SEDIMENTOLOGICAL SIGNIFICANCE OF SUBSURFACE DATE IN THE WESTERN DACIAN BASIN (UPPER NEOGENE, ROMANIA): SEDIMENTARY ENVIRONMENTS, GENETIC SEQUENCE, BASINAL EVOLUTION

Dan JIPA[1], Corneliu DINU[2], Nicolae MARINESCU[3]

[1]National Institute of Marine Geology and Geoecology (*GEOECOMAR*),
23-25, d. Onciul Str., 70318 Bucharest, Romania
[2] Faculty of Geology and Geophysics, University of Bucharest, 6 Traian Vuia Str., 70139 Bucharest, Romania
[3] Prospectiuni S.A., 1, Caransebes Str., 78344 Bucharest, Romania

Abstract: The subsurface data sedimentologic investigation of the Upper Neogene deposits was carried out in order to extend the genetic information towards distal areas of the Dacian Basin. The paleoenvironmental reconstruction rely mostly on the grain size trend analysis as inferred from the electric logs shapes. Electrofacies with paleoenvironmental significance have been used to separate three genetic intervals within the sequence of the Upper Neogene-Pleistocene sediments. The three major paleo-environmental intervals (lacustrine, littoral, fluvial) also represent stratigraphic units, offering the opportunity of setting up an integrated genetic stratigraphic framework of the Dacian Basin (Romania).

Key words: genetic stratigraphy, sedimentary environments, electrofacies, subsurface data, sedimentary sequence, coarsening upward, fining upward, lacustrine, littoral, fluvial.

1. INTRODUCTION

Intensive sedimentological investigations have been carried out in the Upper Neogene Dacian Basin (Jipa 1997, 2000), outlining paleo-dynamic, paleo-environmental and genetic-stratigraphic features (Papaianopoi *et al.*, 1995). These studies have been carried out within the northern zone of the Basin with outcropping, proximal deposits.

Coming from a relatively small and peripheral basinal area, the above mentioned sedimentogenetic knowledge presented a restricted genetic significance. It was essential to extend the investigation to the central and southern area of the Dacian Basin, in order to arrive to a more comprehensive picture of the sediment accumulation process. Satisfying this necessity implied to use subsurface, drilling data, the only source of information for the concealed central and southern marginal Upper Neogene Dacian Basin.

Study area location

The present investigation, representing the first sedimentological approach of the internal part of the Dacian Basin, was carried out in the Slatina-Caracal area (Fig. 1), on the lower course of the Olt Valley.

The investigated wells are located along a north-south oriented section, crossing the central and southern Upper Neogene-Pleistocene deposits of the Dacian Basin.

The wells have been drilled for different purposes (exploration for oil, coal and water resources), their geological primary data being rater unequal. The most informative for a sedimentological investigation proved to be the coal exploration wells.

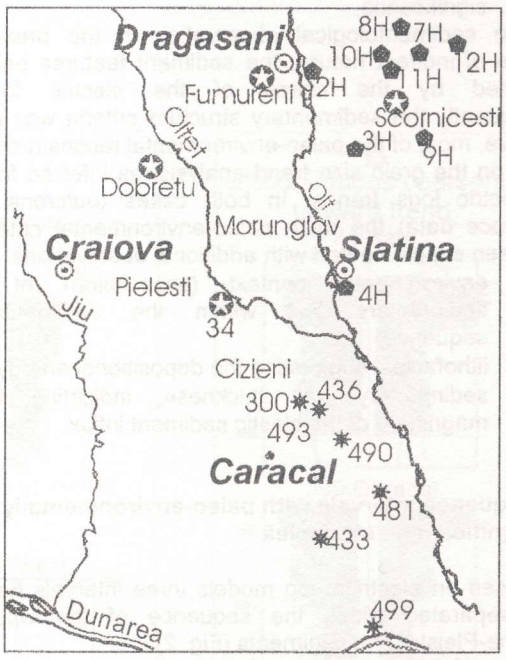

Fig. 1 Study area and wells location. (1) Coal exploration drilling. (2)- Oil exploration driling. (3)- Water resources

Methodology

The present study relies on the recognition and evaluation of the sedimentological features from the data offered by the investigated wells. The electrofacies, based on log models represented the major information source of the investigation. When available, lithologic description data was also used.

Paleo-environments reconstruction was the main line of sedimentological approach. The micro-sequence have been grouped in intervals at mega-sequence scale, then-through well to well correlation - extended to the investigated area.

The acquired paleo-environmental facts were used to point out the evolution of sediment accumulation in the Dacian Basin, during the Pontian-Pleistocene time interval.

One of the goals of the investigation was to define (with the accuracy of the available data) the stratigraphic value of the main genetically-significant intervals in the Dacian Basin.

Comparison with similar, previously realized sedimentological models (based on outcrops observations in the northern area of the Dacian Basin; Jipa, 2000) was intensely used, in order to verify and extend the subsurface sedimentological reconstruction.

2. PALEO-ENVIRONMENTAL ANALYSIS

Sedimentological investigation based on outcrops analysis used the following two main criteria to recognize sedimentary paleoenvironments in the Dacian Basin:

- the vertical grain size trends within sedimentary units;
- sedimentary structures with paleo-environmental significance.

The sedimentological observation in the present study is of indirect nature, the sediment features being suggested by the shape of the electric logs. Consequently the sedimentary structure criteria was not operative, most of the paleo-environmental reconstruction relying on the grain size trend analysis, as inferred from the electric logs trends. In both cases (outcrops or subsurface data) the main paleo-environmental criteria have been supplemented with additional observations:

- environmental context (association) of a sedimentary unit within the sedimentary sequence;
- lithofacies, suggesting the depositional energy;
- sedimentary unit thickness, indicating the magnitude of the clastic sediment influx.

Sequence intervals with paleo-environmentally significant electrofacies

Based on electrical log models three intervals have been separated within the sequence of the Upper Neogene-Pleistocene sediments (Fig. 2):

Interval 1. Deposits with funnel model electric logs, indicating the coarsening upward sediment trend. On this reason sediment intervals with funnel shaped logs are considered of littoral origin. The coarsening upward grain size feature is also displayed by the synchronous, Lower Dacian deposits studied in the outcrops on the northern border area of the Dacian Basin, besides sedimentary structures with environ-mental meaning (hummocky cross lamination and symmetrical wave ripples).

The coarsening upward sediments are easily distinguished and have been correlated on all the investigated well logs, representing a leading interval.

Interval 2. The Pontian sediments underlying the littoral, Lower Dacian coarsening upward interval display electric logs typical for dominantly clayey sediment. The available lithologic well data concur to this image.

The Pontian, very fine-grained sediment accumulation, points out to a quiet environment, developed in the internal, distal area of the Dacian Basin. This sediment facies have been interpreted are representing the typical lacustrine environment of the basin, with deeper water than the above presented littoral environment.

Interval 3. The thick Upper Dacian to Pleistocene sediments overlying the coarsening upward deposits of the interval 1 consist of coarser grained sediments (meters thick sand or - less frequently - fine gravel) alternating with clayey/silty sediments.

Many of the sandy (or gravelly) sediment interbeds display bell or blocky shaped electrical logs, currently regarded as indicating fining upward sediments accumulated in fluvial channels. This assumption is substantiated by the fact that the synchronous sediments investigated in outcrops from the northern zone of the Dacian Basin has also been considered of fluvial origin, based on both internal sedimentary structures (trough cross lamination) and fining upward grain size trend.

Sedimentary features of the coarsening upward, littoral sediments

As already discussed, the littoral sediments belonging to the interval 1 are characterized by electric log models pointing out the coarsening upward grain size trend (Fig. 2). This feature apply both to the mega-sequence representing the interval 1 as a whole, as well as to the sedimentary units making up the littoral unit (micro-sequences).

Mega-sequence grain size trend. At the scale of the entire littoral unit, the following two different coarsening upward trends occur:

(a) the *continuous coarsening upward trend* appears as a regular sediment grain size increase from the clayey bottom to the sandy top of the littoral unit. This feature is associated with the most investigated wells (433-Caracal, 436-Caracal, 481-Caracal, 490-Caracal, 105-Bals, 46-Pielesti-Cernele and others) (Fig. 3A);

(b) other log sequences of the interval 1 (wells 433-Caracal, 300-Caracal and H4-Slatina) shows a *discontinuous, two-steps coarsening upward trend* (Fig. 3B). In this case the upper part of the littoral interval is dominantly sandy and only slightly coarsening upward. The middle and lower parts are clearly finer grained (silty and clayey), also with a limited coarsening upward change.

Micro-sequence grain size trend. The major Dacian Basin littoral sequence consists of a series of minor component sequences, as presented in Figure 4. The electric log analysis reveals the coarsening upward trend of some of these minor sequences.

The existence of minor sequences with coarsening upward features indicates that the major littoral unit is of complex nature, made up of superposed small-scale littoral sedimentary units.

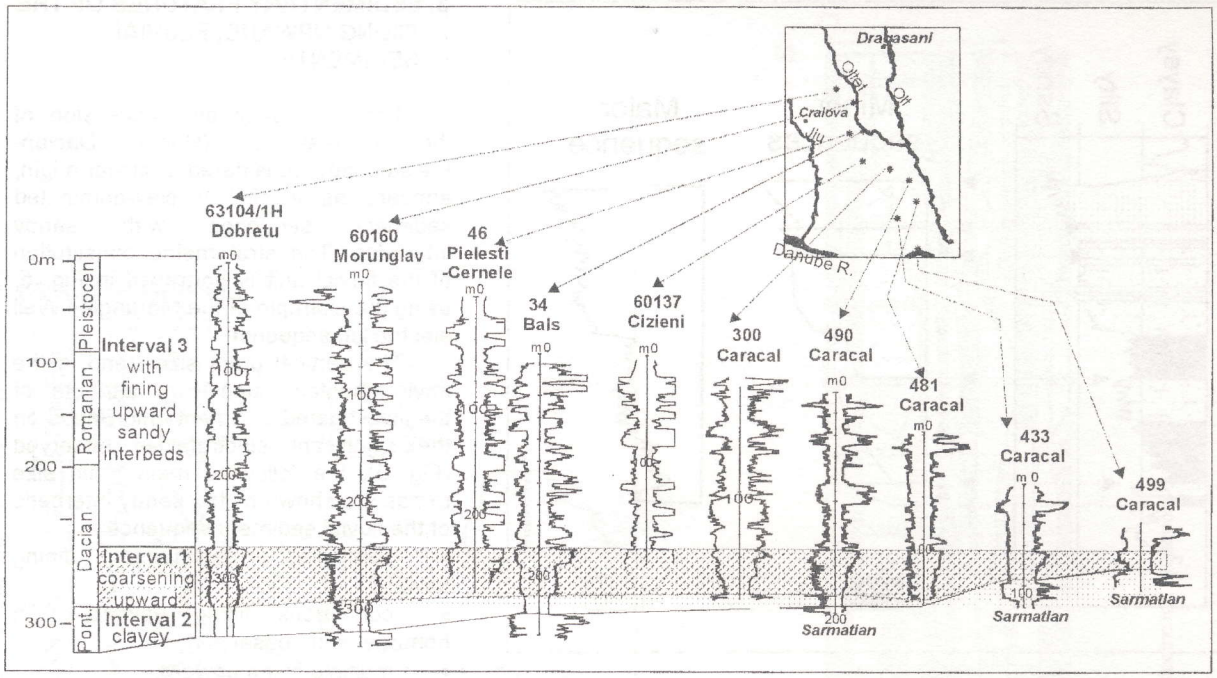

Fig. 2 Correlation of sequence intervals with genetically significant electrofacies. The upper limit of the interval 2 is used as datum.

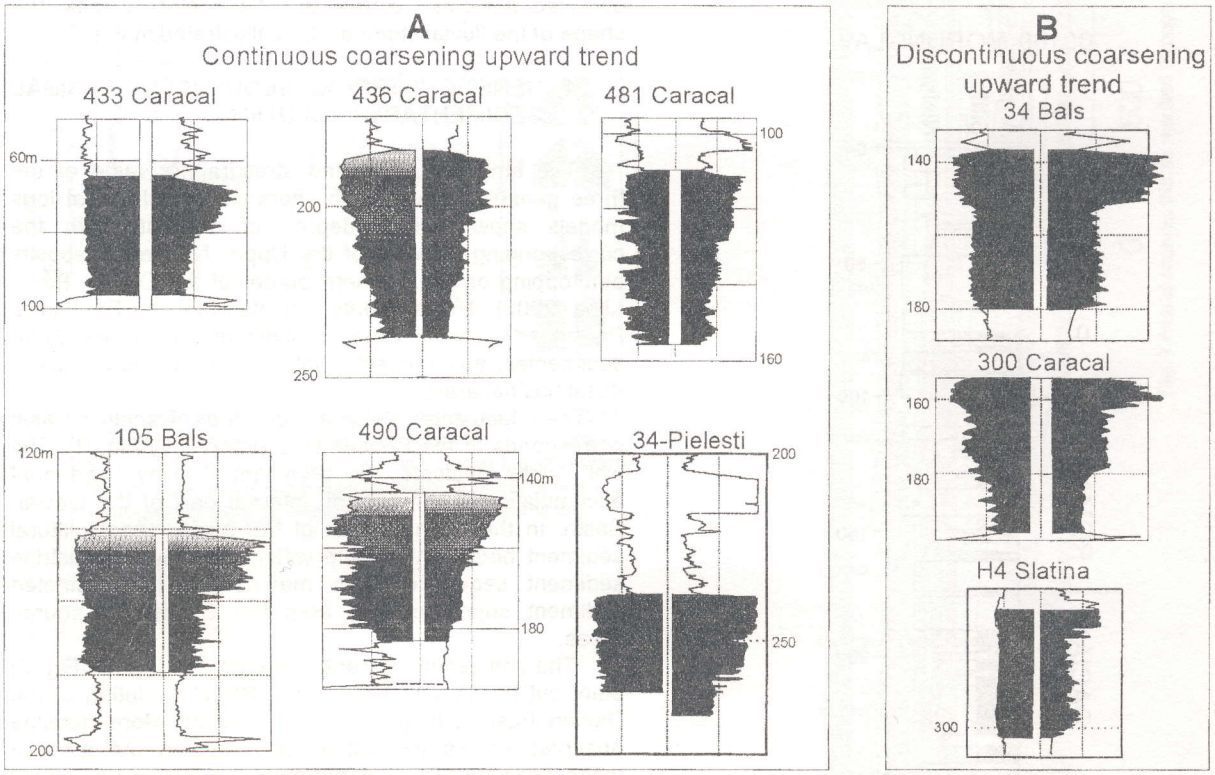

Fig.3 Types of mega-sequence grain size trends of the littoral Dacian Basin sediments.

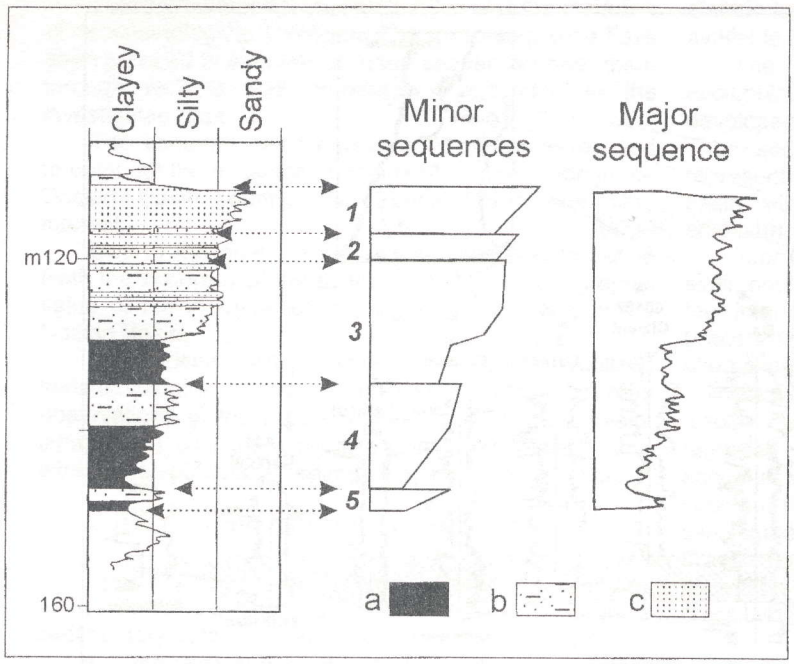

Fig. 4 Mega-sequence and its constituent minor sequence in the littoral unit of the Dacian Basin. Lithologic signs: a- clayey, b-silty, c-sandy (fine and very fine grained).

3. SEDIMENTARY FEATURES OF THE FINING UPWARD, FLUVIAL SEDIMENTS

The thick sediment succession of the Interval 3 (Upper Dacian-Pleistocene), considered of fluvial origin, appears as a slightly clay-dominated sediment sequence with sandy interbeds. The stratometric constitution of the fluvial unit is portrayed in Fig. 5, using the example of the Morunglav Well electric log sequence.

The vertical grain size trend is the environmentally significant attribute of the investigated sediment unit. Based on the significant electrofacies observed (Fig. 6), the following main grain size trends are shown by the sandy interbeds of the fluvial sediment sequence:

- complete, continuous fining upward;
- continuous fining upward, with homogeneous basal part;
- multiple fining upward;
- homogeneity (lack of vertical trend; blocky electric log model).

Al three varieties of the fining upward trend and the homogeneous type are common sedimentary characters of the fluvial channel fills. Based on a detailed investigated site, which permited the close correlation of the electric logs, the shape of the fluvial channel fills is illustrated in Fig. 7.

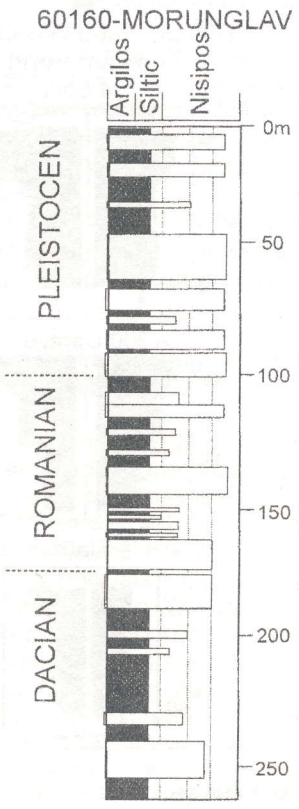

Fig. 5 Stratonomic features of the fluviatil sequences

4. GENETIC INTERVAL SEQUENCE – BASINAL SEDIMENTARY EVOLUTION

The time sequence and stratigraphic value of the three genetic intervals with characteristic electrical logs models show a high degree of similarity with the corresponding features of the Upper Neogene deposits outcropping on the northern border of the Dacian Basin (Jipa, 2000). This similarity indicates that the Pontian to Pleistocene Dacian Basin evolved through three major sedimentary environments, both in proximal as well as in distal basinal areas.

The lacustrine phase of the Dacian Basin corresponds to the Pontian time (interval 2; Fig. 2). The well data indicate a dominant clayey sediment accumulation in the central, internal part of the Dacian Basin. In the northern part of the basin, sandy, littoral sediment bodies intercalate within the clayey lacustrine sediment sequence. This materializes the restricted sediment supply coming from the Carpathian source areas.

The coarsening upward sediments (interval 1; Fig. 2) point out the very shallow water, littoral evolution of the Dacian Basin during the Lower Dacian. More detailed observations, carried out in the cropping out area of these sediments on the northern basinal border, show that both deltaic and shoreline environments existed during the littoral phase of the Dacian Basin evolution. As indicated by the observed sedimentary structures, the deltaic sediment accumulation making up the dominant littoral feature, is marked by the fluvial genetic influence, prevalent over the lacustrine dynamic factors (waves and

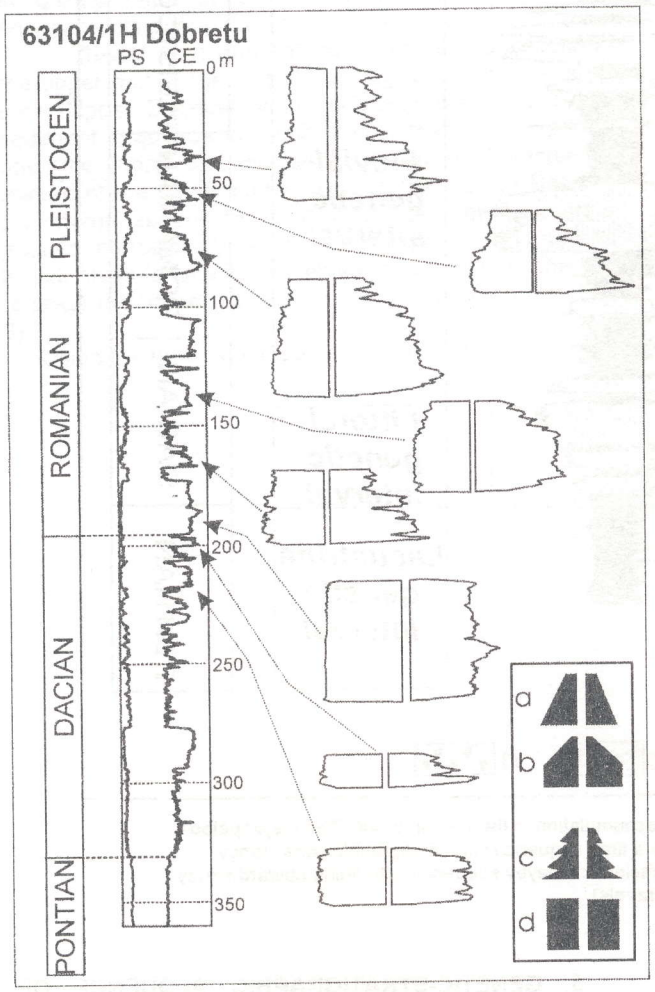

Fig. 6 Vertical grain size trends showed by the sandy interbeds of the fluvial sequence. Types of grain size trends: a - complete, continuous fining upward; b - continuous fining upward, with homogene-ous basal part; c - multiple fining upward; d - homogeneity (lack of vertical trend; blocky electric log model).

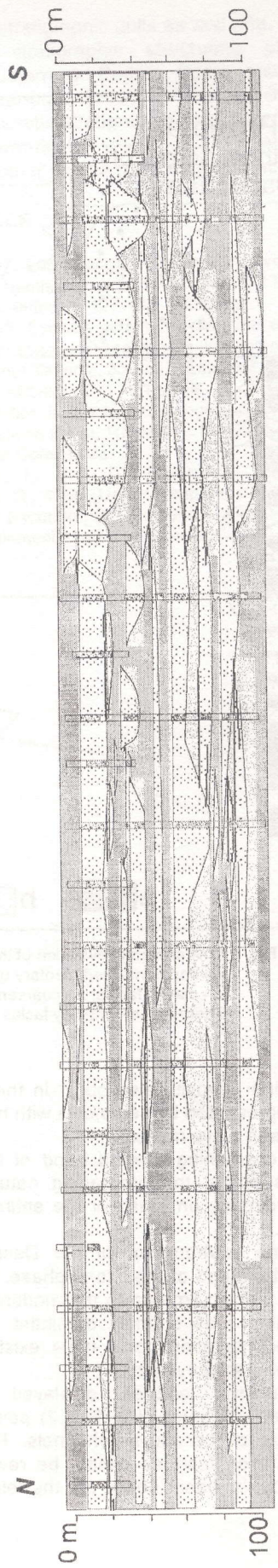

Fig. 7 Fluvial channel fills as resulted through close correlation of electric log sequences

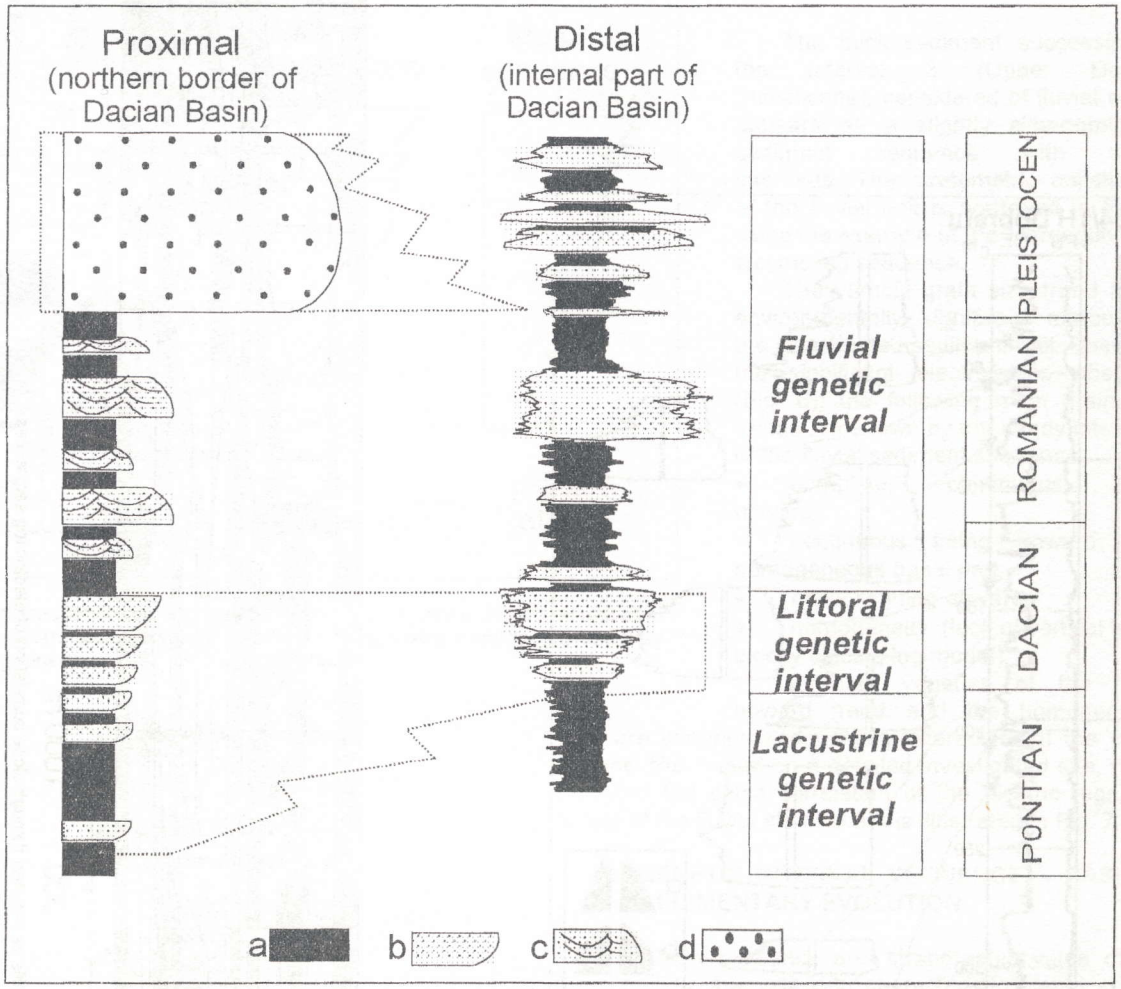

Fig. 8 Environmental evolution of the sediment accumulation in the Dacian Basin. The major paleo-environmental sedimentary units make up a time sequence with stratigraphic consistency.
a - clayey facies; b - coarsening upward facies; c - clayey sequence with fining upward sandy interbeds; d - gravelly facies (Candesti Gravels).

currents). Shoreline deposits also occur in the northern proximal zone, represented by sediments with hummocky cross lamination and wave ripples.

The overall coarsening upward trend of the littoral sediments points out to the prograding nature of the Lower Dacian sediment, on most (or the entire) area of the Dacian Basin.

The lacustrine environment of the Dacian Basin ceases to exist at the end of the littoral phase. Since the upper part of the Dacian time up to the modern time the fluvial sedimentation was strongly dominant. The only lacustrine-like sedimentation could have existed within the alluvial environmental system.

The sedimentary features displayed by the investigated fluvial unit (interval 3; Fig. 2) point out the meandering nature of the alluvial channels. The out of channel sedimentation features cannot be revealed, as the present study is based only on the electric log analysis.

5. GENETIC-STRATIGRAPHIC SEQUENCE OF THE DACIAN BASIN

The sedimentological investigation carried out in the northern border area of the Dacian Basin (Jipa, 2000) pointed out to a major genetic sequence with stratigraphic significance. The study of the subsurface data yielded by wells located along the Olt Valley produced data, which are in agreement with the northern area conclusions. The funnel electric log model (corresponding to the interval 1 on Olt Valley wells) is also visible in wells located in the northern part of the Dacian Basin (the Focşani Depression). These facts, coming from different areas, strongly suggest that the genetic-stratigraphic sequence could be generalized for the entire Upper Neogene Dacian Basin.

According to this genetic-stratigraphic image, the Dacian Basin evolved through the three described major sedimentary paleo-environments (Fig. 8):

- **typical lacustrine environment**, with fine grained, clayey sedimentation and – possibly – deeper water, corresponding to the Pontian time interval, is clearly shaping up in the central part of the basin, while sandy littoral bodies invade the clayey sequence, proximal to the Carpathian source-area;

- **littoral-lacustrine environment**, characterised by a coarsening upward sediment sequence, accumulated in deltaic (Jipa *et al.*, 1996) and shoreline paleo-environments during the Lower Dacian;

- **fluvial environment** came into existence during the upper part of the Dacian, lasting for a long period of time (Upper Dacian-Romanian-Quaternary). The fluvial sediment sequence is much thicker than the lacustrine one (the littoral part included). The most characteristic feature of the fluvial environment in the Dacian Basin is the internal sedimentological organization of the coarser grained intercalations (fining upward grain size trend and trough cross lamination observed in outcrops, or the bell (blocky) log model obvious in the subsurface data (Fig. 6).

Using the three major paleo-environmental sediment intervals as stratigraphic units as well (Fig. 8), a more meaningful stratigraphic structuring of the Upper Neogene-Quaternary Dacian Basin results. This is providing clear-cut criteria to differentiate the stratigraphic units. The genetic-stratigraphic scheme could also serve as a framework to smaller-scale stratigraphic units, outlined on other criteria (bio-facial, lito-facial and others).

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