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MINERALOGICAL CHARACTERIZATION OF THE FINE FRACTION OF THE BEACH AND DUNE SEDIMENTS SITUATED BETWEEN ESPINHO AND TORREIRA (PORTUGAL). A GEOSTATISTICAL APPROACH

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Abstract. The analysis of the grain size fraction fine than 63µm of the beach and dune sediments between Espinho and Torreira shows that this component of the sedimentará spectrum decreases from the beach face towards the dune. The mineral composition consists mainly of K-feldspar, plagioclase and illite. Anhydrite, opal C/CT, kaolinite and dolomite are minor components. Quartz is directly correlated with dolomite and anhydrite; whereas halite is directly correlated with zeolites, kaolinite, illite and chlorite. These associations allowed the establishment of the mineralogical index (An+Do+Qz) / (H+Ze+K+I+CI) found to be interesting as a discriminating tool of depositional enviromnents.

Key words: beach, dune, sediment, finefraction, mineralogy, statistics.

Resumen. Del análisis de la fracción fina de los sedimentos de los dominios de playa y duna del sector comprendido entre Espinho y Torreira se desprende que esta fracción granulométrica disminuye cuando se pasa del dominio de linea de playa al dominio de dunas. Considerando la composición mineralógica de dicha fracción, se constata que los minerales más representativos, en el conjunto de los ambientes muestreados son: feldspato K, plagioclasa e ilita; y los menos representativos: anhidrita, ópalo C/T, caolinita y dolomita. Se verificó igualmente la tendencia a la asociación del cuarzo con la dolomita y anhidrita; y de halita con zeolitas, caolinita, ilita y clorita, hecho que hizo posible la definición de un índice, resultante de la razón An+Do+Qz/H+Ze+K+I+CI, índice que apresenta las características distintivas de los ambientes deposicionales.

Palabras clave: Playa, duna, sedimento, fracción fina, mineralogia, estadística.

1. Introduction

The Espinho-Torreira area is located westwards of the Hesperic Iberian massif in the seaward margin of the «Orla Ocidental Mesocenózoica», the Portuguese westem meso-caenozoic sedimentary basin (Figure l), in the northeminost part of the coastal zone that extends between Espinho and Mondego Cape.

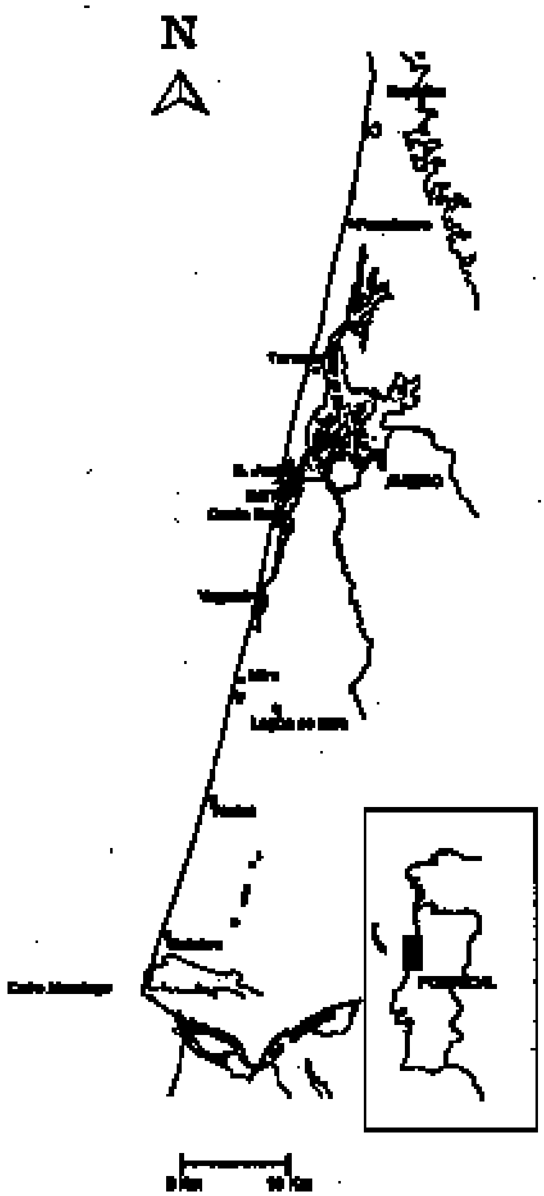

Figure 1. Location of the study area.

The most important geomorphological feature of this area is the Aveiro lagoon, a barrier-enclosed lagoonal body that evolved since AD 550 due to the definition and southwards extension of a complex sand barrier-spit, originally rooted in the Esmoriz area, that completed its growth by the middle 18th century (Vidinha, 1995). The study area includes the northem part of this sand spit which is topped by severas generations of dunes, most of them having accreted as foredunes associated with the welding of recurved sand-hooks.

Results presentes in this study add mineralogical information to the texturas data previously presentes on the littoral area between Espinho and Cape Mondego by Vidinha (1995). This author studied beach and dune sediments including the grain size fraction finer than 63 µm (herewith referred as the fine fraction), using statistical approaches, with the aim of discriminating the environments of deposition, a goal that the Folk & Ward's (1957) parameters failed to accomplish.

The mineral composition presentes and discussed in this study refers only to the fine fraction of the total sediment: silt (> 2µm and < 63µm) and clay (< 2 µm**).** The examination of the sandy fraction revealed a mineralogy almost exclusively composed by quartz, which didn't bring any additional or relevant information.

2. Materials an methods

A set of 50 samples derived from 10 beach profiles, regularly spaced of 2 Km, extending from the beach face to the foredune, were collected. In each profile, samples were taken from the superficial sediment layer, in the beach face —at the mid-tide line—, in the mid-width of the berm and in the windward face of the foredune.

The fine fraction, was separated, concentrated and prepared for mineralogical study according to the methodology describes by Rocha (1993). Mineralogical studies were based on X-ray diffraction (XRD) determinations. The semiquantitative determination of the clay and non-clay minerals followed the criteria recommended by Schultz (1964) and Thorez (1976). The mineralogical data were processed using Cluster Analysis and Multivariate Factorial Analysis.

3. Results and discussion

The relative amount of the fine fraction in the total sample decreases from the beach face to the dune (Figure 2). The beach face samples show proportions of the fine fraction of the 0.63-1.44%, while the berm contains 0.27-1.98% and the dune only 0.25-1. 10%.

Within this fraction, an assemblage of abundant minerals was found, including: quartz (Qz), K-feldspar-(Fk), plagioclase (Pg) and illite (I), as well as Halite (H). As accessory minerals we identified: anhydrite

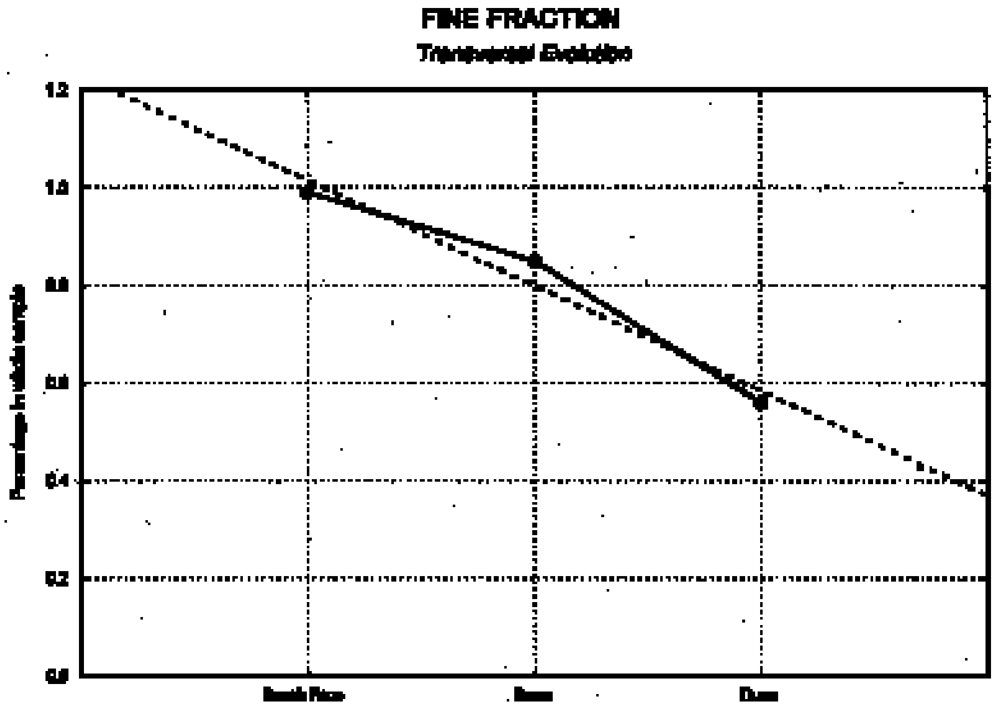

Figure 2. Evolution of the fine fraction, from the beachface to dune. Regression line in dashed.

(An), opal C/T (Op), kaolinite (K) and dolomite (Do). Chlorite (C1), zeolites (Ze), calcite (Ca) and siderite (S) occurred as trace species.

The cluster analysis of the mineralogical data suggests the following comments (Figure 4):

1. The data group in two distinct clusters: one cluster is defined by the association of the fine detrital minerals, such as kaolinite (K), chlorite (C1) and illite (1), with halite (H) and zeolites (Ze)- the second cluster is formed by the association of the coarser detrital minerals, quartz (Qz), plagioclase (Pg) and k-feldspar (K-F), with calcite (Ca), dolomite (Do), opal (Op) and anhydrite (An).
2. The samples group in the three clusters on the basis of the mineralogical parameters. One is essentially formed by samples of the dune sands and the other is fonned by samples from the berm, which show a good internal coherence.

The multivariate factorial analysis (R mode) of the mineralogical data obtained for the fine fraction suggests the following comments (Figure 5):

i. Factor 1 explain 22% of the total variance and shows quartz (Qz) and dolomite (Do) opposing of halite (Ha) and zeolites (Ze).
ii. Factor 2 shows kaolinite (K), illite (1) and chlorite (C1) opposing of calcite (Ca). This factor explains 17.5% of the total variance.
iii. Factor 3 that accounts for only 14% of the total variance, shows plagioclase (Pg) and k-feldspar (K-F) opposing of anhydrite (An) and opal (Op).

These results indicate that quartz preferably associates with anhydrite and that halyte associates preferably with zeolites, kaolinite, illite and chlorite. This conclusion supports the definition of a mineralogical ratio (An+Do+Qz) / (H+Z+Ke+I+Ca) which doesn't have a genetic connotation, but displays an evident ability to differentiate sedimentary enviromnents. This mineralogical ratio increases from the beach face to the dune profile, as shows in Figure 6. This pattem results of the dominance of the quartz and halite in each cluster. The application of the F-Test (Table 1) to these results, in order to test

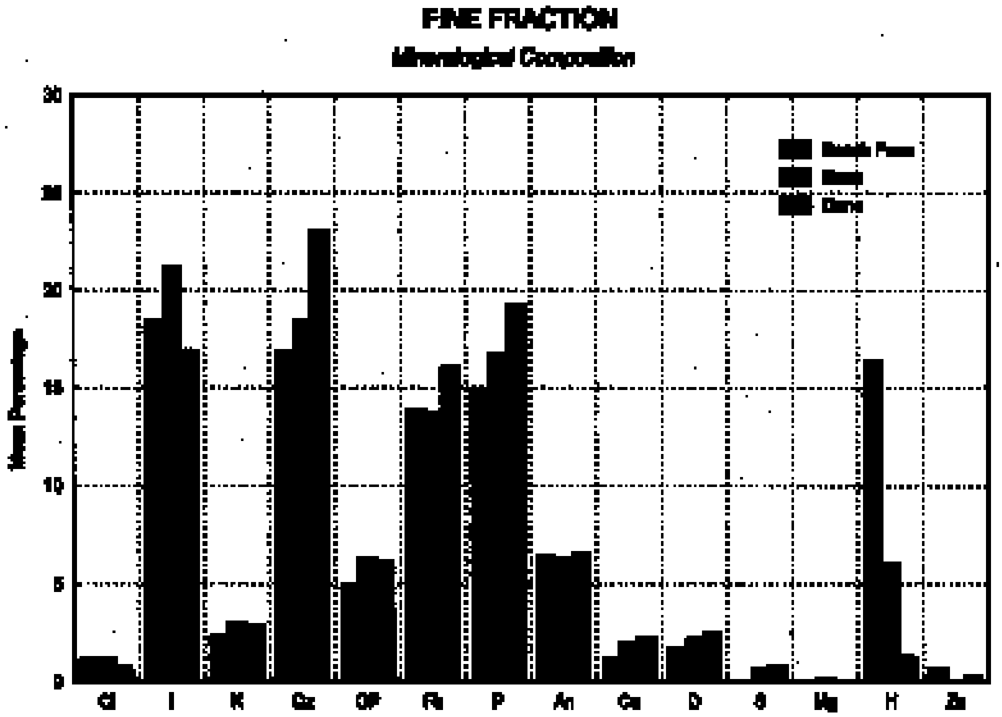

Figure 3. Mineralogical composition of the fine fraction of beach and dune sediments. The mean percentage was calculated take in consideration only the fine fraction. Quartz (Qz), K-feldspar-(Fk), plagioclase (Pg), and illite (I), anhydrite (An), opal CIT(Op), kaolinite (K) and dolomite (Do), chlorite (C1), zeolites (Ze), calcite (Ca) and siderite (S).

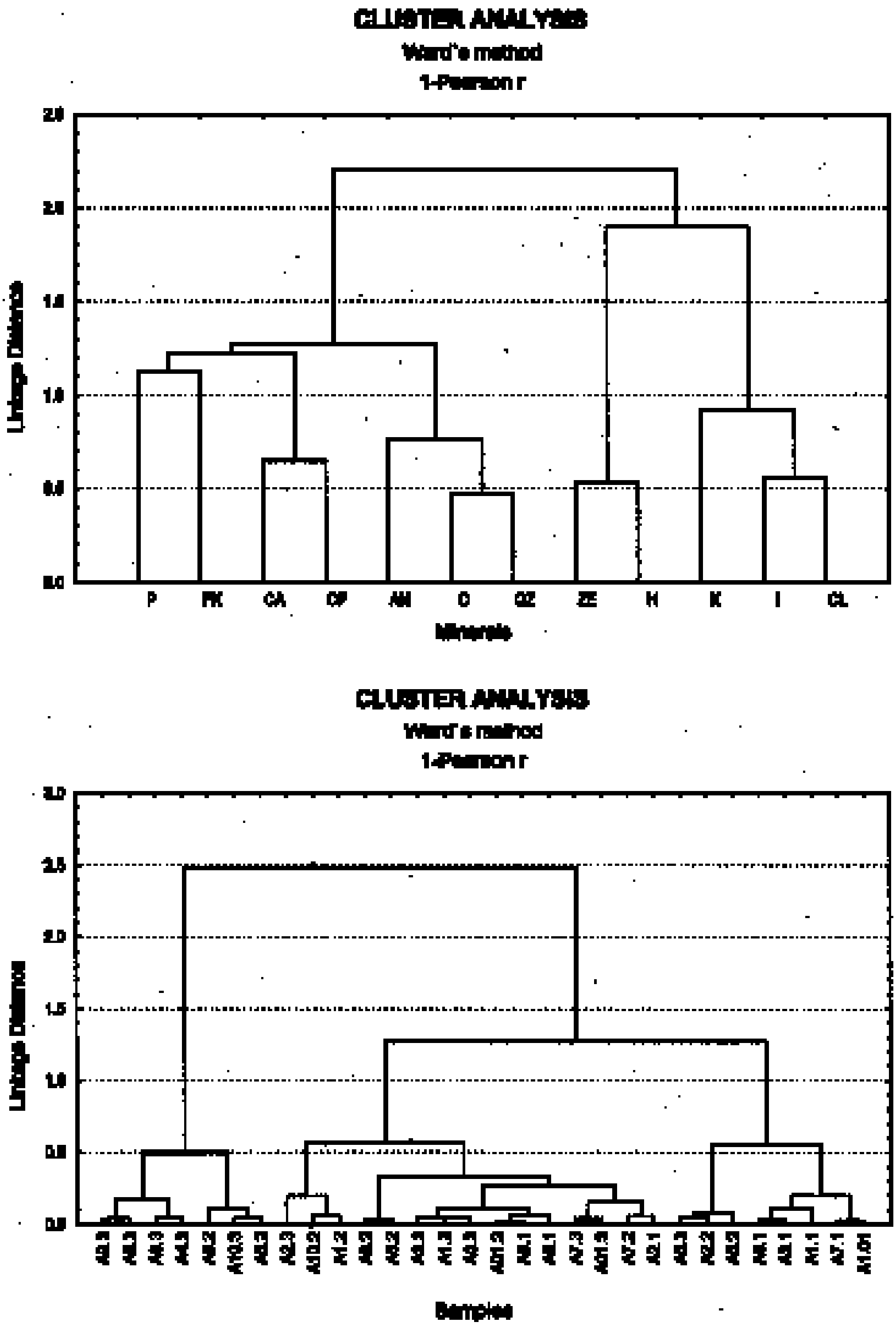

Figure 4. Cluster analysis of the mineralogical data.

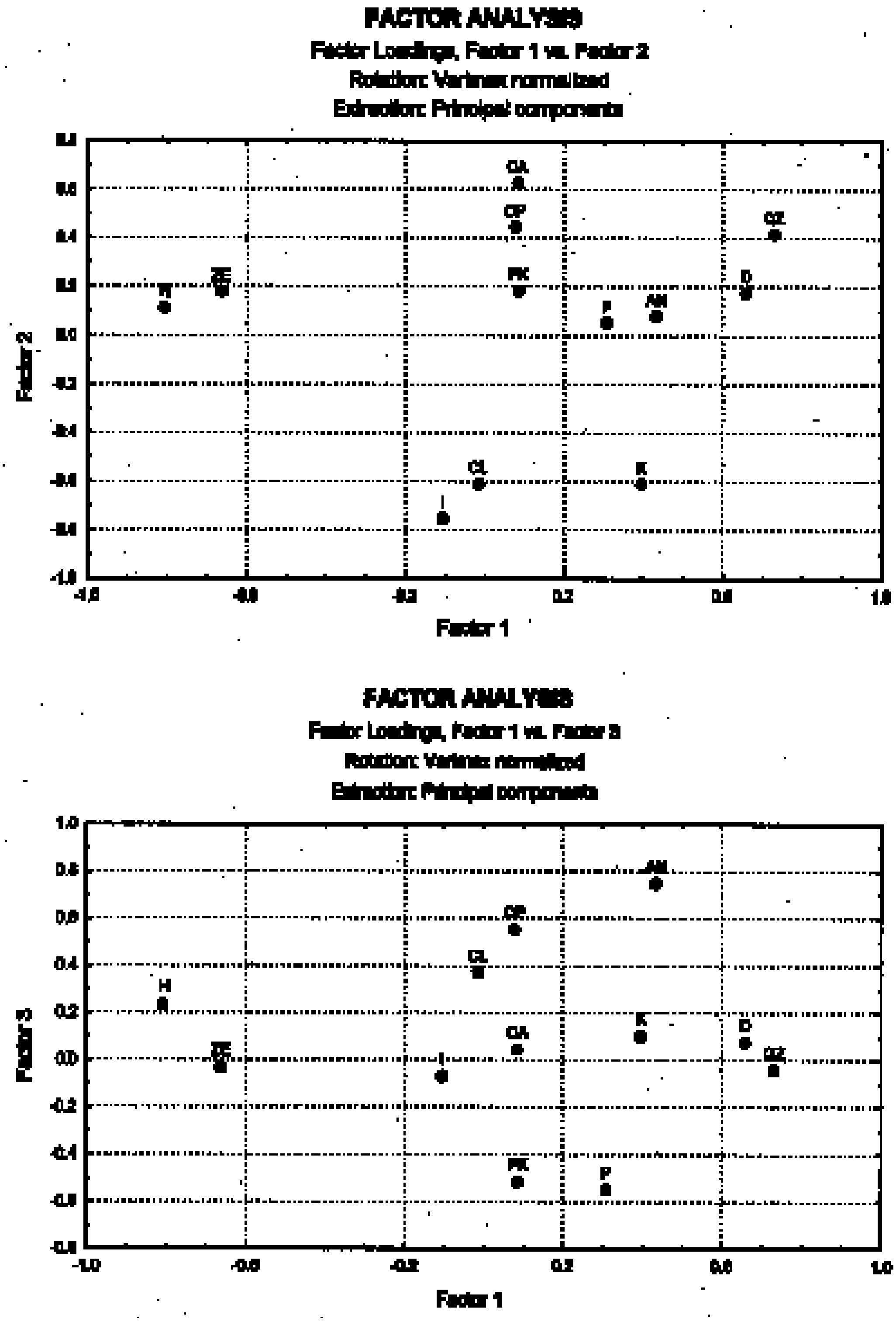

Figure 5. Multivariate factorial analysis (R mode) of the mineralogical data.

equality between variances of the samples, yields different variances between minerals association, when the results of the three domains are crossed. This indicates that this mineralogical index may be used to discriminase present-day depositional environments. The use of such an indicator may be of value in this area and similar ones where the textural parameters of Folk & Ward (1957) are unable to perform this task (cf. Vidinha, 1995).

The variation of the relative proportion of the fine fraction in sediments from distinct domains of the beach profile is not readily explained by textural constraints. We believe that the following several factors could account for this observation:

1. The beach and berm sands could retain some signature of fluvial input to the littoral area as suspended load, not completely washed out of the textural spectrum of the sands accreted to the beach area by swash and berm overwash episodes. The remobilization of this sand by wind would readily promote the ablation of the fine fraction, carried away further inland as wind-blown dust, and avoid its resedimentation in the aeolian structures together with the coarser sandy framework.

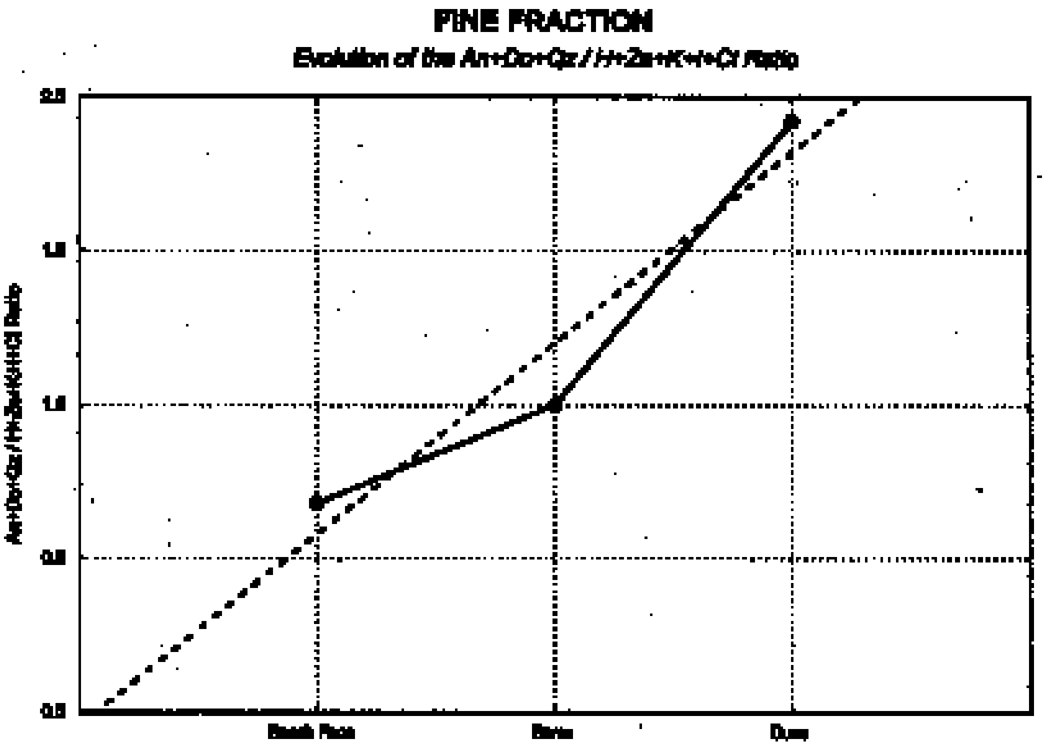

Figure 6. Transversal evolution of the (Qz+An+Do) / (H+Ze+K+I+Ca) ratio, from the beach face to berm. The regression line in dashed.

Table 1. F-test: two samples for variance. Significant level of 5%

	Dune *versus* **Berm**		**Dune** *versus* **B. Face**		**Berm** *versus* **B. Face**	
Mean	2.35	1.08	2.35	0.75	1.08	0.75
Variance	2.22	0.27	2.22	0.06	0.27	0.006
Observations	8	9	8	11	9	11
Gl	7	8	7	10	8	10
F	**8.28**		**35.58**		**4.3**	
Critical F uni tall	3.5		3.14		3.07	

2. The highest contents of fine fraction in the beach face and berm domains could result of the influence of the moisture because of the proximity of the sea and high water table. Thus, its later remobilization is difficult in the beach but not on the dune domain, where this influence is weaker.

4. Conclusions

From the results of the preliminary studies presented in this paper we can conclude:

1. The silt and clay proportion of the grain size spectrum of sediments deposited in the beach and frontal dune environments decrease from the beach face to dune domain. This fact most probably reflects the selective capacity of transport agents and the influence of the moisture;
2. The mineral composition of the fine fraction defines two major mineral groups: one composed by k-feldspar, plagioclase and illite as the most representative minerals, and a second one, less abundant, composed by anhydrite, opal C/T, kaolinite and dolomite.
3. Quartz associates preferably with dolomite and anhydrite, and zeolites associate with kaolinite, illite and chlorite.
4. A mineralogical ratio (An+Do+Qz) / (H+Z+Ke+I+Ca) may be derived which shows capacity to discriminase between beach and dune depositional environments.

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