Middle Sarmatian (Bessarabian)
970 – 975 m	Marl	-	-	-
975 – 980 m	Fine sand	-	-	-
980 – 985 m	Fine sand	*Elphidium* sp. aff. *E. crispum* Linne, *Articulina* sp., *Elphidium* sp. B (F)	Complete tests	Middle-Lower Sarmatian (Bessarabian – Volhinian ?)
985 – 990 m	Siltstone	-	-	-
990 – 995 m	Fine, argillaceous sand	*Aurila* sp. aff. *angularis* (Schneider)	Fragment	Sarmatian
995 – 1000 m	Fine, argillaceous sand	*Missidae* (?)		Middle Sarmatian (Bessarabian)

Table 7 Paleontologic content of the Badenian deposits

Drilling depth	Cutting lithologic composition	Fossils	Remarks	Estimated age
1220 – 1225 m	Grey siltstone	*Leptocythere* sp. aff. *L. plana* (Reuss)	Identifiable fragment	Sarmatian
1225 – 1230 m	Grey, quartitic, fine sand			
1230 – 1235 m	Quartzitic sandstone	-	-	-
1235 – 1240 m	Grey, quartitic, fine sand, plant debris	-	-	-
1240 – 1245 m	Sand	-	-	-
1245 – 1250 m		*Solenostrea* sp. (C)	Identifiable fragment	Badenian
1250 – 1255 m	Sand	-	-	-
1255 – 1260 m	Ferugineous sand	-	-	-
1260 – 1265 m	Sandstone, gypsum concretions	*Ostrea* sp. (BV) No nannoplancton	Fragment	Badenian
1265 – 1270 m	Sandstone, gypsum concretions	No nannoplancton -	-	-
1270 – 1275 m	Micaferous sand, gypsum concretions	*Heliastrea* sp (C)- No nannoplancton	fragment -	Badenian -
1275 – 1280 m	Gypsiferous silty	No nannoplancton -	-	-
1280 – 1285 m	Gypsiferous silty	No nannoplancton -	-	-
1285 – 1290 m	Gypsiferous silty, quartz, mica, pyrite	No nannoplancton -	-	-
1290 – 1295 m	Sandstone, calcareous cement, quartz, pyrite	*Discorbis* (?) sp. (F) *Plicene ostracod valves* (contamination). No nannoplancton	Fragment	Badenian
1295 – 1300 m	Sandstone, carbonatic cement	No nannoplancton -	-	-
1300 – 1301 m	Gypsiferous siltstone	-	-	-
1301 – 1302 m	Gypsiferous siltstone	*Globigerina triloba Reuss, Globigerina* sp A, aff *G. conglobata* Brady, *Dentalina* sp. aff. *D. elegans* dOrb., *Dentalium* sp., *Uvigerina* sp. A Reworked ostracods from Pliocene	Complete tests	Badenian
1302 – 1303 m	Limestone	*Uvigerina* sp. (F), *Flexus* sp. aff. *F. plicatula* (Reuss) (O)	Identifiable fragments	Badenian
1303 – 1303.5 m	Sandstone, marls, gypsum	*Globigerina* sp. (F), *Buntonia* sp. (O)	Genre identifiable	Badenian
1303.5 – 1304 m	Sandstone, marls, gypsum	-	-	-
1304 – 1304.5 m	Sandstone, marls, gypsum	*Bulimina* aff *aculeata* Czjk. *Globigerina bulloides* Reuss (F)	Identifiable test	Badenian
1304.5 – 1305 m	Fine silty	No nannoplancton -	-	-
1305 – 1310 m	Silty, quartz, gneiss, calcite	No nannoplancton-	-	-
1310 – 1315 m	Quartzitic, fine sand	*Ammonia beccari* (Linne) (F), *Triquetrohabdulus rugosus, Sphaenolithus heteromorphus, S. abies, Reticulofenestra pseudoumbilicus, Coccolithus pelagicus, Pontosphaera multipora, Brarudosphaera bigelowii*	Complete test	Fresh-oligohaline biotop NN 6 nanno zone (lower part)

Table 7 (continued)

Drilling depth	Cutting lithologic composition	Fossils	Remarks	Estimated age
1315 – 1320 m	Fine, grey sand	Reworked foraminifers, *Triquetrohabdulus rugosus, Sphaenolithus heteromorphus, S. abies,Calcidiscus macintyrei, Syracolithus dalmaticus, Reticulofenestra pseudoumbilicus, Coccolithus pelagicus, C. miopelagicus, Pontosphaera multipora, Pontosphaera japonica, Rhabdopshaera clavigera*	-	NN 6 nanno zone (latest Badenian – Earliest Sarmatian)-
1320 – 1325 m	Fine, grey sand	*Triquetrohabdulus rugosus, Sphaenolithus heteromorphus, S. abies, Calcidiscus macintyrei, Syracolithus dalmaticus, Reticulofenestra pseudoumbilicus, Coccolithus pelagicus, C. miopelagicus, Pontosphaera multipora,* -	-	NN 6 nanno zone (lower part) Latest Badenian – Ealiest Sarmatian-
1325 – 1330 m	Fine, grey sand	*Triquetrohabdulus rugosus, Helicosphaera walsberdorfensis, Discoaster variabilis, Sphaenolithus abies, Calcidiscus leptoporus, Calcidiscus macintyrei, Reticulofenestra pseudoumbilicus, Coccolithus pelagicus, C. miopelagicus, Pontosphaera multipora, Pontosphaera japonica* -	-	NN 6 nanno zone (lower part), Latest Badenian – Earliest Sarmatian-
1330 – 1335 m	Fine, grey sand	*Triquetrohabdulus rugosus, Sphaenolithus abies, Calcidiscus leptoporus, Calcidiscus macintyrei, Syracolithus dalmaticus, Reticulofenestra pseudoumbilicus, Coccolithus pelagicus, C. miopelagicus, Pontosphaera multipora, Pontosphaera japonica,* -	-	NN 6 nano zone (lower part), Latest Badenian – Earliest Sarmatian-
1335 – 1340 m	Fine, grey sand	*Triquetrohabdulus rugosus, Sphaenolithus abies, Calcidiscus leptoporus,Calcidiscus pataecus, Syracolithus dalmaticus, Reticulofenestra pseudoumbilicus, Coccolithus pelagicus, C. miopelagicus, Pontosphaera multipora, P japonica,* - -	-	NN 6 nanno zone (lower part), Latest Badenian – Earliest Sarmatian-
1340 – 1345 m	Fine, micaferous sands	*Triquetrohabdulus rugosus, Discoaster brouweri,Coronocyclus nitescens, Calcidiscus pataecus, Helicosphaera walsberdorfensis, H. Walichii, Sphaenolithus heteromorphus, S. abies, Calcidiscus leptoporus, Reticulofenestra pseudoumbilicus, Coccolithus pelagicus, C. miopelagicus,* -	-	NN 6 nanno zone (lower part)-), Latest Badenian – Earliest Sarmatian
1345 – 1348.5 m	Fine, grey sand, quartz and limonite	Reworked Pliocene ostracods *Triquetrohabdulus rugosus, Discoaster brouweri,Coronocyclus nitescens, Calcidiscus pataecus, Triquetrohabdulus rugosus, Sphaenolithus abies, Calcidiscus leptoporus, Reticulofenestra pseudoumbilicus, Coccolithus pelagicus, Pontosphaera multipora, Brarudosphaera bigelowii*	-	NN 6 nanno zone (lower part)

Table 7 (continued)

Drilling depth	Cutting lithologic composition	Fossils	Remarks	Estimated age
1348.5 – 1350m	Fine, gray-dark sands	*Helicosphaera walsberdorfensis, H. walichi, Sphaenolithus heteromorphus, S. abies, Calcidiscus leptoporus, Reticulofenestra pseudoumbilicus, Coccolithus pelagicus Reticulofenestra pseudoumbilicus Cyclicargolithus floridanus* -	-	Middle – Late Badenian-
1350-1355m	Fine, gray sands	*Helicosphaera walsberdorfensis, H. walichi, Sphaenolithus heteromorphus, S. abies, Calcidiscus leptoporus, Reticulofenestra pseudoumbilicus, Coccolithus pelagicus, Pontosphaera multipora* -	-	Middla – Late Badenian-
1355-1360m	Fine gray sands	*Orbulina universa* (Reuss), *Cyherella sp. Helicosphaera walsberdorfensis, H. walichi,H. scissura, Sphaenolithus heteromorphus, S. abies, Calcidiscus leptoporus, Reticulofenestra pseudoumbilicus, Coccolithus pelagicus,C. miopelagicus Rhabdosphaera clavigera, Pontosphaera multipora* -	Three complete orbulinae shells	Middle – Late Badenian
1360-1364m	Fine gray sands	*Orbulina universa* (Reuss), *Cytherella aff badenica* (Olteanu), *Mutilus polyptichus* (Reuss), *Helicosphaera walsberdorfensis,H. welichii, H. scissura, Sphaenolithus heteromorphus, S. abies, Calcidiscus leptoporus, C. macintyrei, Reticulofenestra pseudoumbilicus, R. minuta, Rhabdosphaera pannonica, R. clavigera, Cyclicargolithus floridanus, Pontosphaera multipora*	Complete shells and valve	Early Badenian (Middle – Late Badenian, after nannoplancton analysis)

2.3. Lithology

Information on the lithology of the deposits crossed by the Băleni-1 borehole comes from the following sources:

- examination of the drill cuttings (as presented in the tables 1 to 7);
- well logs.

The lithologic column obtained on this basis has a non-quantitative character

Lithology of the Lower Dacian deposits

Both cuttings observations and the resistivity log indicate in the Lower Dacian the sand content increases upward. The resistivity log suggests a moderate growth of the sand content in the depth interval 85 to 35 m (Fig. 3), and a sharper increase above the 35m depth. Consequently the Lower Dacian appears as a coarsening upward unit.

Lithology of the Pontian deposits

The well logs evidence a subtle increase in the silt/clay content from the base to the top of the Pontian succession (Fig. 4).

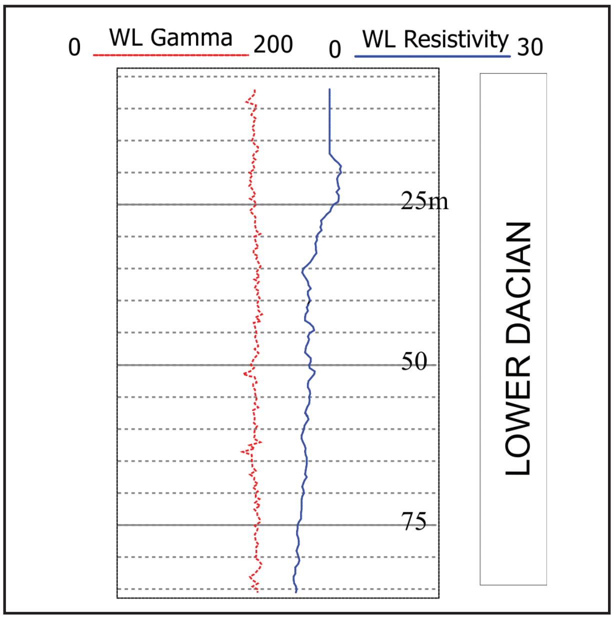

Fig. 3 Well logs of the Lower Dacian deposits crossed by the Baleni-1 borehole

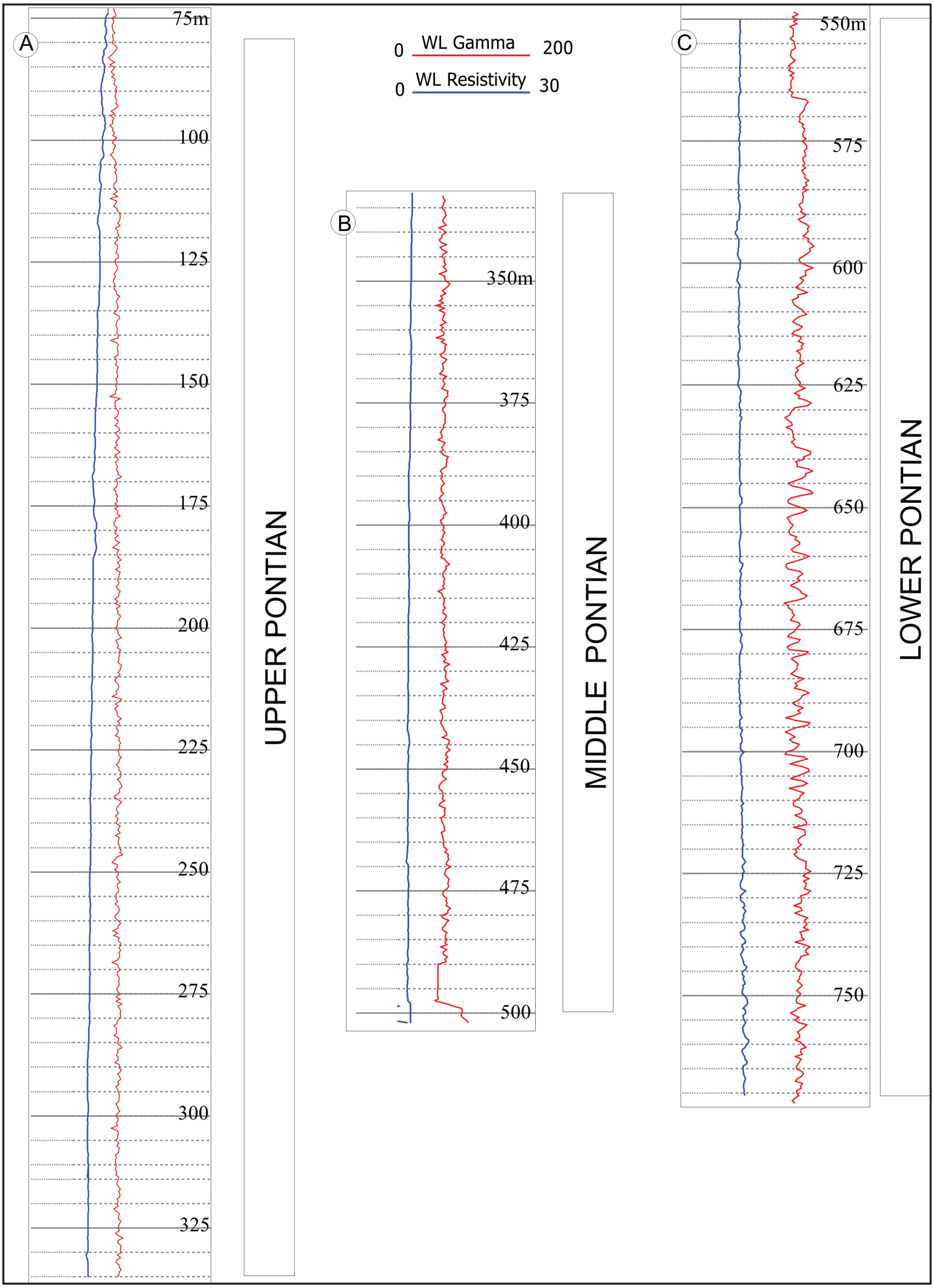

Fig. 4 Well logs of the Pontian deposits crossed by the Baleni-1 borehole

The Upper Pontian (Bosphorian) deposits are characterized by an almost linear resistivity well log (Fig. 4A), indicating a clayey log facies. This is also pointed out by the lithology of the cuttings, which is shaly with only one mention of quartzitic fragments (Table 2).

The notches of the serrated resistivity log slightly enlarge in case of the Middle Pontian (Portaferrian) deposits of the Băleni-1 borehole (Fig. 4B), describing a shaly and silty lithology. The increasing siltic character is also expressed by the siltstone fragments observed in several cutting samples (Table 3).

The serrated aspect of the resistivity log is maintained in the Lower Pontian (Odessian) interval of the Băleni-1 borehole (Fig. 4C). The indentations of the log line are more extensive, but remain in the siltic lithology range. The analysis of the cutting evidence siltstone fragments in several samples and fine-grained sand fragments in only one case (Table 4). The shaly character of the Băleni-1 Lower Pontian sediments is dominant, but the siltic attribute is more pregnant in comparison with the Middle Pontian deposits.

Fragments of coal appear, with low frequency, in the cutting samples coming from Pontian deposits.

Lithology of the Maeotian and Sarmatian deposits

The gamma and resistivity logs (Fig. 5) show the Upper Maeotian lithology is similar to that of the Lower Pontian deposits, but without the thicker sand intercalations. The dominant siltic grain size constitution is suggested by the observations made on the cutting samples (Table 5).

The Sarmatian sediments are silty with several sand intercalations (Fig. 5), similar with the deposits cropping out near the Bala village, about 5 km away from the Băleni 1 borehole location.

Lithology of the Badenian deposits

All the cutting samples collected from the upper half of the Badenian interval are sandy. In the lower part the sandy cutting samples alternate with the silty ones, and the gypsiferous character is evident.

3. INTERPRETATION OF DATA

3.1. Position of the Băleni-1 borehole in the Dacian Basin area

The Băleni-1 was drilled in the western end-area of the Dacian Basin, close to the Carpathian nappe outcrop boundary. The well location appears to be at the northern periphery of the depression representing the deepest part of the Dacian Basin (Jipa, Olariu, 2009) (Fig. 6).

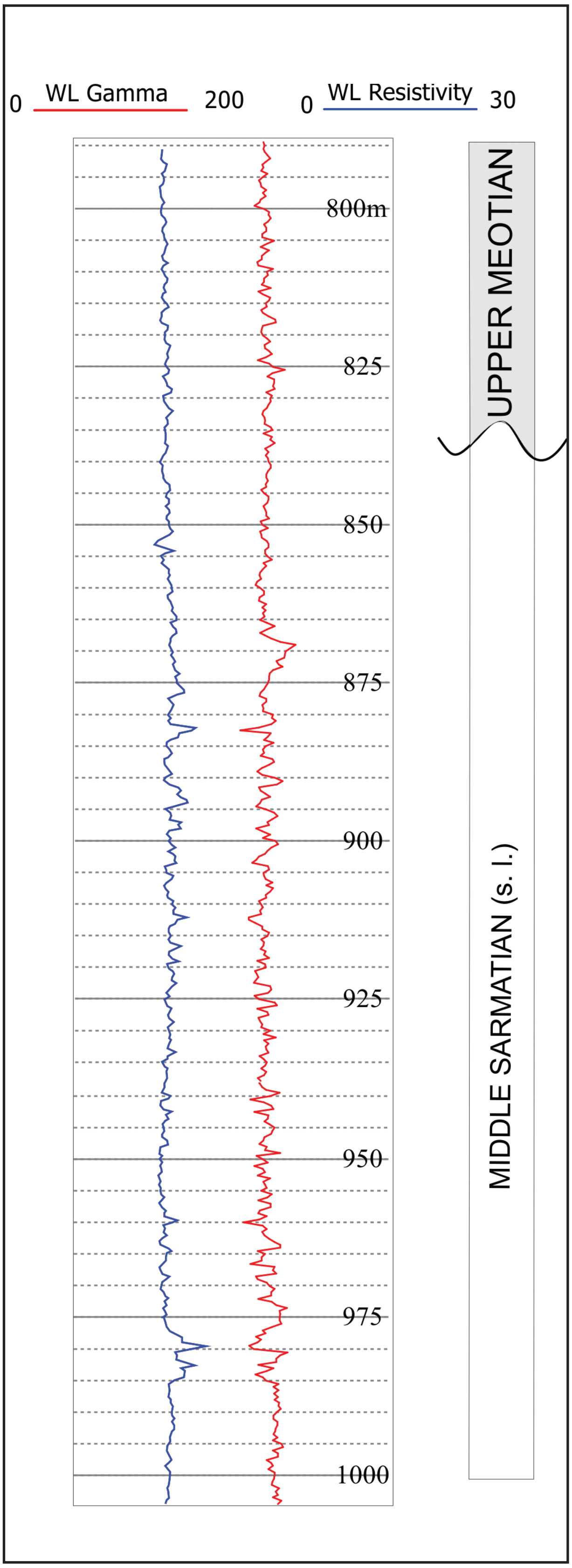

Fig. 5 Well logs of the Middle Sarmatian (*s.l.*) and Upper Meotian deposits crossed by the Baleni-1 borehole

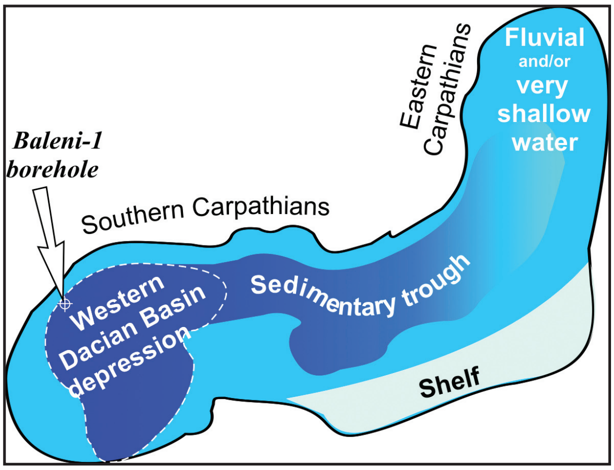

Fig. 6 Baleni-1 location on the Dacian Basin physiographic model (Jipa, Olariu 2009)

3.2. Stratigraphic record of the Upper Neogene deposits drilled at the Băleni-1 location

A significant aspect of the Upper Neogene succession evidenced by the study of the Băleni-1 lithological column is the continuous stratigraphic record of the interval dating from the Upper Maeotian through the Pontian and up to the Lower Dacian. This continuity was throughout documented by Marinescu (1978) on many geological sections from Turnu Severin to Baia de Arama, in the western Dacian Basin. The study of the Băleni 1 sedimentary succession provides the confirmation on the continuity of the Upper Maeotian – Lower Dacian stratigraphic succession, from the presently subsurface area of the basin.

The investigation of the Băleni 1 cutting samples failed to point out any Upper Sarmatian (*s.l.*) – Lower Maeotian fossils. This could indicate a local gap or could be due to a barren interval. In the western Dacian Basin area Marinescu (1978) acknowledged the presence of the both Maeotian (Oltenian and Moldavian) and Upper Sarmatian (Bessarabian and Kersonian) substages.

3.3. Lithologic succession of the Upper Neogene deposits drilled at the Băleni-1 location

Both well logs and cutting data indicate the clayey lithologic component is dominant in the Upper Maeotian-Upper Pontian sedimentary succession evidenced by the Băleni-1 borehole (Figs. 4, 5 and 7). More frequent silt intercalations seem to occur in the Upper Maeotian and the Lower and Middle Pontian. Few fine-grained sand interbeds are probably present in the Lower Pontian sequence.

Overall the Upper Maeotian-Upper Pontian lithology is very fine-grained and rather monotonous. Although transgressions and regressions affected the western Dacian Basin during the Maeotian and Pontian time (Marinescu, 1978; Leveer, 2007), these events did not introduce obvious lithologic changes in the sedimentary succession drilled at Băleni-1 site.

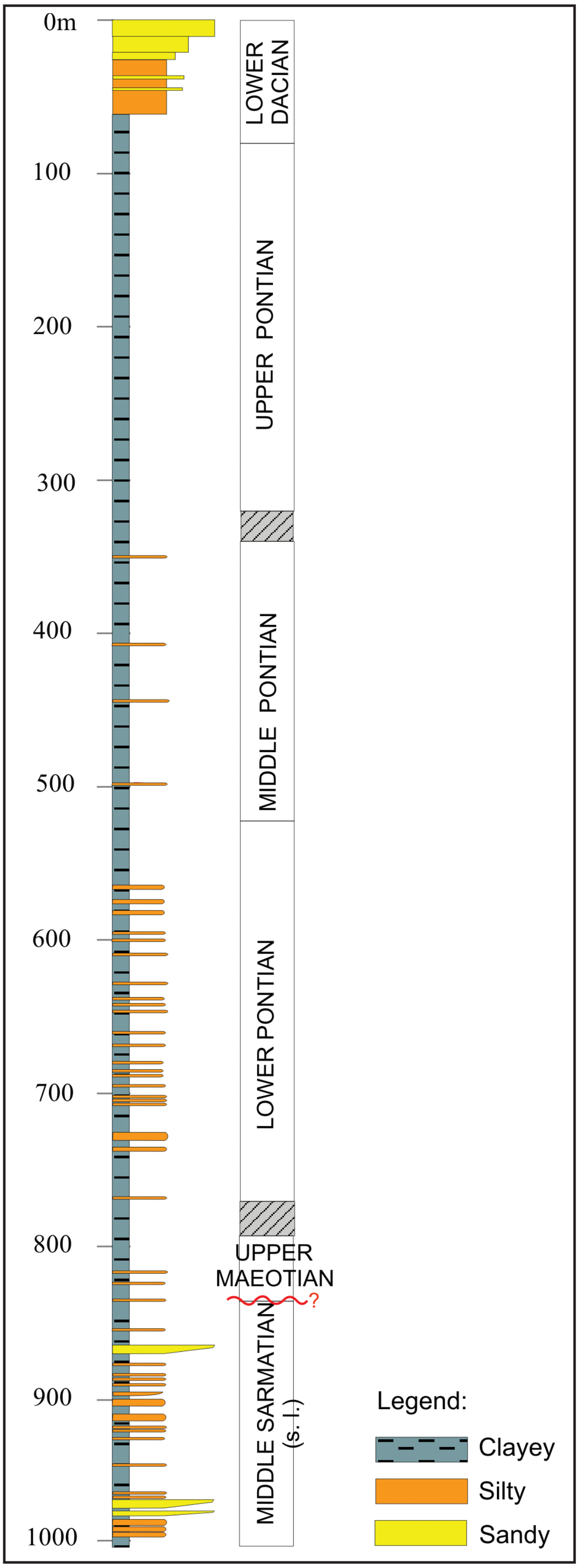

Fig. 7 Estimated lithology of the Sarmatian (*s.l.*) – Dacian deposits drilled at the borehole location Baleni-1. The sedimentary column is based on cutting observation and well logs shape

The lithologic trend of the Pontian deposits cut by the Băleni-1 well appears to be different from the similar trend observed in the outcrop area, where the Lower Pontian is dominantly clayey and the Middle Pontian includes relatively coarser-grained deposits (Marinescu, 1978). This difference could be due to the location of the Baleni-1 borehole in a deeper part of the basin.

As pointed out by the Băleni-1 investigation, there is a gradual transition between the uppermost Pontian and the Lower Dacian deposits (Fig. 3). The resulting sedimentary succession is a Lower Dacian coarsening upward sequence, which was evidenced all over the western and central Dacian Basin (Jipa *et al.*, 2007). This littoral-deltaic sequence is the last episode of the Dacian Basin, before its closure as a Paratethys brackish marine unit (Jipa, Olariu, 2009).

ACKNOWLEDGEMENTS

The authors are grateful to Rompetrol SA and Zeta Petroleum Ltd for the permission to use the Băleni-1 well lithostratigraphic data.

This study was partly carried out in the framework of the project 144/2007, CNCSIS code 816 (Romanian National Programme of Research, Development and Innovation – II, IDEI)

We acknowledge with thanks the improvements suggested by an anonymous referent.

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