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# GEOMORPHOLOGICAL EVOLUTION OF LITTORAL PLATFORM FROM OPORTO REGION (NORTH OF PORTUGAL)<sup>1</sup>

## ABSTRACT

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The most outstanding aspect of the area between the mouth of river Ave and Espinho, in the geomorphological point of view, is the opposition between the littoral platform, where there are many outcrops of cenozoic deposits, and the "marginal relief" (figure 1) which is bordering it from inland.

The main difficulty to establish the correlation of littoral platform deposits lies in the lack of chronological data from the sediments. This is particularly annoying in an area that is undergoing recent tectonic movements. To solve this difficulty, we made a sedimentological approach mainly based on grain size, morphoscopy, clay mineral and bed-rock weathering.

There are three main kinds of cenozoic sediments in this area.

### **1 - Fluvial deposits (higher than 40 meters)**

We find out that the older and higher deposits have a fluvial nature. The most recent, lower than 40 meters, have a marine origin. There is a step between the two kinds of sediments that must have a tectonic origin. It means that, during Quaternary the western part of littoral platform must have subsided along Oporto-Tomar fault, which allowed marine erosion and sedimentation to take place in the depressed block.

Besides its stratification, calibration and pebble shape, the mean roundness of sand grains and its surface analysis has been an important distinctive criterion between fluvial and marine deposits. At figure 2 we can see a sharp difference between mean roundness<sup>2</sup> of the higher, fluvial deposits and the lower marine ones.

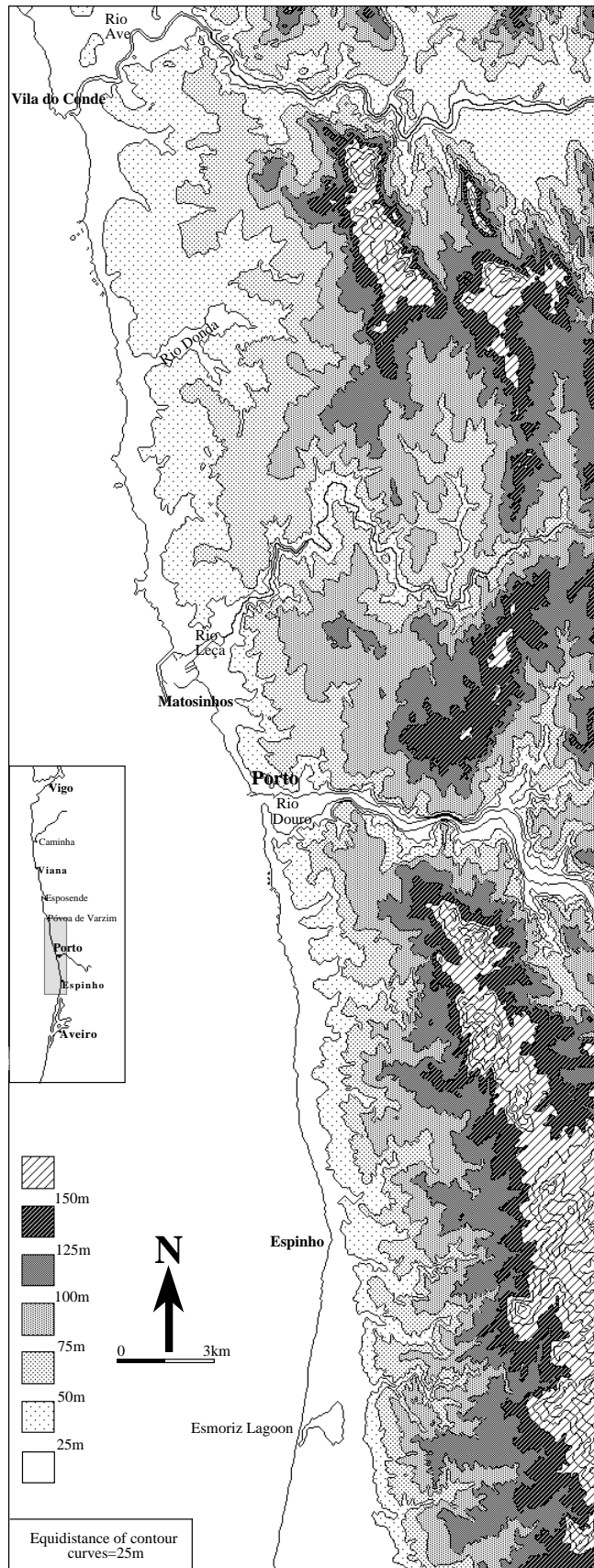
The older, fluvial deposits lay in a complex sequence, which is rather difficult to identify and correlate, because they appear in many small patches, and they are recent tectonics affected.

The older ones are fine, micaceous sands, with more than 90% of crystallised caulinite in the matrix. Probably, these deposits were created in a low energy plain (littoral?), certainly before the tectonic uplift of the marginal relief. Afterwards the conditions must

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<sup>1</sup> This work was presented as a PhD Thesis in Physical Geography at Oporto University (June 1991).

<sup>2</sup> Shepard and Powers, see G. S. Carvalho, 1966. Theoretically the value of mean roundness can vary between 0,1 (very angular) and 0,85 (very well rounded).



**Figure 1: Hypsometric map of studied area**

(based on contours of Portuguese chorographic chart;  
original scale = 1:50.000)

have radically changed, because there are very coarse deposits too, probably to be correlated with the *rañas*<sup>3</sup>.

## **2 - Marine deposits (below 40 meters)**

We have recognised three marine levels, lying beneath 40 meters. The distinction between them lies in their sedimentological nature, mainly in colour, bed rock weathering, clay mineral analysis and degree of consolidation. Within a certain area these three levels are staggered. Nevertheless, they appear at different altitudes within the studied area (figure 3).

There is a general trend of sinking to the South. However, it is not a regular one. It seems that the interference of different tectonic orientations produced an irregular pattern, going up and down.

We correlate the higher position of last interglacial sea level with the rare cliffs that exist in this generally low coast. We believe that this correlation proves the importance of neotectonics in the building of present relief.

## **3 - Solifluxive, aeolian and lagoon deposits (late Pleistocene and Holocene)**

Afterwards, we studied the solifluxive and aeolian deposits linked with the last cold period, as well as some podzolic soils and lagoon formations existing some miles South of Espinho, to draw a picture of the climatic and eustatic variations after last interglacial times.

We found a clear difference between the area North of Espinho and the area to the South of this town.

At the North of Espinho we found solifluxive deposits inter stratified with aeolian ones. We think that wet cold and dry cold climate alternations during Würm caused this situation. The younger aeolian deposits belongs to Holocene.

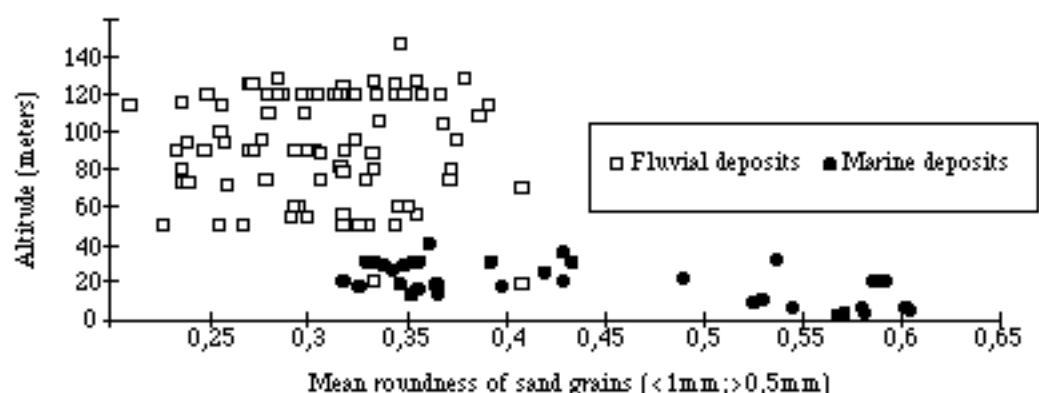
To the South of Espinho the aeolian processes are still working. We found different aeolian systems there. Some of the deposits belong to the end of Würm (13810±380 BP). Others are already Holocene (some pieces of coal from a hydromorphic podzolic soil were dated 5885±75, BP). Inter stratified within aeolian deposits we found peat formations bearing fossil trees remains.

Some C14 datations obtained by colleagues (H. Granja, 1993) showed that some of them are rather old (29.000±690BP). However, the remains of another forest conserved *in situ*, over a peat layer, at low tide level, has produced an age of 1180 ±45 BP.

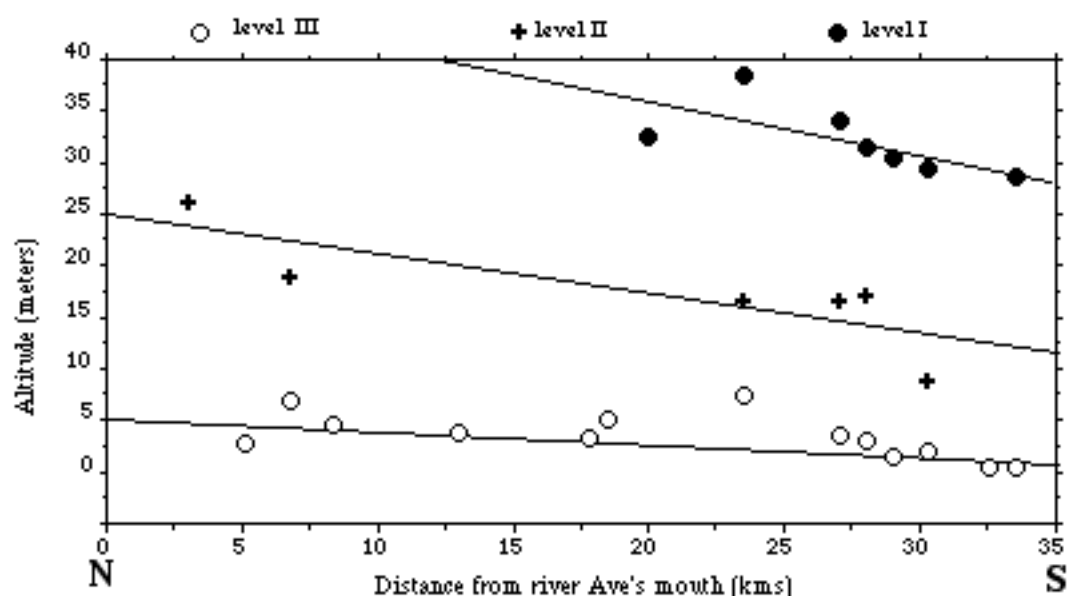
We can explain this persistence of aeolian sedimentation by the general trend for subsidence of this area (figures 3 and 4), caused by its situation in the Northern part of

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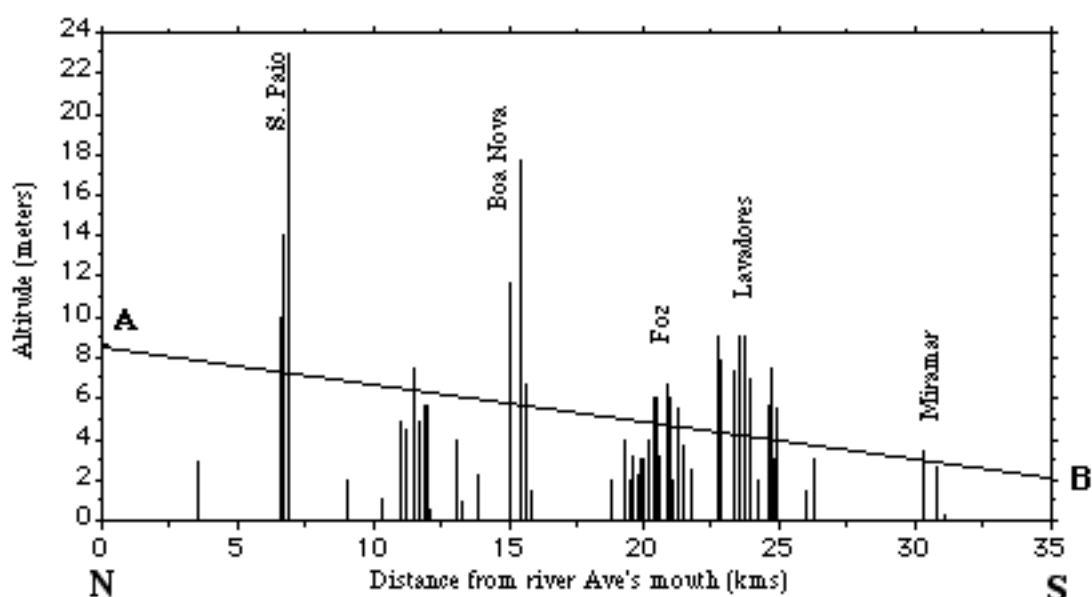
<sup>3</sup> *Rañas* are very coarse and badly calibrated alluvial fans, probably from Vilafranquian times, linked with an arid climate and/or tectonic movements. They appear in the region of Toledo and in several places in Portugal.



**Figure 2: Relationship between altitudes and mean roundness of sand grains (see G. S. Carvalho, 1966)**



**Figure 3: Mean altitudes of ancient marine levels between river Ave's mouth and Espinho**



**Figure 4: The altitudes of bed-rock outcrops between river Ave's mouth and Espinho and their regression straight (A-B)**

western Meso-Cenozoic basin of Portugal. Climate and sea level variation could explain the recurrence of aeolian/lagoon/tree colonisation sequences.

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