HEAVY MINERALS DISCHARGED IN THE BLACK SEA BASIN BY THE DANUBE BRANCHES

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Abstract. The terrigenous minerals discharged in the Black Sea basin by the Danube were investigated into the sediment of Tulcea, Sulina and Sf.Gheorghe branches. The discriminative studies of the fine sands in the superficial bottom sediments and in the saltation bed-load indicate that the velocity of the sediment movement is different on the branches. The transportation and sedimentation of the terrigenous material respect the general rule of sedimentology in branches, and meanders. However, the cut-off channels changed the natural sedimentation. The hydrotechnical work generating sediment unbalance on the Danube and Danube Delta determined an erosion of the river bed.

Key words: Danube Delta sediments, mineralogy, heavy minerals, terrigenous minerals

INTRODUCTION

The materials used in this paper were collected and studied for the mineralogy section of the GeoEcoMar part in the 1996-2000 EROS projects (European River and Ocean System) (Fulga and Fulga, 1998; Fulga, 1996).

MATERIALS AND METHODS

The qualitative and quantitative mineralogical studies of the fine arenites (grain-size 0.250-0.063 mm) with a significant interest in the heavy minerals were done on average samples collected in 58 stations from the sampling interval ≈0-20 cm, in the bottom sediments, and with a sediments trap, the saltation bed-load of Danube Delta.

The samples were sieved in the laboratory and arenitic granoclastes - fine sand (0.250-0.125 mm grain size) and very fine sand (0.125-0.063 mm grain size) were used to separate the heavy minerals and for mineralogical analyses (Partenoff and Pomerol, 1970).

The size fraction was used to analyse representative heavy mineral associations. Determinations of the heavy mineral varieties were also made from this size fraction in order to minimise compositional variations resulting from grain size effects.

The separated fine and very fine sand fractions were treated with 10% HCl. The contents of carbonate and siliciclastes+oxides from arenites were calculated.

Further separation into heavy and light fractions was made by exposure to bromoform (sp.w. 2.9 g/cm^3). The heavy mineral separates were placed on glass slides that were used for petrographic and point-count analyses, especially for subordinate heavy minerals. For microscopic preparations, an "immersionsoel Leitz" [n] =1,518 or glycerine [n] =1.48 was used for the grains to be miscible under the upper slide, allowing for change of investigation angle.

Heavy fractions were qualitatively and quantitatively studied on more than 1,000 grains (sometimes 1,500-1,800 grains) especially for morphometric study (more than 400 garnet or opacites grains). The samples with a higher quantity of heavy fractions were separated with electromagnetic Frantz isodynamic separator (Partenoff and Pomerol, 1970).

Individual heavy mineral grains are expressed as a percentage of the total heavy mineral fraction.

The main components of the sandy fractions are *lithoclastes* (rock fragments), represented by petrographic terms characteristic of the different sources of terrigenous detritus material; *organoclastes* (shell fragments) and, importantly, *terrigenous minerals*, in general *siliciclastes*, composed from a *light fraction* and a *heavy fraction*.

All the details about heavy minerals, their contents, and their granoclastic morphology are represented in column chart type. The contents of the samples in sandy fraction were represented as area chart type, carbonate in fine sand and heavy fraction in fine sand, as line graphs.

RESULTS AND DISCUSSIONS

The terrigenous sediments discharged in the Black Sea basin by the Danube were studied in the sediment of Tulcea, Sulina and Sf.Gheorghe branches (see Figs. 1-4). Heavy minerals concentrate in fine and very fine sand (0.250-0.125mm. and 0.125-0.063mm.).

Their quantitative content is very small, but the heavy fraction characteristics are the most important pointer on sources areas of the terrigenous material, and an indicator of sediment maturity.

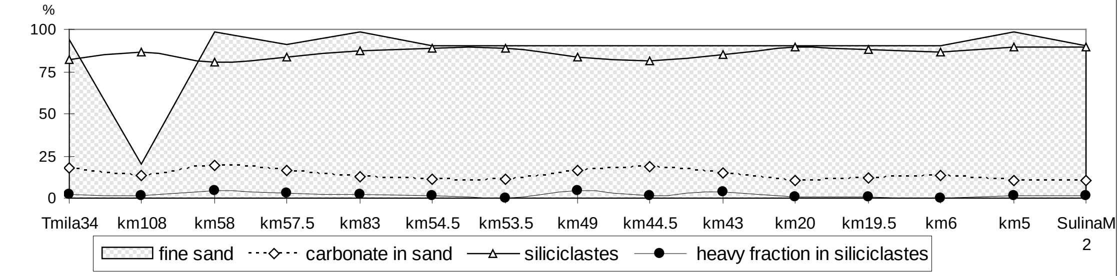


Fig.1a.Danube Delta. Fine and very fine sand, carbonate and heavy fraction in the bottom sediments (boden)

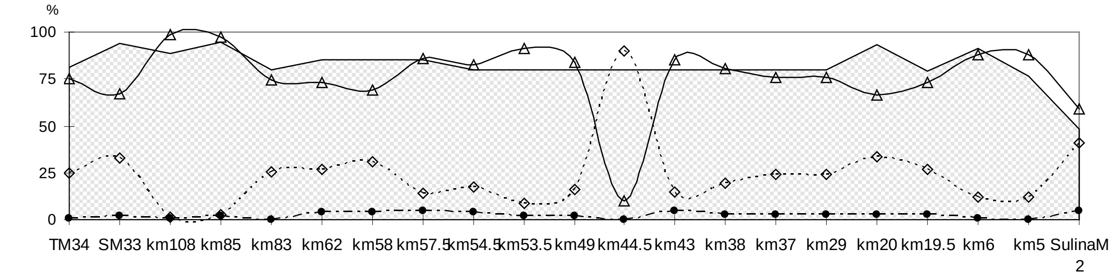


Fig.1b. Danube Delta. Fine and very fine sand, carbonate and heavy fraction in the bed-load sediments (trap)

The discriminative investigation of the fine and very fine sand in the superficial bottom sediments and in the saltation bed-load shows that:

- *In the saltation bed-load as compared to the superficial bottom sediments:*
  -there is higher quantity of fine and very fine sand which carry away heavy minerals
  -the carbonate fraction in the fine and very fine sand is higher too
  -the heavy fraction is lower
  -the siliciclastic fraction and quartz content is lower too
  -heavy minerals less resistant to transport and environmental change, and with a higher lift linked with their habitus and density -amphiboles, pyroxenes, steatite - are more important.
  The above are determined by a selective segregation, in concordance with the density and lower portance in the saltation bed-load fine sand.
- *In the superficial bottom sediments*
  All those characteristics are in reverse order. Heavy minerals highly resistant to transport and environmental change - garnet, ilmenite (in opacites), accumulate in the fine sand of the bottom sediments more than in the saltation bed-load.

Observations upon the zones where the branches are divided and upon the intersection meander-channel (see Figs. 1-4):

- ➢ The samples taken from the Sulina (M 33) and Sf.Gheorghe (Km 108) branches are more sorted out and rounded than a sample characterised by nonuniformity of heavy mineral composition and by roundness of garnet and opacites (with a similar habitus and grain size). The above are determined by a selective segregation in concordance with the density and low portance in the saltation bed-load fine sand. The velocity of the sediment movement seems to be higher on the Sf. Gheorghe branch. The studied granoclastes were noticeably affected by the wind.

- ➢ There is a similar situation in the intersection Km 85 - Km 83 (on the meander) and Mahmudia channel. Although heavy minerals in the principal branch (km 85) are rounded both in the bottom sediments and in the saltation bed-load. There are a turbulent jet with a higher velocity of the sediment movement on the channel and a lower one on the meander where a selective segregation appears too. The more rounded minerals as well as the ones with a little bit higher content in zircon, tourmaline and titanite are located on the meander

- ➢ In the South Dunavat channel a lower velocity of the sediment movement and a mineralogical segregation enriched in titanite and zircon occur; garnet and opacites are more rounded and clean. Yet an authigenic mineral appears - pyrite. It seems to be a colmatation (clogging) process. The amount of the heavy fraction is very low.

Fig.2a.Danube Delta. Main heavy minerals in the fine sand of the bottom sediments

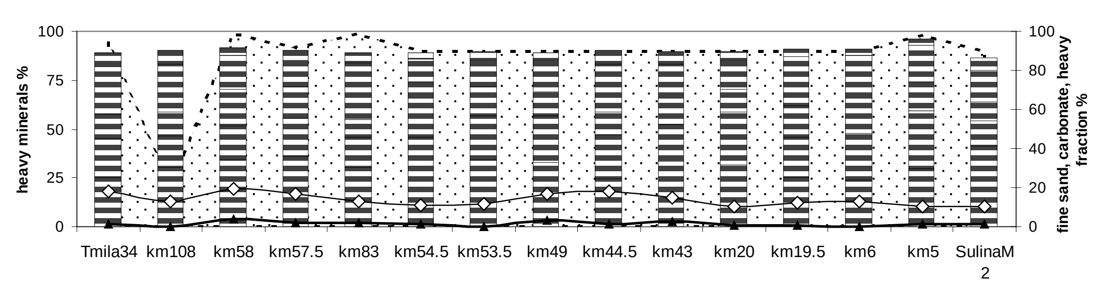


Fig.2b.Danube Delta. Main heavy minerals in the fine sand of the saltation bed-load

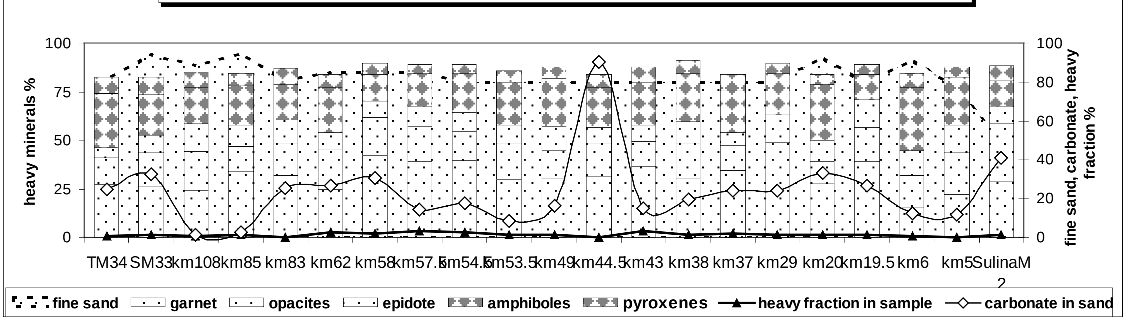


Fig.3a. Danube Delta. Subordinated heavy minerals in fine sand (% from heavy fraction) - the bottom sediments

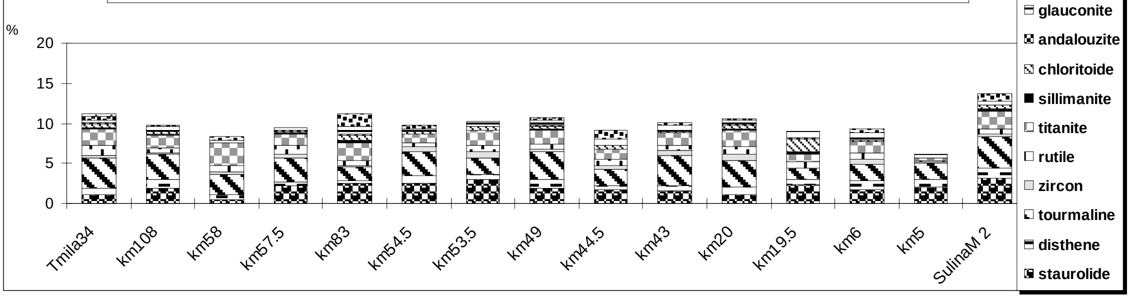
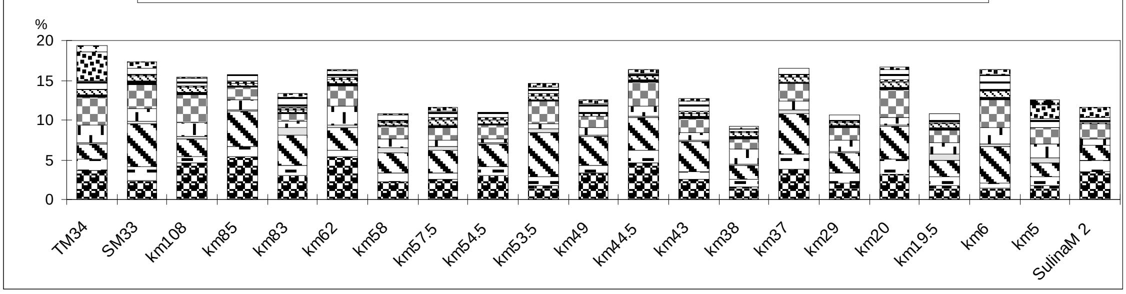


Fig.3b. Danube Delta. Subordinated heavy minerals in fine sand (% from heavy fraction) the bed-load



- In the intersection Km 53.5-54.5 (on the meander) and Lower Dunavat the velocity of the sediment movement is the same in the main branch and in the meander but it decreases in the channel, with cumulative processes in the quantity and quality of heavy minerals. It might be a colmatation (clogging) in this entire zone (including Km 49).
- In the intersection Km 44.5 with the Dranov channel, the heavy mineral association shows a possible fossil source (more rutile, titanite, monazite, olivine, lithium micas). The Dranov and Erencic channels seem to be colmatated. There is a big amount of clay fraction.

- In the intersection km.20 -19.5 (on the meander) and Ivancea channel the velocity of the sediment movement was higher on the channel and the heavy minerals in the meander had an additional fossil supply (roundness of the grains and there were more titanite, rutile in the saltation bed-load)
- At the mouth of the Sf.Gheorghe distributary, the velocity of the sediment movement is higher and the erosion of the bottom sediments is present. There are some old sediments at km.5 zone. At the mouth of Sulina branch the velocity of the sediment movement is lower.

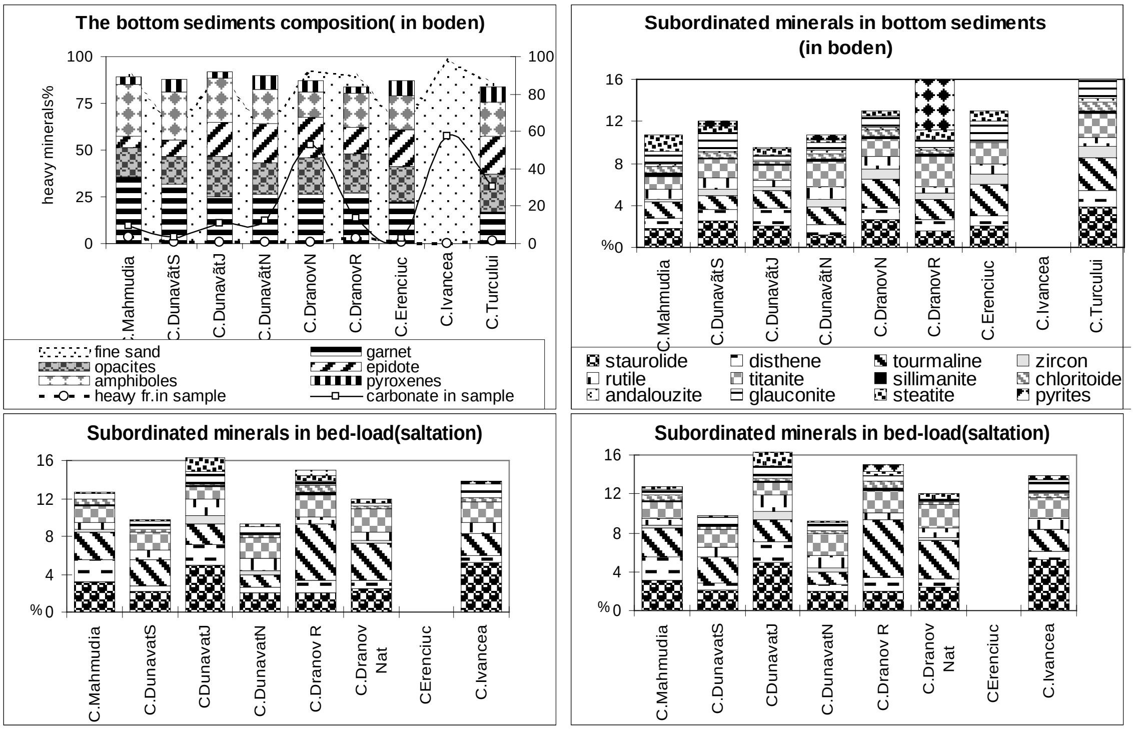


Fig. 4 Danube Delta (natural and cut-off channels - sediment composition

CONCLUSIONS

In the saltation bed-load: the quantity of fine sand which carries away heavy minerals is higher; the carbonate fraction in sand is higher; the heavy fraction is lower; the siliciclastic fraction and quartz content is lower; heavy minerals less resistant to transport and environmental change, and with a higher portance linked with their habitus and density - amphiboles, pyroxenes, steatite - are more important.

In the superficial bottom sediments, all those characteristics are in reverse order. Heavy minerals highly resistant to transport and environmental change - garnet, ilmenite, are accumulated here.

The above are determined by a selective segregation in concordance with the density and lower portance, in the saltation bed-load fine sand.

The fine sand of the saltation bed-load is very rounded and its provenience is considered to be from the "*littoral diffusion zone*".

The transportation and sedimentation of the terrigenous material respect the general rule of sedimentology in a river, branches, and meanders. However, all the cut-off channels changed the natural sedimentation. The hydrotechnical work generating sediment unbalance on the Danube and Danube Delta determine an erosion of the river bed. The natural meanders are the "shield" against the Danube Delta's erosion and destruction.

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