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THE COASTAL AREA NEAR VILA NOVA DE MILFONTES

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Abstract

The coastal area near Vila Nova de Milfontes present two different landscapes: the coastal platform and a small mountain (Serra do Cercal). They are supported by two geomorphological units which are the result of the faulting and unequal uplifting of a Tertiary planation surface. This area is now protected by law (it is a Natural Park). The human pressure was very low till the 80's, when its accessibility was improved. Several management plans have been made, most of them putting in risk the natural systems, mainly by water pollution, by the increasing of rill and gully erosion and by the disturbance of the coastal systems, in a zone vulnerable to earthquakes and tsunamis.

Key words: coastal zone, morphotectonics, management plans, human impact, Natural Park.

1. THE GEOMORPHOLOGICAL UNITS

In the area of Vila Nova de Milfontes we can recognize two different geomorphological units: the called coastal platform, facing the sea and the small mountain of Cercal (Serra do Cercal). This two geomorphological units support two complete different landscapes.

The regional geomorphological study was carried out in all the coastal area of Alentejo and Western Algarve (Fig. 1). It showed that the two geomorphological units present near Vila Nova de Milfontes are the result of a Tertiary planation surface which was submitted to a fault tectonics in the Early Quaternary. The fault blocks created was submitted to different degree of uplifting, maximum in the tectonic compartment of the small mountain.

As a matter of fact, in this region, the planation surface cuts the Palaeozoic metamorphic rocks (schist and greywacke of the Brejeira and S.Luís Formations) and has a diversified cover of deposits, from alluvial to dune-beach facies (*Pereira*, 1990).

The oldest deposits, belonging to the Red Formation (RF) exist, not only on the coastal platform, but also on the top of Serra do Cercal. It is inherited from the Tertiary planation surface, previous to the Serra do Cercal rise (Fig. 2a and 2c). Between the present coastline and the top of Serra do Cercal, the textural and structural study of the RF has revealed the evolution of the environmental conditions, from a beach environment that becomes aeolian and finally turns into an alluvial plain.

This alluvial plain worked by the sea in its western section, was submitted to a very important Iberian tectonic event, resulting from the convergence of the African and Iberian plates, in the Early Quaternary (Vilaffranchian). At the same time, a climate change took place, creating a warm semi-arid climate. Then, alluvial fans with predominance of debris flows came from the uplifted compartment (Serra do Cercal) and spread on the coastal plain and rarely reached the present coastline (Fig. 3).

In this tectonic event, also the coastal platform was faulted and the several tectonic compartments were successively less uplifted westwards (a trend which is followed in the continental margin).

Only the most western compartments were once again invaded by the sea, giving rise to the Aivados-Bugalheira Formation (ABF; Fig. 2b and Fig. 3). The ulterior regression allowed the winds (originally from North, turned NW and finally to W) to moved the thin fraction of the ABF and to create a huge dune field. This dune field is today consolidated and penetrate 3 km towards E of the present coastline. Near the present coastline, the aeolianites (of Malhão; AM) were, still, levelled by the sea, which left behind potholes of mechanical erosion, today high up about 20m. These aeolianites are today cut into cliff (Fig. 3).

Fig. 1 – The coastal platform in the Southwest and its boundaries. Legend: 1 – scarp fault in the eastern and northern border; 2 – areas with slope ≤1º; 3 – scarps in the coastal platform and horst at its eastern border; 4 – valley (*Pereira*, 1990).

The compressive regime has lasted through the Quaternary and the testimony of it is proven by the faulting of AM, uplifted on the eastern compartment and tilted to NW near the coastline (Fig. 2b).

2. COASTAL SYSTEMS

In the vicinity of Vila Nova de Milfontes, the coast is, mainly a cliff coast, sometimes with narrow beaches during the Summer times. The cliffs cut the basement and the Plio-Quaternary deposits (RF, ABF, AM). These two sets of materials have different behaviours to wave mechanical erosion. On the whole, the Palaeozoic rocks behave like resistant materials, while the deposits are easily eroded. The aeolianites are from among the deposits, the most resistant ones. Nevertheless, another factor must be taken into account about the two sets of materials: the folding and faulting degree, also affecting the deposits.

In this area, the cliffs erosion rate depends not only on the factors referred to, but also on the cohesion degree and the thickness of the deposits cut into cliffs.

The cliff erosion processes and its retreat rate depend, therefore, on the nature and disposition of materials, their thickness cut in cliffs and the cliffs position (exposed or sheltered) to the wave climate.

The rockfalls can be of two different kinds, according to the volume and nature of the material engaged:

- on aeolianites and greywacke layers (of decimetrical thickness), the rockfalls affect a larger amount of material, therefore they have greater magnitude but low frequency;
- on schist they affect small rock splinters, they have medium frequency and low magnitude (the toppling phenomena are rare and they only occur when the cliff is cut in magmatic intrusions).

The rill and gully erosion is prevailing on cliff predominantly cut into deposits (*Pereira*, 1993; *Neves*, 1995) and their efficiency depends on the rainfall regime, which has in Portugal, a great interannual variability. In rainy years, rill and gully erosion are the main cause for the cliff retreat, but is absent in dry years.

The SW coast cliffs can still be affected by another kind of slides. This cannot be seen in the area of Vila Nova de Milfontes, but southwards, where the tectonic strains have been stronger. In these places, folding and faulting of the basement rocks had lead to a more intense weathering and the slope deposits are more clayey. Although less

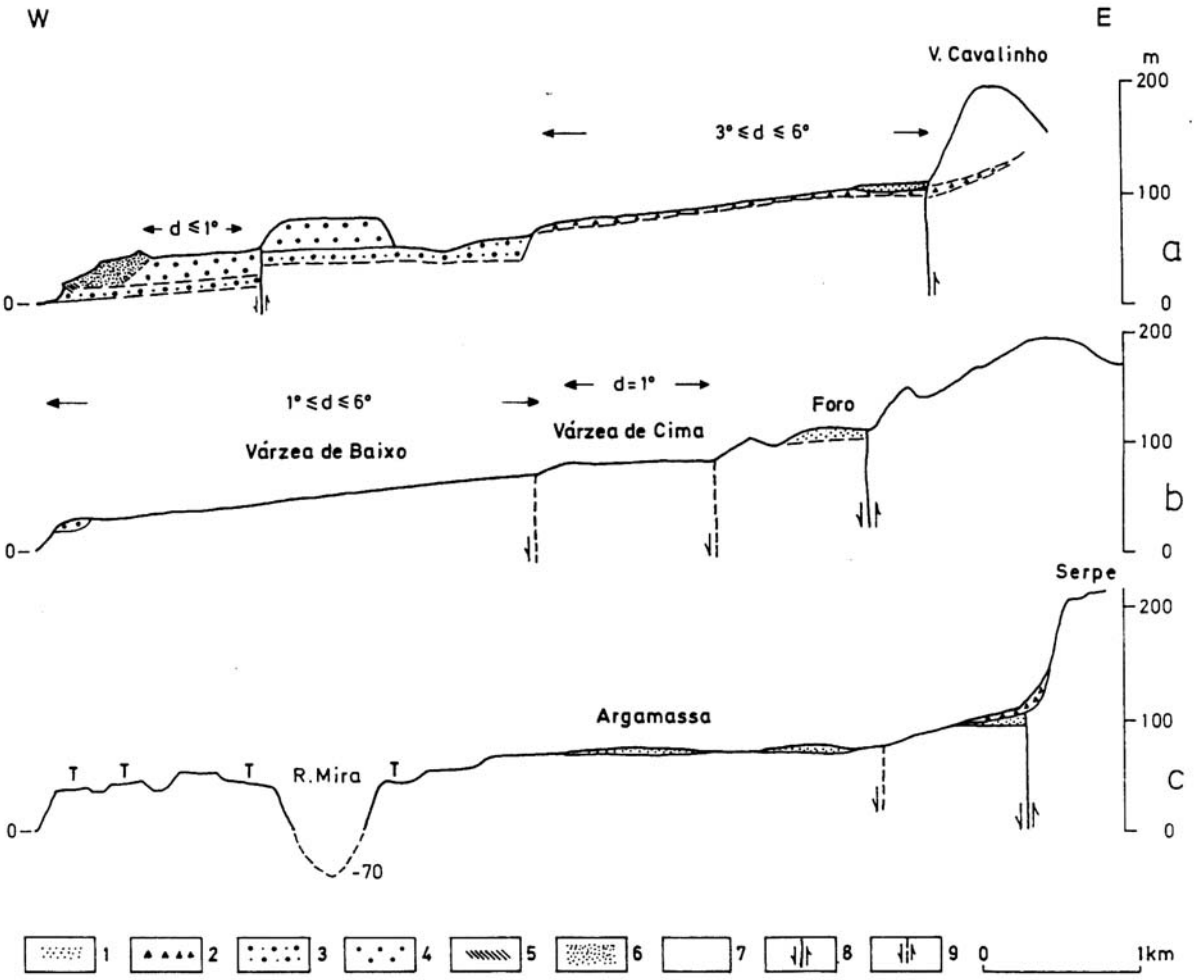

Fig. 2 – Exemples of the geomorphology from Serra do Cercal to the coastline near Vila Nova de Milfontes (based in *Pereira*, 1990). Legend: 1 – Red Formation; 2 – alluvial fan; 3 – Aivados – Bugalheira Formation; 4 – Malhão aeolianite; 5 – Aivados aeolianite; 6 – sand dune; 7 – bedrock; 8 – fault; 9 – probable fault.

frequent, they reach a high magnitude and can hide the beach completely. This situation does not last long since the swash and backwash cleans the thin elements of the slide deposit, leaving to the last the rocky fragments.

In the coastal area of Vila Nova de Milfontes, another coastal shape deserves to be highlighted: the estuary of River Mira (Fig. 3). This river is the biggest one on the western coast south of Sines and was hewn in the Middle Quaternary, following the regression which took place after ABF. To explain the estuary position concur several intersected tectonic accidents (ENE-WSW, Lousal fault and NNW-SSE, fault of the river mouth; Fig. 3). In the estuary, the bedrock was reached at -70 m (cores under the bridge: Fig. 2c). The deep valley are probably correlated to the last great regression, when the coastline was approximately at -180 m, i.e., about 18 km west from the present coastline (*Pereira*, 1992). Therefore, the slopes reach 130-120 m high, 70 m of which are under sea-level.

North of the river mouth, at the base of the cliff, there are also some particular microforms. They are the result of chemical and biochemical corrosion and of mechanical erosion developed by organisms, in the carbonated aeolianites (Fig. 4). Depending on the thickness of the salt water column upon them; the time of sea water submersion and the related position of the break and surf zone, there is the following zonation: coastal karst (partly destroyed after the construction of an underwater pipeline of effluents), more inland; *plateformes à vasques* (solution and mechanical benches), *mares and mares de défoncement de vasques* (potholes), surrounded by a low tide cliff (Fig. 4).

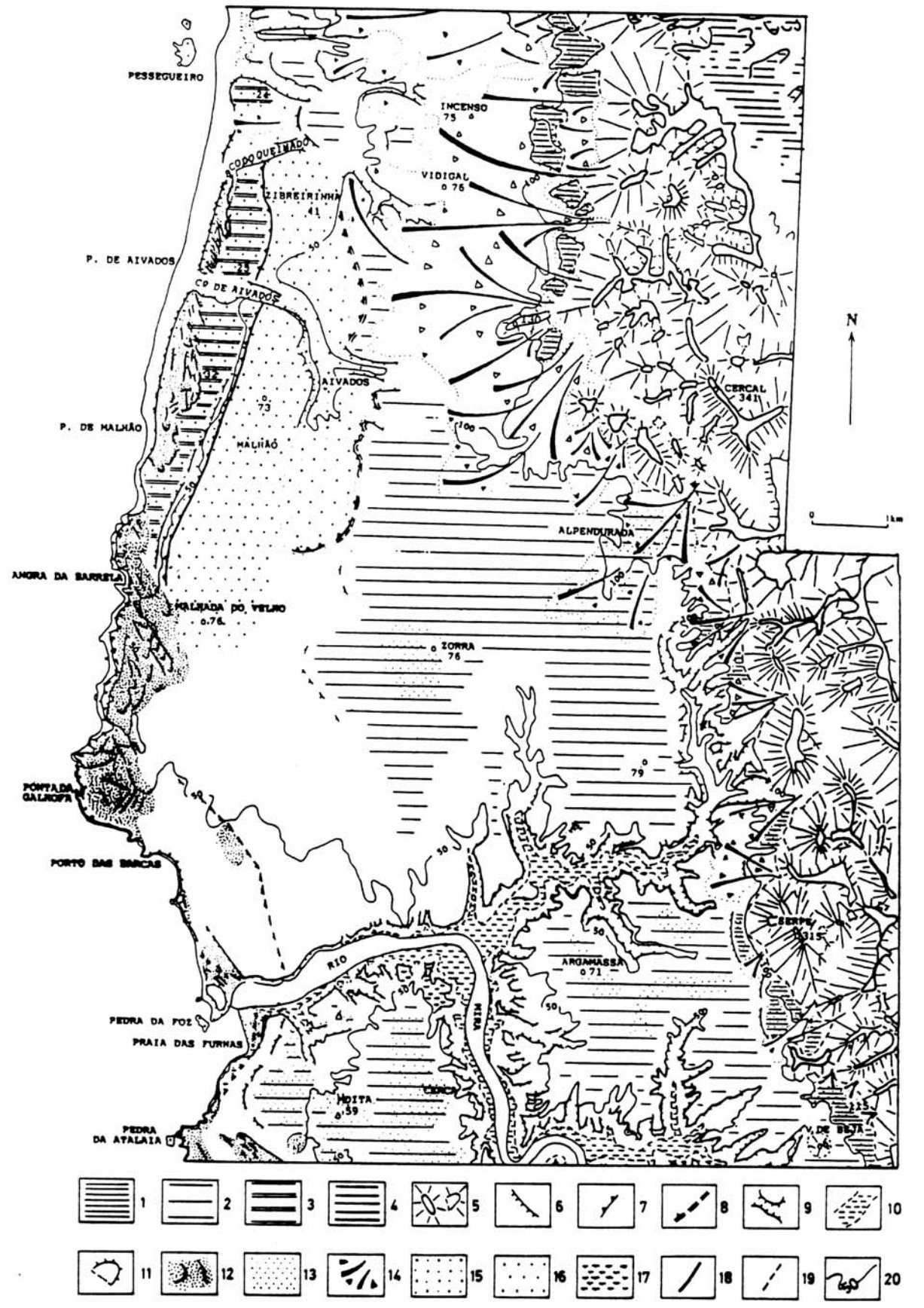

Fig. 3 – Geomorphological map of the coastal platform and its boundaries near Vila Nova de Milfontes.

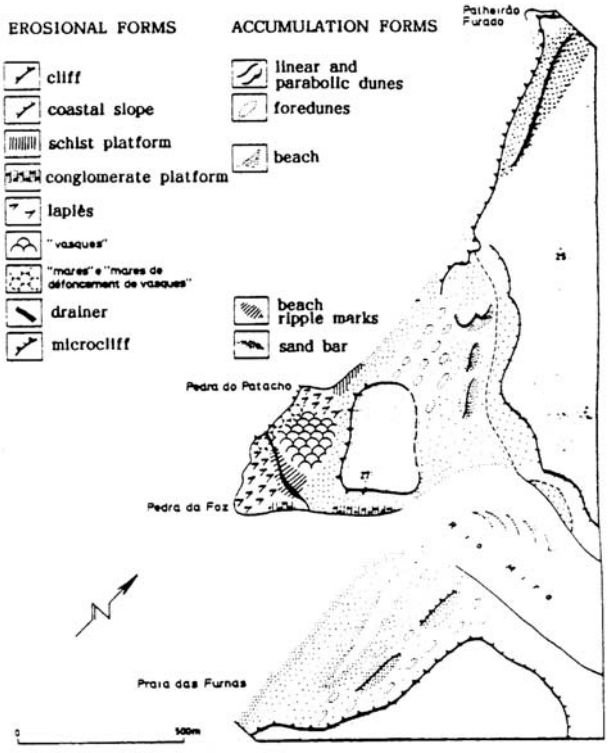

Fig. 4 – Coastal zonation of the corrosion and mechanical microforms developed in the aeolianites, on the River Mira mouth (*Pereira*, 1987).

3. URBANISATION PROJECTS

From what was stated before we can see that this area and the whole SW coast, besides its natural beauty, has a rich geomorphological heritage, it has unstable cliffs and shows the evidences of morphotectonic. It is also vulnerable to tsunamis, the biggest of which took place in 1755 and destroyed several buildings in Vila Nova de Milfontes.

These data should be taken into account in the management and land-use of this coastal area, which have started to be known by the public in the 80's after the improvement of the road network and the construction of the bridge over the River Mira. At this time, the settlement of Vila Nova de Milfontes started to grow in a quick pace. It was also since then that the SW coast began to be taken into consideration in the national legislation. Since 1988, it is a protected coast (and a Natural Park since 1995) with a network of geomorphological and archaeological classified sites and botanical and zoological reserves. The legislation concerning 74 785 ha of the coast (plus 26 000 ha on the continental shelf) was a consequence of the human pressure growth in a region until then close to its natural conditions. As a matter of fact, the main area of Summer leisure, Algarve, was already saturated and this coast, equally beautiful, was still preserved. It started then to be the target of tourist agents. The local population, of weak resources, depending on the agriculture performed in balance with the natural conditions, but resorting to traditional technics, saw the chance of a short-term profit. It was scheduled an increase in about 3 times as many the urban nucleus area of Vila Nova de Milfontes, with an identical growth of the population density (which would increase to 350 inhabitants/ha like the density in the interior of the urban perimeter, according to the PDM of Odemira, not yet approved), such as the creation of two tourist building estates of considerable dimensions, N and S of Vila Nova de Milfontes.

The Aivados-Malhão building estate (Fig. 3), 6 km N of Vila Nova de Milfontes, would urbanise an area of about 8 km^2, which would receive 7 600 visitors (3 600 places are already available in the camping and the remaining 4 000 would be in allotments; *PROTALI*), and a set of supporting structures namely a golf field. This tourist complex would be located near the coast, where the cliffs are cut into deposits and where there are the evidences of recent morphotectonics (which affects the Malhão aeolianites; Fig. 3).

The building estate south of Mira, complex of Vila Formosa, had also anticipated the building of a complex with identical extent, but *PROTALI* only predicts 600 beds.

Fig.3 – Geomorphological map of the coastal platform and its boundaries near Vila Nova de Milfontes. Legend: 1 – step at the base of Serra do Cercal; 2 – Red Formation planation level; 3 – Malhão planation level; 4 – Sonega planation level; 5 – Serra do Cercal; 6 – sacrp; 7 – cliff; 8 – coastline related to Aivados marine episode, with old cliff; 9 – valley; 10 – alluvial plain; 11 – terrace; 12 – dune ridge; 13 – Red Formation; 14 – alluvial fans deposits; 15 – Aivados – Bugalheira Formation; 16 – Malhão aeolianite; 17 – terrace deposits; 18 – fault; 19 – probable fault; 20 – countour line (*Pereira*, 1990).

Until now only the broadening of the urban perimeter of Vila Nova de Milfontes was made, since the other plans had to confront several scientists and environmental organisations with more and more impact on the public opinion, as well as part of the local population, not to speak of the legislation

4. MAIN IMPACTS AND VULNERABILITY

We can summarise some of the main predictable consequences of the human pressure on the coast and its vulnerability.

4.1 Water pollution

It affects already the mouth of the River Mira and the surrounding beaches. Until this year, the effluents of ETAR (treatment station of residual waters) were thrown into the sea, north of the River's mouth (the longshore drift is N-S). It is planned a submarine exutor 1 760 m long (almost concluded) which will throw during the Winter time, into the sea, the mud from the ETAR of Vila Nova de Milfontes.

The new tourist projects would (or will) worsen the problem and would (or will) bring new expenses to the municipality, mainly because the treatment and expulsion of the effluents was conceived for the right bank of the Mira, and one of the foreseen building estates, Vila Formosa, is on the left bank.

Besides, along River Mira there are other pollution sources, such as animal and plant-farming (especially swine's), olive-presses, a factory of tomato concentrate that throw their effluents into the river.

4.2 Rill and gully erosion

The urban areas growth will promote the impermeability of the soil. With the Mediterranean weather conditions, the heavy rainfalls will certainly trigger off rill and gully erosion phenomena, which will be stronger near the coastline and on the valley of the Mira river, where slopes are higher.

In the dune areas, especially near Malhão, where one of the building estate is planned, the continuous irrigation of the green spaces and of the golf field would promote this kind of erosion in Plio-Plistocene deposits cut into cliff, causing an increase in their retreat rates. This phenomenon has been causing several problems, namely in tourist urbanisation's in Algarve of which Vale do Lobo is an example.

4.3 Disturbance of the coastal systems

In addition to the pollution and the rill and gully erosion which would affect the cliff dynamics, the predictable human pressure caused by the tourist urbanisation of Malhão, would give rise to the complete disturbance (even destruction) of the mobile dune system, already subject to treading and to the circulation of ATV's. Their effects can already be seen on the scarce vegetation which covers the dunes and by means of the inland advance of the dune field. Until last decade, this dune system was in balance with the narrow contiguous beach, which would feed during Winter. The degradation of the dune field and its predictable migration inland will have consequences on the beaches. As a matter of fact, this coast has a clear-cut lack of sediments, reason why the cliff systems are dominant. The contiguous dunes and beaches belongs to a system in which the beaches nourish the dunes during Summer and are partly feed by them in Winter. The dune migration inland will brake the system balance, cutting off the beach from a part of its Winter nourishment, at the beginning, with its consequent narrowing. Later on, the decrease of sediments available on the beach will put in danger the nourishment of the dune field, in the Summer time.

4.4 Vulnerability to earthquakes and tsunamis

In several places of the southwest coast active faults with morphological expression were spotted, some of them affecting the aeolianites, as we have pointed out.

The latest earthquakes (1755 and 1969) with their epicentre in the abyssal plain, had consequences both in the destruction of houses, and on the flood in the lower areas.

All the SW coastal zone is vulnerable to tsunamis. An attempt on the high of the tsunami formed by an earthquake with a magnitude 8, 5-9 of the Richter scale (with a returning period of 250 years) with its epicentre in the abyssal plain of Ferradura-Bank of Gorringe (Southwest of the area taken into account) was made by *D'Appolonia* (1982) in (*POAPPSACV*, 1992). In

these conditions, the wave would have 3,8 m at the origin and 2,3 m when it leaves the perturbation zone. Approaching the coast with a speed of 20 m/s, it would reach 4,4 m at a depth of 20 m, and 7 m in front of Sines at a depth of 5 m.

The building estate of Malhão occupies an area where clear evidences of neotectonics were spotted, not to mention the vulnerability of the whole area to the tsunamis. This fact was not taken into account by the land use planning agents.

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