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# Contribution to the understanding of the hydrodynamic processes that controlled the evolution of the Aveiro coastal lagoon: a sedimentological and geochemical study of a sediment vertical profile in the Baixo Vouga Lagunar (Aveiro – Portugal)

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## 1. INTRODUCTION AND GEOLOGICAL SETTING

The region of Baixo Vouga Lagunar (BVL) is located in the Central Coastal zone of mainland Portugal, at the mouth of the Vouga River and is part of the Ria de Aveiro lagoon system.

“Baixo Vouga Lagunar” is characterised by:

- An environment and landscape with unique characteristics;
- A wide diversity of fauna and flora;
- A zone of great agricultural potential.

The objective of this work is to investigate the driving mechanisms of coastal evolution and assess the potential influence of natural and anthropic factors on lagoon deposition using sedimentological and geochemical data for a sediment core retrieved at the BVL.

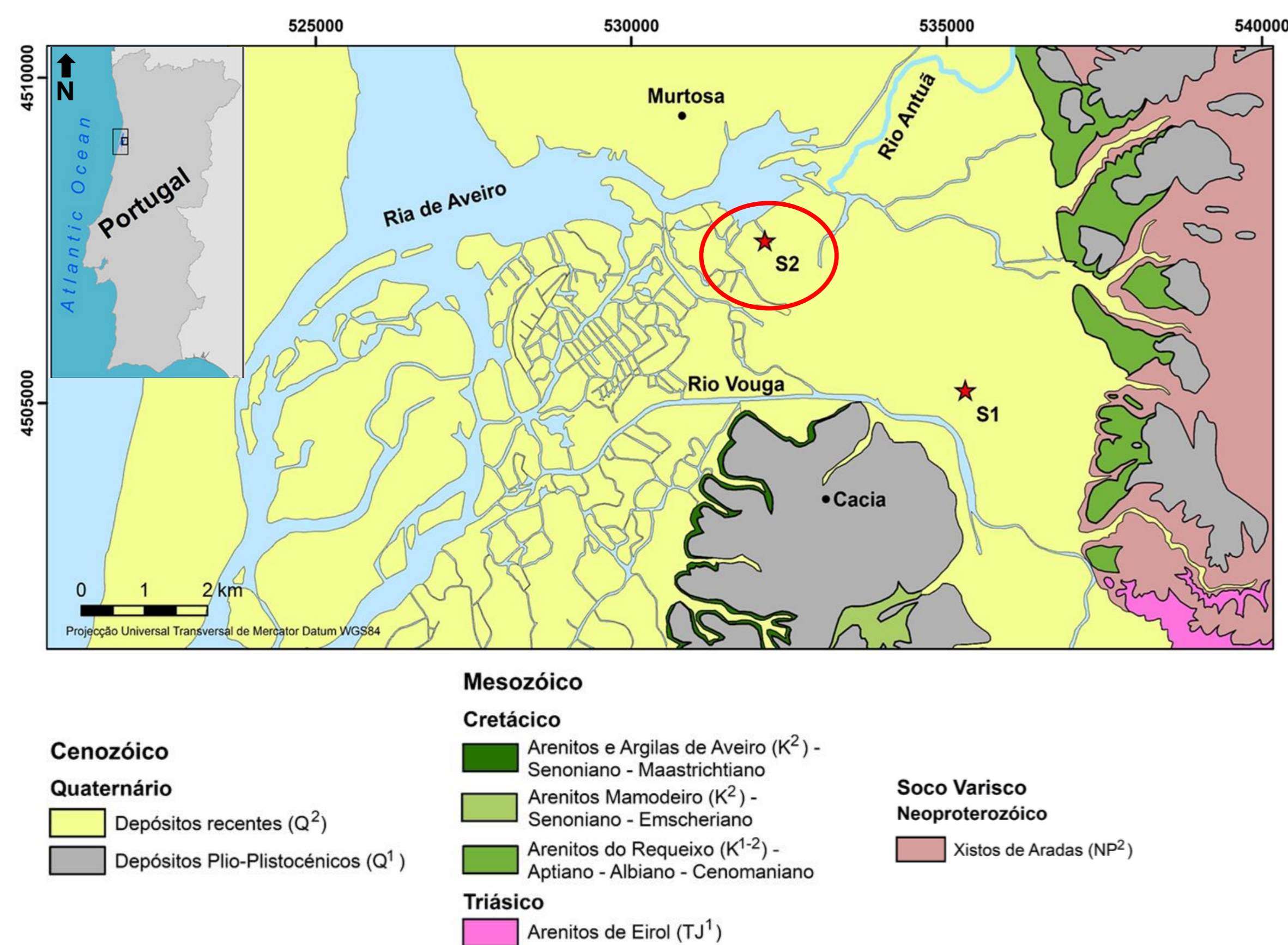


Fig. 1: Geological sketch map of the Baixo Vouga Lagunar (BVL).

## 2. ANALYTICAL TECHNIQUES

- A 12-meter vertical core was drilled in the BVL area;
- The sedimentary log was divided into 47 samples and pH and electrical conductivity (EC) were measured in each sub-sample;
- Nine composite samples (consisting of ca. 5 samples each) were prepared for granulometric analysis and organic matter (OM) determination;
- Twenty samples were selected for chemical analyzes (Al, K, Mg, Fe, Mn, Ca, Sr, Ba, Zn, Cu, Pb, As) by ICP-MS at Department of Geosciences of University of Aveiro.



Fig. 2: Sample collection and processing.

## 3. GRANULOMETRIC ANALYSIS

Results suggest that samples may be subdivided into two groups:

(1) a basal unit essentially composed of sands (12 to 4 meters) and (2) an overlying unit where the silty-clay component predominates (4 meters to top of the series);

From a hydrodynamic point of view, the analyzed samples are distributed between fields of high (III) to very high (IV) hydrodynamic conditions;

**Fácies A** - Basal sandy deposits, assuming the hypothesis that they were beach levels prior to the formation of the lagoon or the remobilization of these materials;

**Fácies B** - Increase in the fine fraction, marking the transition to a confined intralagoon environment.

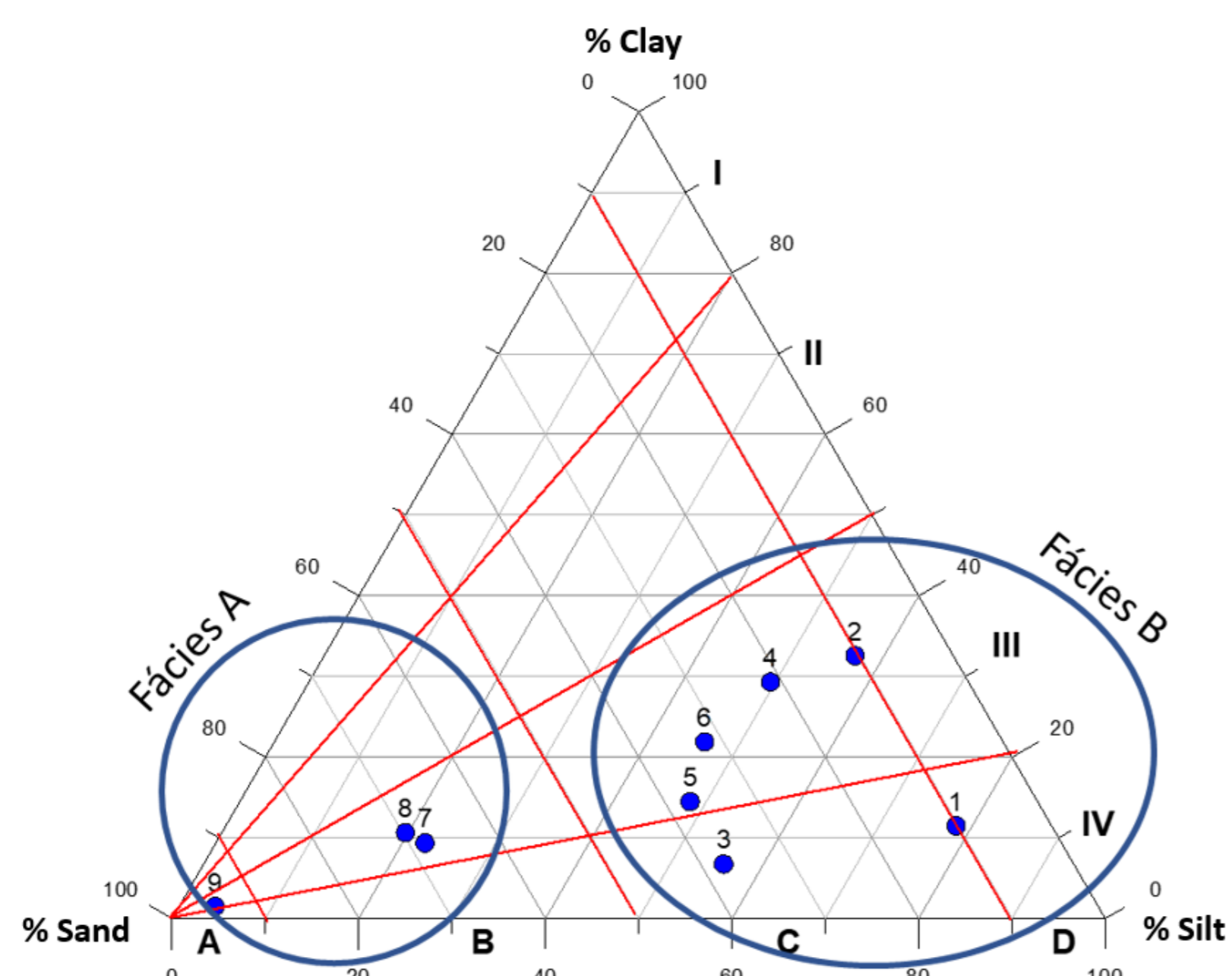


Fig. 3: Projection of composite samples from studied vertical core on the diagram of Pejrup (1988).

## 4. PHYSICO-CHEMICAL PARAMETERS AND ORGANIC MATTER

- pH: tends to decrease with increasing loamy fraction since OM promotes pH decrease in the medium;
- EC: higher in fine sediments rich in clay minerals, OM, Fe and Mn oxides and hydroxides;
- OM content: lower in the basal section of the profile (predominance of sands) and higher in the overlying levels.

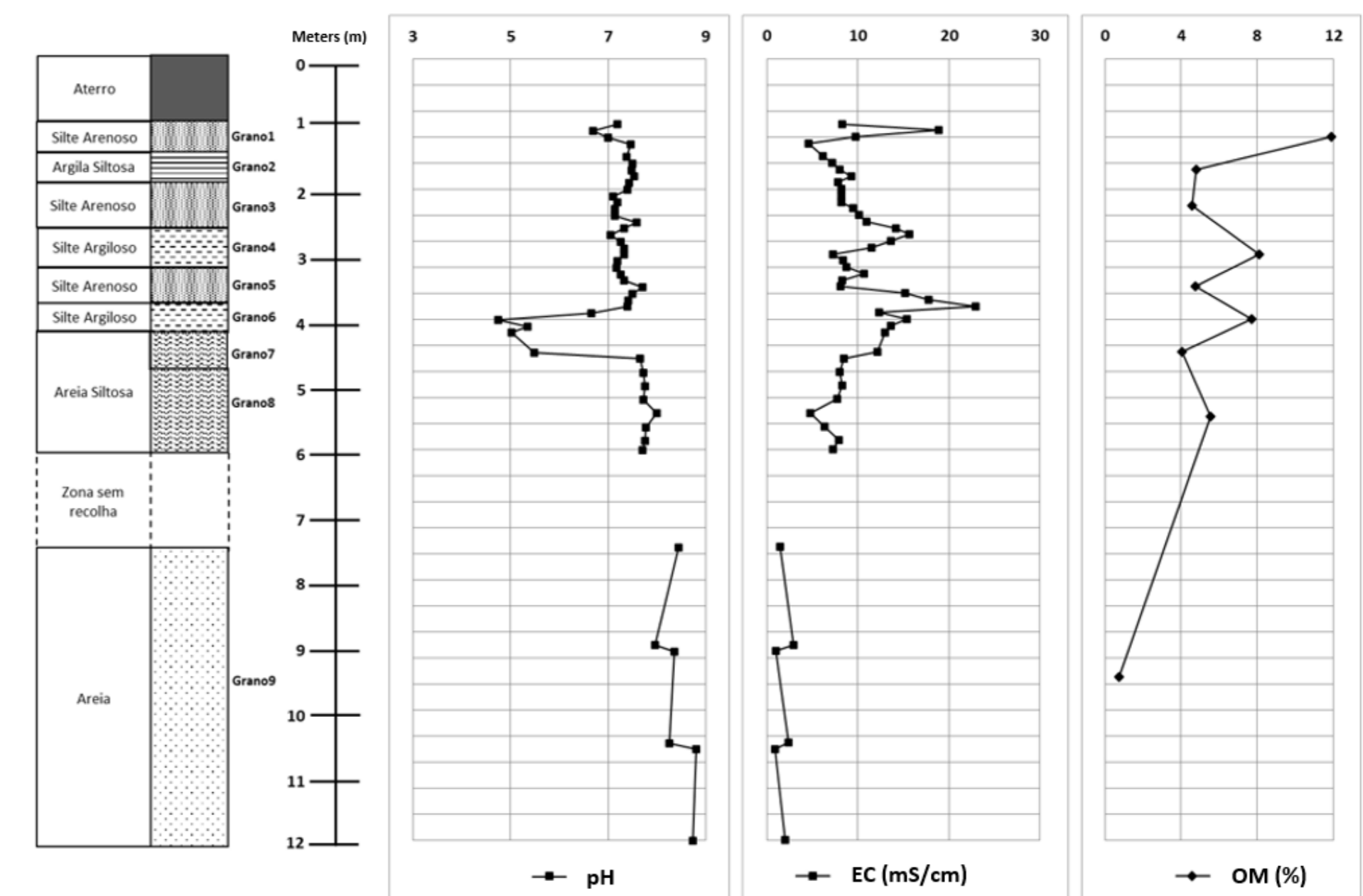


Fig. 4: Variation of pH, electrical conductivity (EC) and organic matter (OM) content along the vertical profile.

## 5. GEOCHEMISTRY

- Elements such as Al, K, Mg, Fe, Mn show similar behavior along the profile (Fig. 5). They occur in higher concentrations in the upper part of the profile and are particularly enriched in horizons with higher proportions of aluminosilicates (clay minerals);
- Arsenic, Zn, Cu and Pb, have a high peak concentration at the top of the sequence (Fig. 5), which alludes to an anthropogenic influence. A higher risk of toxicity for living organisms may be implied for some of these potentially toxic elements;
- Ca and Sr (which easily replaces Ca in the mineral structure), the only elements that decrease with decreasing granulometry, are associated with the bioclastic component present at the deeper levels of the drilling (Fig. 5).
- The Sr/Ba ratio is often used as an indicator of the salinity of the medium (Wang & Zhai, 2008). Sections with low Sr/Ba ratios (<1) indicate contribution of fresh waters, whilst those with high Sr/Ba ratios (>1) represent inputs of brackish/salt waters (Fig. 5).

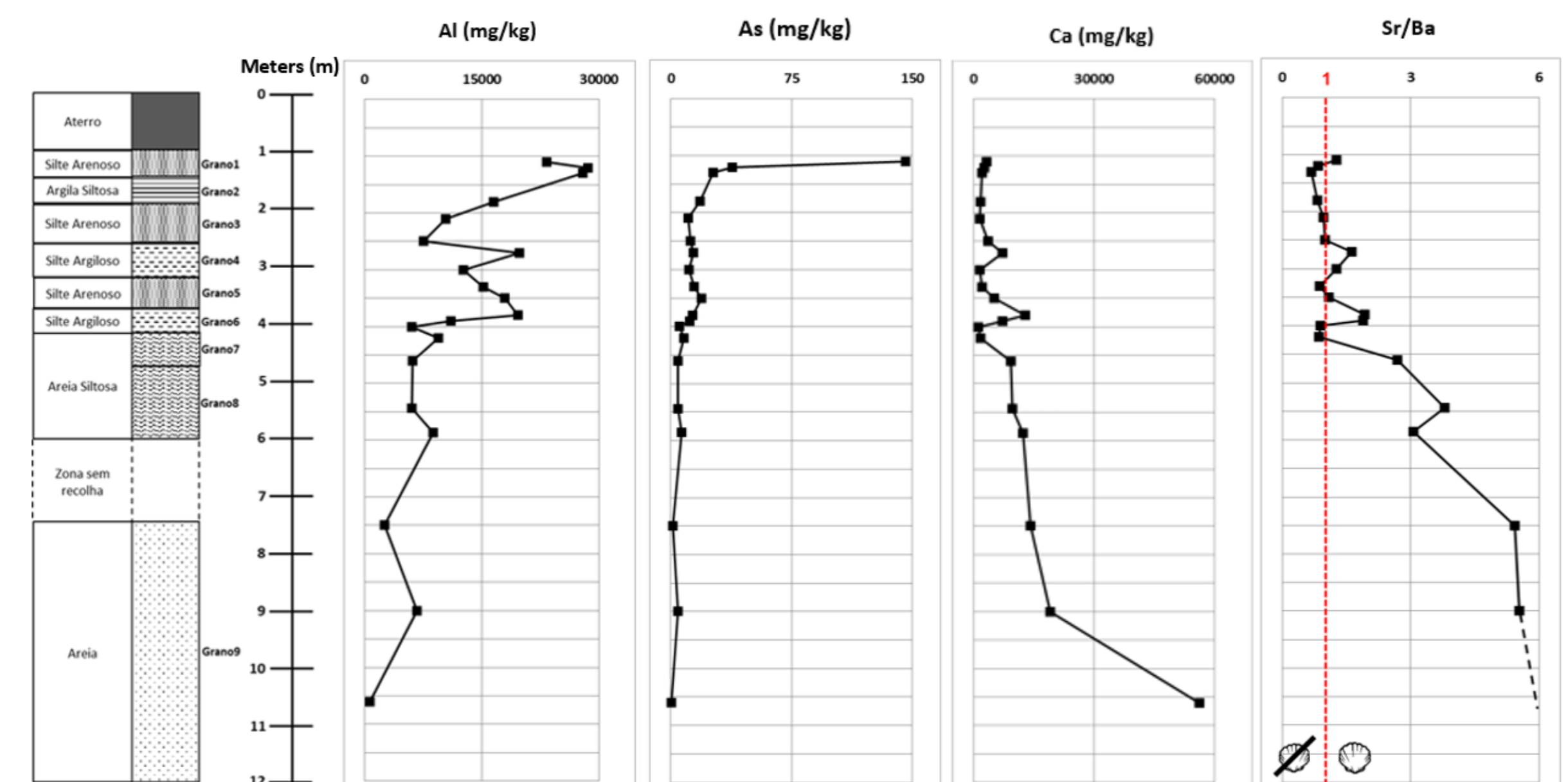


Fig. 5: Variation of some chemical elements in the vertical profile. Sr/Ba ratio with variation of environments influenced by fresh or brackish/salt water and presence/absence of bioclasts.

## 6. CONCLUSIONS

The sedimentological, granulometric and geochemical study allowed us to conclude that:

- the sedimentary column shows an upward fining bedding, comprising basal deposits rich in the sandy fraction, followed by finer sediments in which the silty-clay component is dominant.
- the sandy deposits located below 4 meters possibly correspond to beach levels prior to the formation of the lagoon or to the remobilization of these materials;
- the silty-clay sediments that occur above 4 meters accumulated in a confined intra-lagoon environment under the influence of tidal dynamics.

Based on the data of the physical-chemical parameters, the presence/absence of the bioclastic component and the chemical composition of the sediments, it is assumed that the sedimentation conditions in this sector of the BVL varied over time, starting with: deposition of the basal levels of the sequence before the formation of the lagoon; a subsequent evolution would have involved the accumulation of sediments in a shallow muddy/low marsh environment (occasionally affected by flood events); and ended with the transition of a high marsh environment.

## References

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- Wang, G-P, Zhai, Z-L (2008). Geochemical data as indicators of environmental change and human impact in sediments derived from downstream marshes of an ephemeral river, Northeast China. *Environmental Geology* 53: 1261-1270.

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