DELTA FRONT SEDIMENTATION IN THE UPPER NEOGENE LACUSTRINE DEPOSITS OF TIGVENI (DACIC BASIN. ROMANIA)

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Abstract: The delta-front facies of the Upper Neogene deltaic sequences consist mainly of fine grained, homogeneous sand accumulated by sediment gravity flow. Fine grained sand with internal lamination, generated by currents and waves, is interbedded with homogeneous sands. Sedimentary features indicate that the investigated Upper Neogene lacustrine deltas have been generated under the dominant influence of the external, fluvial factor. Distinctive features and significance differentiate the delta front from the mouth bar microenvironments.

Key words: delta front, sand bodies, homogenous sand, quartzitic pebbles, trace fossils, mass transport, gravity flow.

1. Introduction

The sedimentological data presented in this paper come from a zone located south of Southern Carpatian Mountains (Arges County, Romania) (Fig.1).

The investigated Upper Neogene deposits belong to the Paratethys paleogeographic unit known as the Dacic Basin. These deposits consist of sand bodies (partly gravely) intercalated into a dominant clayey accumulation.

According to Marinescu and Papaianopol (1992) the deposits under discussion are of Pontian to Dacian age. Their lacustrine character is indicated by the faunal content.

Tectonical deformations affecting the investigated Upper Neogene deposits are very weak. This is one of the factors which made possible the individual survey on aerial photographs of the sand bodies and their geological mapping.

Considering their genetic evolution, the Upper Neogene deposits of Tigveni zone make up a symmetrical sequence. It consists of fluvial and littoral deposits at the base and the upper part, with offshore deposits mainly in the middle part (Jipa 1993,1994).

2. The Upper Neogene deltaic environment

The upper and lower littoral units of the Upper Neogene sequence in Tigveni zone include deposits of deltaic, shore and offshore environments.

Deltaic deposits occur as sand bodies with the

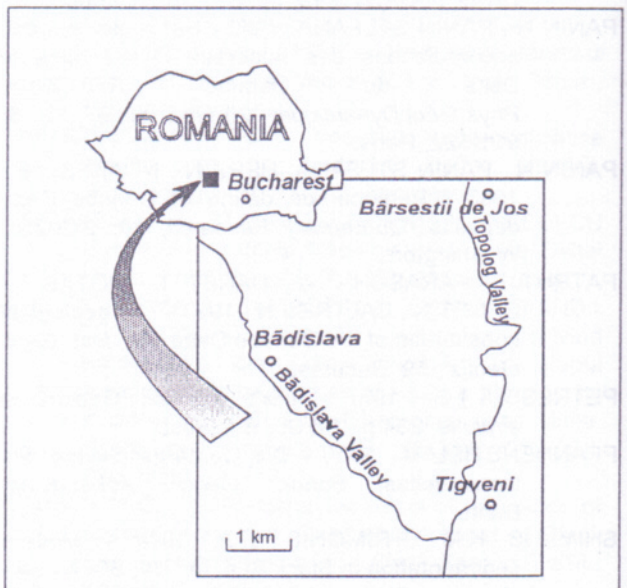


Fig. 1. Location of Tigveni study area

following main features (Fig.2):

- 5 to 20 m thick bodies with important lateral extension (at least 1 to 2 Km), sometime showing obvious lateral terminations;
- coarsening upward vertical sequence pointed out by the vertical grain size trend and the thickness variation of the trough cross lamination structures;

- sequence of several facies units interpreted as (a) deltaic plain, (b) mouth bar zone and (c) delta-front microenvironments. The coarsening upward deltaic sequences is complicated by the occasional presence of coarse grained sediments accumulated at the base of the delta-front slope (Fig.2)..

3. Description of the delta-front environment in the Upper Neogene deposits of Tigveni zone

Grain size features

The delta-front microenvironment in the Tigveni zone is represented by sediments consisting of (Fig.3):

- 60 to 90% fine and very fine grained sand fraction;
- 2 to 20% silt fraction;
- 1.5 to 10% clay fraction;
- 3 to 28% coarse and very coarse grained sand fraction.

Median diameter (Md) of the delta-front sediments varies around the 3 phi value (2.8 to 3.2 phi; fine to very fine sand).

The vertical grain size trend of the delta-front sediments is dominantly constant, imposed mainly by the equable ratio between the fine grained sand to very fine grained sand fractions.

Lithological features and sedimentary structures

The distinct character of the investigated delta-front deposits reside in the homogenous aspect of the most sandy deposits, frequently with scattered small quartzitic pebbles (2 to 9 mm in diameter). These homogenous sediments display no internal sedimentary structure (plate I a).

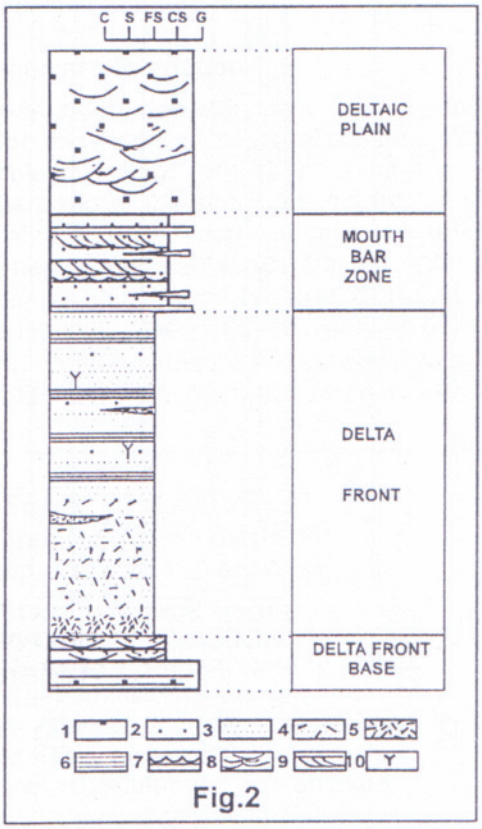


Fig.2

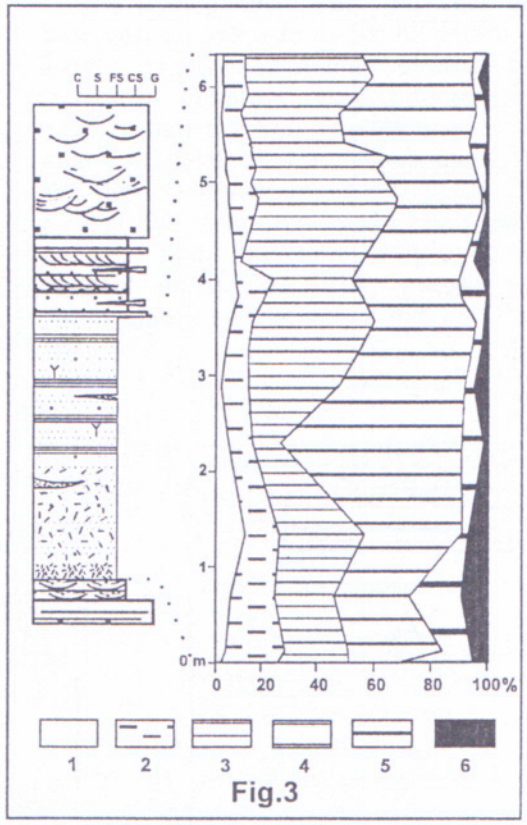


Fig.3

Fig. 2. Local facies model of the Upper Neogene lacustrine deltaic sequences in the Tigveni zone. Not to scale. Legend: 1.gravel and gravely sand; 2.medium grained sand; 3.homogeneous fine and very fine grained sand with scattered small pebbles; 4.homogeneous fine and very fine grained sand with frequent large mica grains; 5.high concentration of large mica grains; 6.fine and very fine grained sand with internal lamination (mainly wave ripple lamination); 7.wave ripples; 8.large scale through cross lamination; 9.medium scale cross lamination; 10.trace fossils; grain size scale= C.clay; S.silt; F.S.fine and very fine grained sand; CS. coarse and very coarse grained sand; G.gravel.

Fig. 3. Grain size fractions of the Upper Neogene delta-front sequence in Tigveni zone - north of Balilesti Village. Legend: 1.clay fraction; 2.silt fraction; 3.very fine sand fraction; 4.fine sand fraction; 5.medium and coarse sand fraction; 6.very coarse sand and very fine gravel fraction. For other signs see legend at figure 2.

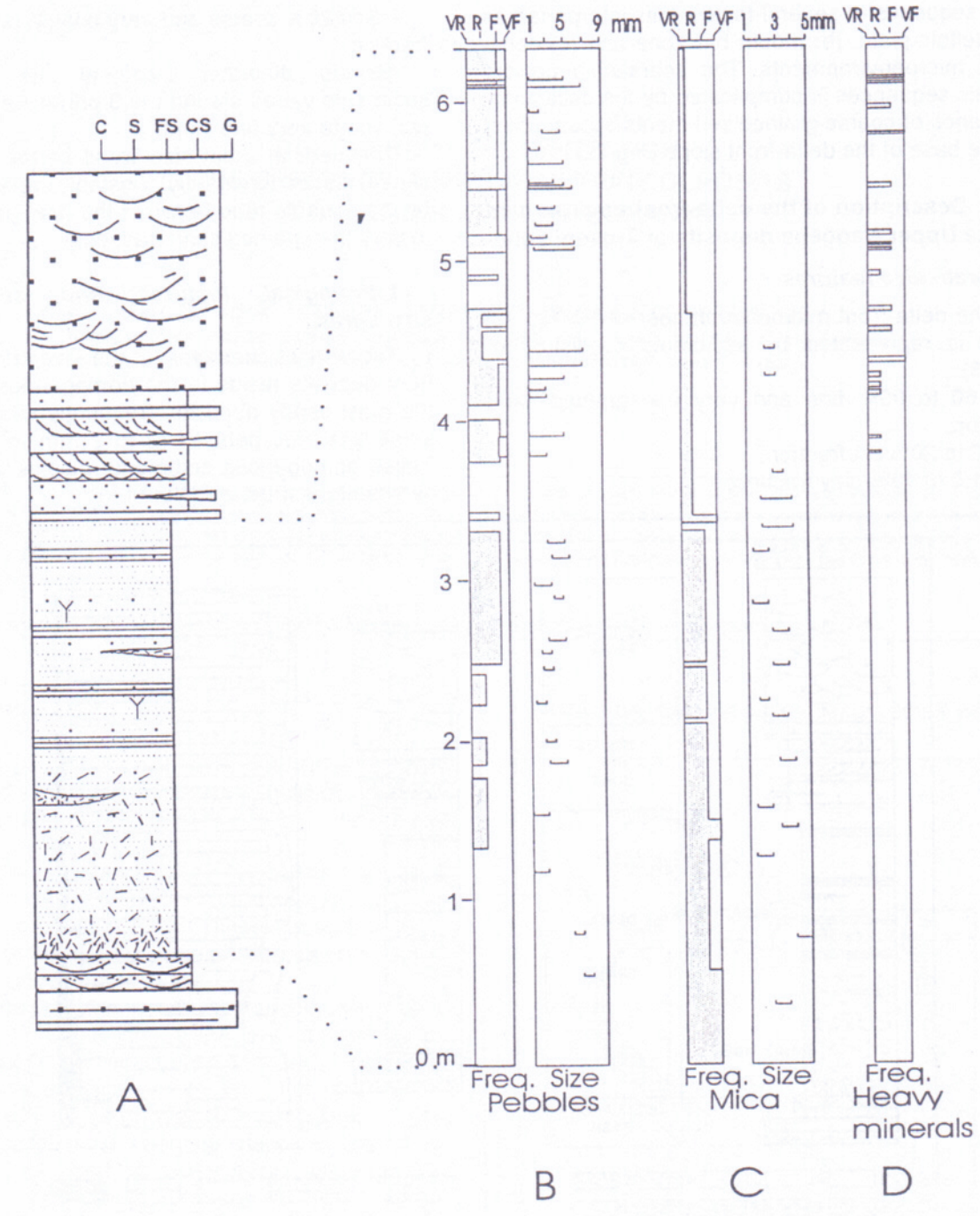


Fig. 4. Syntethic graph of the lithologic and mineralogic variations in the Upper Neogene delta front sediments of Tigveni zone. Based on the sequence outcropping north of Balilesti Village. Legend: A. local deltaic sediments facies model (see legend at fig.2); B. frequency and size variations of large mica grains; D. frequency variation of heavy minerals; VR. very rare; R. rare; F. frequent; VF. very frequent - visual frequency estimation.

The frequency of the small pebbles within fine to very fine grained homogenous sand deposits is highest toward the upper part of the delta-front unit. The small pebbles become rare and smaller disappearing in the middle or lower part of the delta front unit (Fig.4).

Although the homogenous sandy sediments represent a characteristic feature, the delta-front sequence is clearly bedded. This is mostly due to the presence of intercalated deposits with internal lamination. The thin intervals consist of fine to very fine grained sand with parallel lamination, small scale cross lamination and mostly small scale wave generated concave-upwards lamination (plate I b). Some of the laminated sediments are better sorted than the homogenous sand.

Another type of intercalated sediment consists of scarce and very thin clay beds, contrasting with the dominant coarser grained character of the delta-front sequence.

Trace fossils are present within the delta-front sediments. They occur mostly as long (more that 10 cm) vertical burrows, several milimeters wide, affecting mostly the homogenous deposits. Less frequent are the intervals with oblique or horizontal, shorter and thinner burrows.

Mineralogical segregation

The delta front deposits show an evident tendency for mineralogical segregation along the vertical lithologic column (Fig.4). In some cases, following the trend of the small pebbles frequency variation, at the upper part of the delta-front sequence heavy mineral concentrations occur. They appear as thin layers (several centimeters thick) or as laminae. Observing the two main delta-front facies, the heavy minerals accumulations are either homogenous with dispersed small pebbles, or displaying internal lamination (parallel or concave-upwards laminae) (plate I). Few Upper Neogene deltaic bodies show significant heavy minerals accumulations.

The concentration of large mica particles (2-6 mm in diameter) is frequent in the lower part of the delta-front sequence. The highly micaceous basal delta-front sediments are homogenous with rare, isolated small quartzitic pebbles. Mica grains are also commonly concentrated within through cross laminated structures, at different levels of the delta-front sequence.

4. Interpretation of data

Types of genetic facies

According to their internal structure the delta front sediments belong to two genetic categories (Fig.5).

The homogenous, fine and very fine grained sand with (or without) dispersed small pebbles and without internal sedimentary structures represents the most important genetic facies. Its features indicate that the sedimentary load of this facies was accumulated by mass transport. This facies includes the homogenous sediments at the upper part of the delta-front units (with isolated small pebbles and sometime with heavy minerals concentrations), as well as the micaceous homogenous sediments at the lower part of the units.

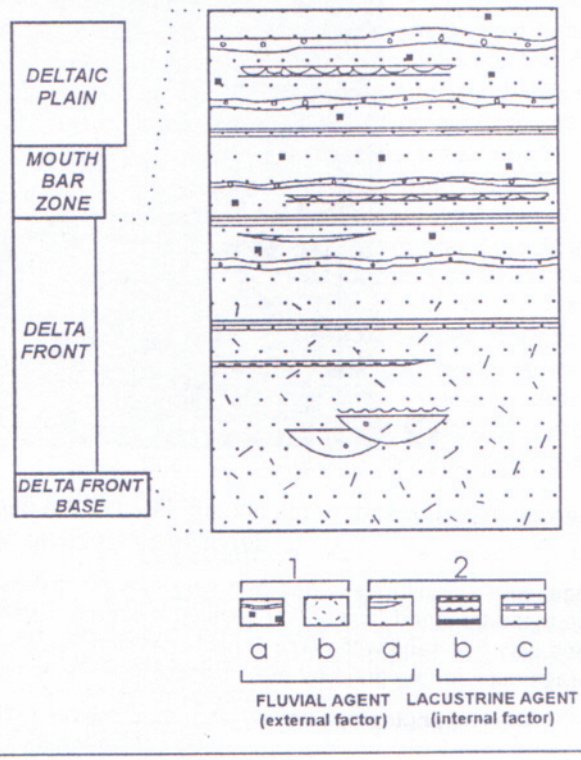


Fig. 5. Facies model of Upper Neogene delta-front sequences in Tigveni area. (Not to scale)

Legend:

1- mass-transport genetic facies:

1a- hommogeneous, fine and very fine grained sand with small pebbles and heavy minerals;

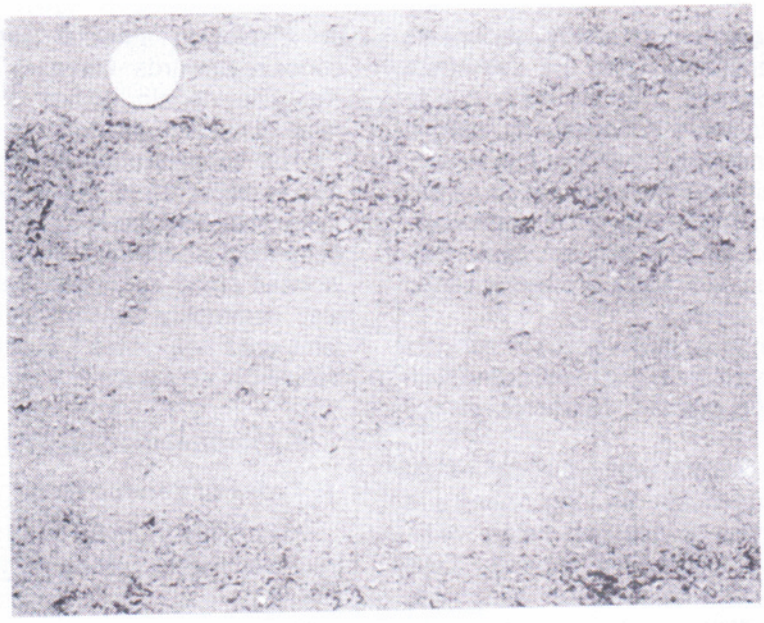
1b- homogeneous, fine and very fine grained sand with large mica grains and unfrequent small pebbles;

2- grain-by-grain transport genetic facies;

2a- trough cross lamination units (current action);

2b- concave upward, wave ripple lamination and parallel lamination (wave action);

2c- thin clay layers (pelagic type sedimentation)



a

b

Main genetic types of sediments accumulated in the delta front environment of the Upper Neogene deltaic deposits outcropping in the Tigveni zone

a. Homogeneous, structureless fine and very fine grained sands with scattered small quartzitic pebbles. This is the genetic mass-transport facies, representing a fluvially dominated delta front environment.
b. Fine and very fine sand with wave ripple lamination (concave upward structures) and parallel lamination. This aspect is characteristic for the grain-by-grain transport, wave dominated facies of the delta front environment.

The two photographs show internal structures outlined by the concentration of heavy minerals.
Bădislava Valley, Băilesti Village

The second genetic facies is represented by a smaller fraction of the delta-front sediments, characterised by laminar internal sedimentary structure. These are sediments transported particle by particle, due mostly to the wave action.

Accumulation processes in delta-front environments

The fact that most of the investigated deposits belong to the mass transport genetic facies imply that sediment gravity flow is the main mechanism of deposition acting in the delta-front environment. This phenomenon was probably caused by the high amount of fine grained sediment supplied at the top of the delta-front slope. Previously the sediment was "filtered" through the accumulation of coarser particles (sand and gravel) in the mouth bar zone at the embouchure the deltaic fluvial distributaries.

The effect of the sediment gravity flow mechanism is visible in the numerous homogeneous sandy episodes occurring in the investigated Upper Neogene delta-front sequence. Consequently, it appears that the gravity flow mechanism was not continuous, but multiple sediment gravity flow events occurred.

Thin sandy units with visible internal structure display three main categories of sedimentary structures:

(a) trough cross lamination, occurring mostly as small (centimetric) lens - like units or, less frequently, as larger (20 to 50 cm thick) channels; these structures are the result of normal bottom currents action;

(b) concave-upwards lamination structure (plate I b), attributed to the wave action belong to the main category; the wave origin being most obvious when the characteristic symmetrically undulated upper surface is preserved;

(c) parallel lamination, probably generated by both, current and wave action.

Few thin clay intercalations have been observed in the studied delta-front units. They might represent pelagic-type or flocculation sedimentation episodes.

The homogeneous sandy units as well as the trough cross lamination units (with north to south paleocurrent directions) imply the transportation of sediments down the delta-front slope. They are under the indirect influence of the external, alluvial agent, as this is responsible for supplying the sediments.

The activity of the internal, lacustrine factor is expressed by the wave accumulated sediments, mostly with concave-upwards laminae and -partly - with parallel lamination.

Factors governing the delta-front sediment accumulation

Comparing the weight of the two major factors in building up the delta-front sediment accumulation, it results that in Upper Neogene Tigveni zone we are dealing with fluvially influenced deltas. The sediment gravity flow and the normal, bottom current flow are the mechanisms indirectly triggered by this external factor.

The action of the internal, lacustrine factor was definitely of subordinate importance. The wave laminated sediments, accumulating under the influence of the internal factor, were probably reworking homogeneous fluvially derived sediments. These episodes record periods of low sediment influx, which allowed the wave action to become prevalent in the delta-front microenvironment.

Position of delta-front unit within the deltaic sequence

The sedimentary sequence representing the object of this paper is singled out by the dominant gravitational flow character of the sediments. Consequently, this sequence interpreted as the delta-front microenvironment, essentially represents the deltaic slope. The field observation data collected in Tigveni area made possible to differentiate between the delta-front and the mouth bar zone units of the Upper Neogene lacustrine deltas investigated in Tigveni area. While the delta-front represents the deltaic slope, the mouth bar zone appears as the lacustrine environment where the first penetration of the alluvial sediments is taking place. Consequently the mouth bar zone is characterised by the selective accumulation of the medium sand grained particles under current action. In contrast the delta-front mainly represents the fine sediment gravitational flow domain.

The mineralogical and grain size segregation observed in the vertical column of the delta-front sequence appears to be due to the sediment flow down the deltaic slope. Heavier particles (small pebbles and heavy minerals) settles down earlier, accumulating on the upper segment of the deltaic slope. Mica particles, more flotable, are setting down later, accumulating on the lower part of the deltaic slope.

5. Conclusions

The homogeneous, fine and very fine sand with scattered small quartzitic pebbles, accumulated through sediment gravitational flow represents the major, diagnostic and genetic facies of the Upper Neogene sequences in Tigveni zone, Romania.

Fine and very fine grained sand with internal sedimentary structures (parallel lamination, trough cross lamination and wave lamination) make up the second, minor, genetic facies.

The upper part of the delta-front sequence includes frequent scattered small pebbles and occasional heavy minerals concentrations. In the lower part of this sequence large mica grains tends to concentrate, while the small pebbles are rare or absent.

The dominant delta-front sedimentary process reflects the indirect prevalent influence of the fluvial, external factor. The action of the internal, lacustrine factor was only recorded during low sediment influx periods.

Delta-front and mouth bar zone have been separated in the sedimentary sequence of the investigated lacustrine deltas. They are differentiated by distinct sedimentary features and sedimentation function.

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