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Outstanding pleistocenic megafauna in southernmost Brazil

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Fossiliferous Banks of the Chuí Creek, State of Rio Grande do Sul

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The origin of Rio Grande do Sul coastal plain, at the southernmost portion of Brazil, dates back to Pleistocene. Its geomorphological features are the result of four great sea level transgression-regression events, each one originating extensive barrier-island/lagoonal environments. Fossils of extinct mammals belonging to Lujanian age megafauna (about 120.000 years B.P.) are found in lagoonal deposits of the Lagoon-Barrier III System, which corresponds to the penultimate transgression-regression event of the Quaternary. Nowadays, these deposits are well-known in outcrops along Chuí creek's banks. The study of these deposits and fossils has provided valuable information regarding palaeoecologic and palaeoclimatic aspects in southern Brazil, as well as has improved our understanding of coastal physical processes that led to the Rio Grande do Sul coastal plain development.

Keywords: *Pleistocene, megafauna, taphonomy, biostratigraphy, palaeoecology, barrier-island/lagoonal systems.*

INTRODUCTION

The fossiliferous banks of the Arroio Chuí Creek (Fig.1), are located on the Rio Grande do Sul Coastal Province. The origin of this province is linked to tectonic events dating back to Jurassic Period that led to the breakup of Gondwana supercontinent and resulted in the opening of the Atlantic Ocean (Villwock & Tomazelli, 1995). These events produced two major geomorphological units that integrate the Coastal Province (Fig. 2): (a) the Highlands, which comprise Sul-riograndense Shield, composed mainly by Precambrian igneous and metamorphic rocks, and the Central Depression and Araucárias Plateau, formed by Paleozoic-Mesozoic sedimentary and volcanic rocks of Paraná Basin; and (b) the Lowlands, constituted by Mesozoic and Cenozoic sedimentary deposits of the upper portion of the Pelotas Basin, which constitute the coastal plain.

The Pelotas Basin is a marginal, open and stable sedimentary basin (Weeks, 1952) deposited between the Lower Cretaceous (Albian-Aptian) and the Miocene (Fontana, 1990), and which is more than 10 thousand meter thick. It is constituted by terrigenous clastic sediments originated by erosion of the Sul-riograndense Shield and the Paraná Basin rocks. Re-working of sediments of the upper portion of the Pelotas Basin by sea level oscillations between Miocene and Holocene times, originated a wide range of transitional and marine depositional environments. These environments are constituted by sedimentary facies accumulated in two main siliciclastic

depositional systems (Tomazelli *et al.*, 2000), as follows.

- **Alluvial Fans System**, adjacent to the Sul-riograndense shield, fans were deposited between Miocene and Pliocene times, and their distal portions were subject to re-working in lacustrine and marine environments.

- **Lagoon-Barrier Systems**, constituted by four systems parallel to the coastline, developed seawards from the alluvial fans. This unit results from four major glacio-eustatic sea level oscillations during the Pleistocene and the Holocene, between 450.000 and 6.000 years B.P.

Each lagoon-barrier system is constituted by long and relatively narrow sandy barrier-islands that isolate large lacustrine bodies landwards, such as the Patos lagoon, and the Mangueira and Mirim lakes. In the coastal plain area southward of the Patos lagoon estuary, Lagoon-Barrier systems II, III and IV are well-preserved. The development of System II originated the Mirim lake. According to oxygen isotopic curves (Schackleton & Opdyke, 1973; Imbrie *et al.*, 1984), the third sea-level transgressive maximum occurred about 120.000 years B.P., originating the Patos lagoon and other lacustrine environments in which fossils of terrestrial mammals (pleistocenic megafauna) were accumulated. Nowadays, these fossiliferous deposits are exposed along the banks of the Chuí creek, close to the of Santa Vitória do Palmar town. Lagoon-Barrier System IV, correlated to the last transgressive maximum of 6.000 years B.P., constitutes the coastline and several coastal lakes.

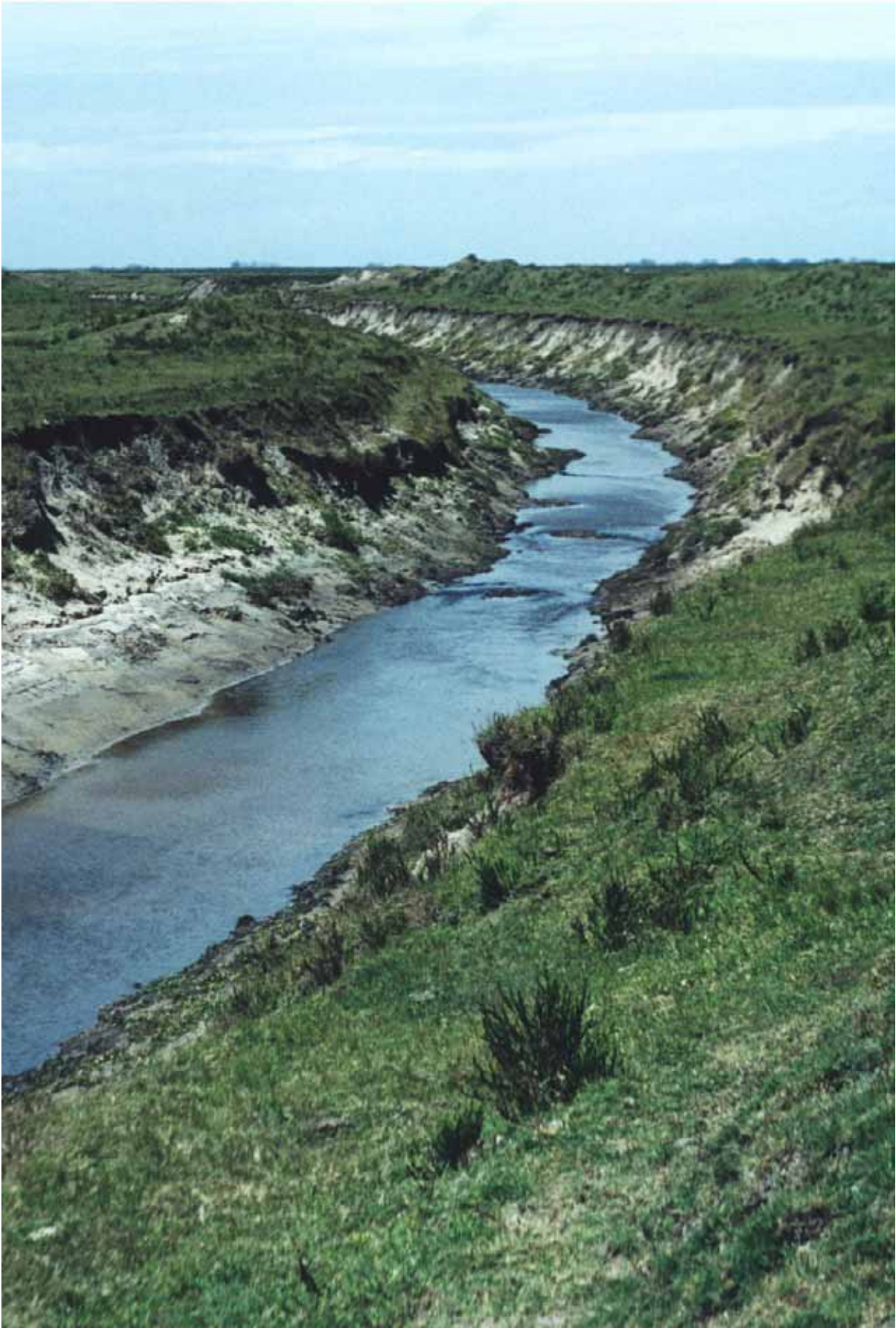


Figure 1 – Panoramic view of Chuí creek banks (Photo: Lopes, 2000)

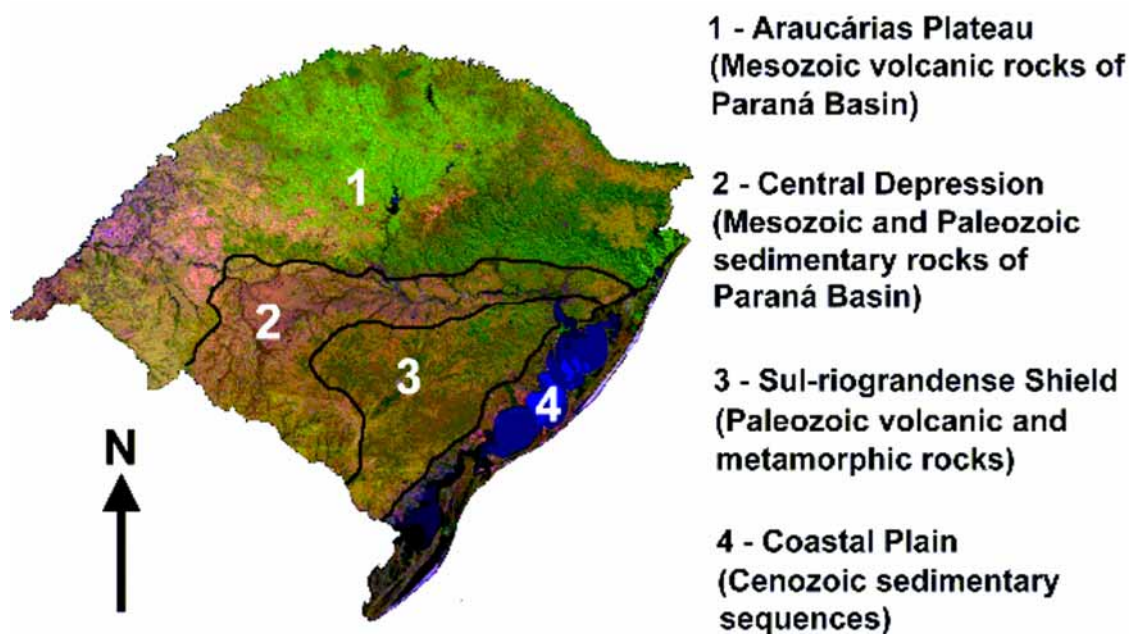


Figure 2 – Major geomorphological units of Rio Grande do Sul state (Satellite mosaic: EMBRAPA, 2000)

LOCATION

Lagoon-Barrier System III is well-preserved along the coastal plain of Rio Grande do Sul and its associated lacustrine deposits are remarkable due to the presence of ichnofossils of marine organisms, such as molluscs and galleries of *Callichirus* sp. (crustacea), and fossils of terrestrial mammals (Pleistocene megafauna). In the southern portion of the coastal plain, the presence of these fossils is well-known in sedimentary layers exposed along the banks of the Chuí creek, as well as in deposits along the continental shelf. Although personal communication from inhabitants of Santa Vitória do Palmar suggest the existence of other possible fossiliferous sites, until now only those exposed along the Chuí creek have been surveyed.

The Chuí creek (Fig. 3), about 25 km long, originates in the wetlands at southern of Banhado do Taim and flows from NE to SW to the Chuí town, where turns to SE following the Chuí lineament direction down to the Atlantic Ocean. Northward the bridge on the road that connects Santa Vitória do Palmar and Hermenegildo beach, the originally meandering course of the creek was artificially straightened in the 1960's and 1970's, then exposing the fossiliferous layers along the banks. The type-section of the outcrop is located about 1 km northward the bridge, on the coordinates 33°35'26" S and 53°20'22" W. Southward the bridge, the creek's course is meandering and the fossiliferous layer is covered by vegetation and aluvionar sediments, so avoiding the clear view of the fossiliferous layer.

SITE DESCRIPTION

Lithological and stratigraphical data of the deposits exposed along the banks of the Chuí creek (Fig. 4) were obtained through excavation and manual sounding (Lopes *et al.*, 2001). At the base of the banks, about 4 m beneath the surface, there is a layer of indeterminate thickness, composed by fine to medium-grained yellow-reddish sands, exhibiting parallel and crossed stratification. This layer also contains ichnofossils of molluscs and galleries of *Callichirus* sp. These characteristics suggest that this layer was deposited on a beach environment, more specifically in the intertidal zone. On the top of this layer there are a few thin lenses of dark-brown sand, suggesting higher concentration of organic matter.

There is an erosional unconformity between this layer and the overlapped layer, which is composed by beige-coloured clayey sand. It is about 1,5-meter thick and contains *in situ* fossils of terrestrial Pleistocene mammals. Above, there is a layer with higher concentration of fine sediment and vegetal remains. At certain points along the banks this layer is capped by a carbonatic layer ("caliche"), which origin was attributed to precipitation of carbonates under warmer and dry semi-arid climate regime (Delaney, 1965; Bombin & Klamt, 1975). The surface layer is about 0,5 and 0,6-meter thick and consists of modern soil and sand with high concentration of organic matter, grass covered.

The granulometric variation on the layers from the bottom to the top indicates a transition from a high-energy beach environment to a low-energy

lacustrine environment. This transition may be explained by the growth of a sand spit that isolated a coastal lagoon. Subsequently, when the free communication between the lagoon and sea has been closed, it became a wet continental environment where remains of Pleistocene mammals were

accumulated. The process that led to the closing of the lagoon was probably similar to the process that had closed the connection between Mirim palaeolagoon and Atlantic Ocean and originated the Bahhado do Taim and Mangueira lake (Buchmann, 1997).

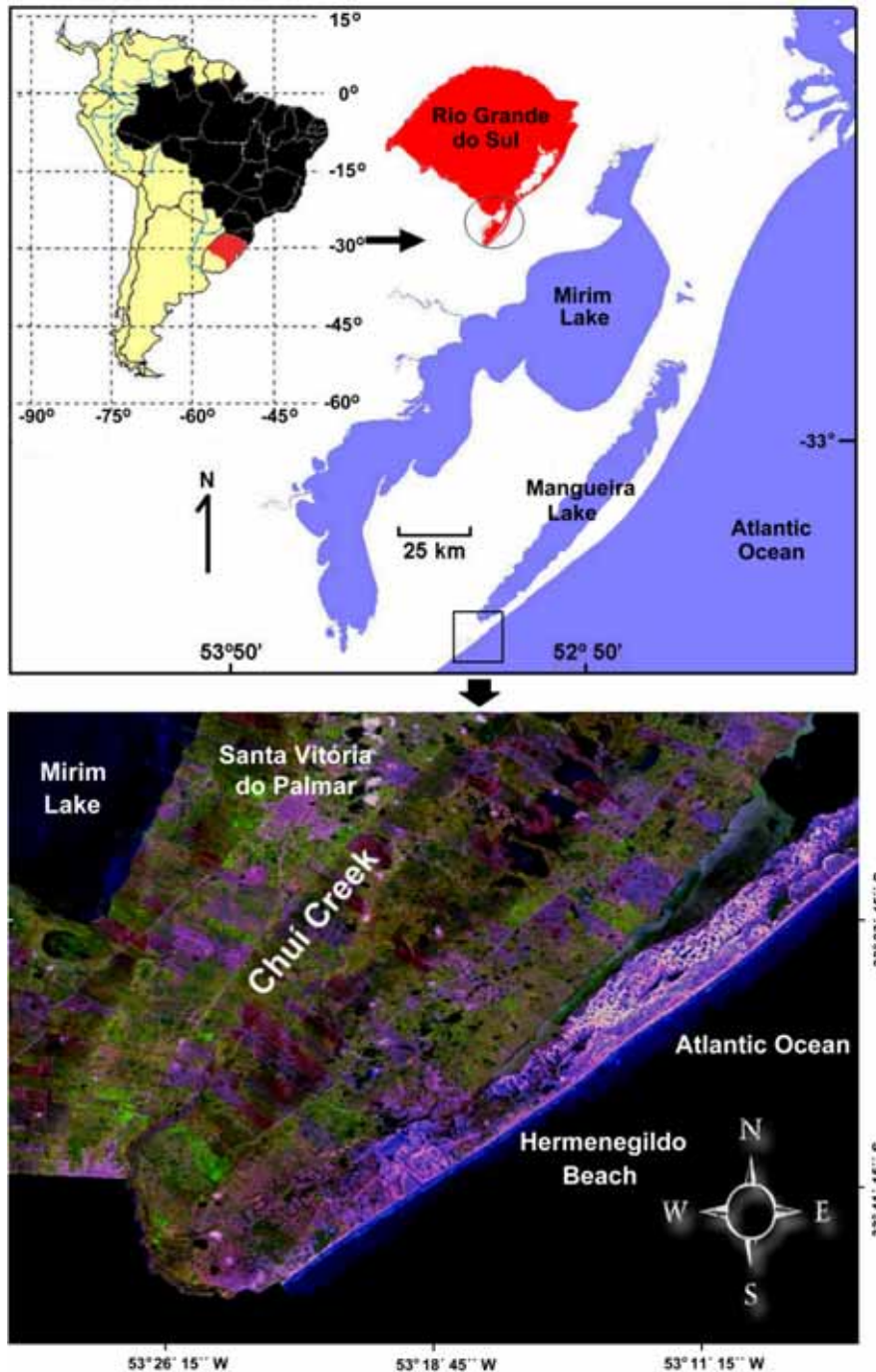


Figure 3 - Map of the southernmost portion of Rio Grande do Sul coastal plain, where Chui creek is located (Satellite mosaic by EMBRAPA, 2000)

Stratigraphic revisions of these outcrops by Buchmann *et al.* (2001) and Lopes *et al.* (2001), based on geologic studies of Villwock & Tomazelli (1995) and Tomazelli *et al.* (2000), led to the re-evaluation of the stratigraphic description of the area carried out by Soliani Jr. (1973). The sediments of the Santa Vitória Formation, identified by Soliani Jr. (1973) as deposited

in lacustrine environments are, actually, those beach sediments containing ichnofossils of *Callichirus* sp and molluscs. The sediments that the author interpreted as paleosoils are the lacustrine sediments containing Pleistocene megafauna fossils of the Barrier-Lagoon System III.

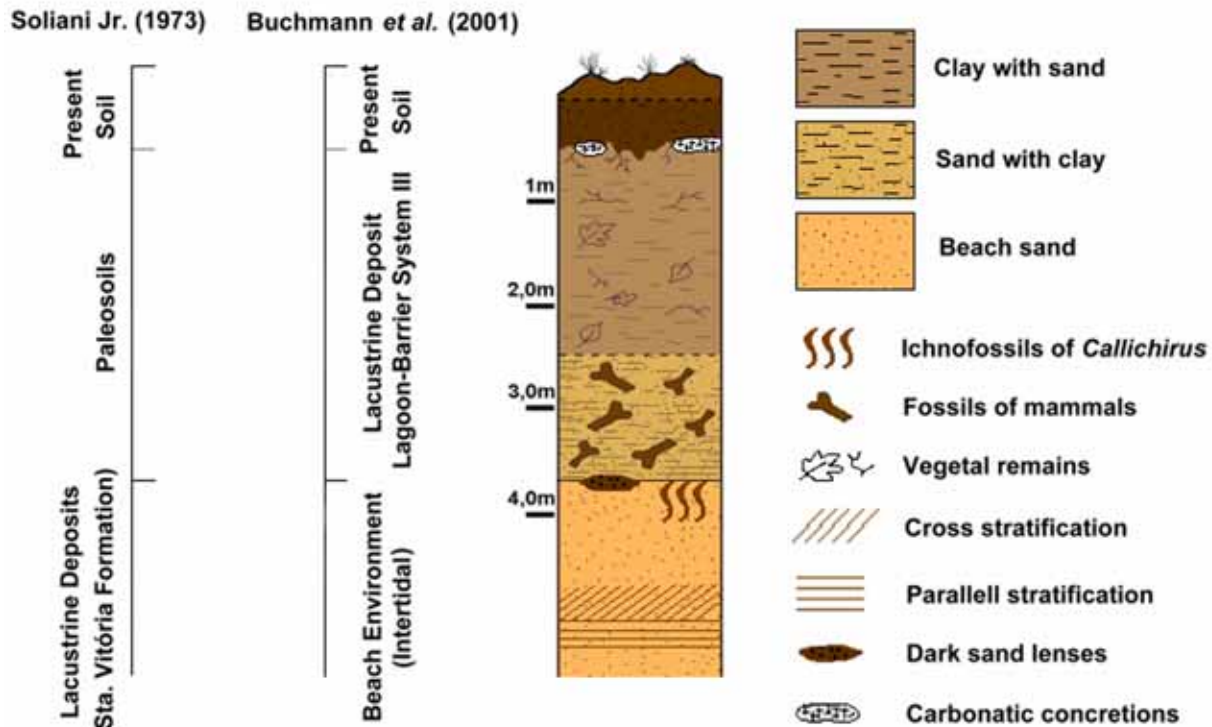


Figure 4 - Stratigraphic column of the deposits exposed along the banks of Chuí creek, with corresponding paleo-environmental interpretations by Soliani Jr. (1973) and Buchmann et al. (2001). (Modified from Lopes et al., 2001)

Dating of Pleistocene mammals fossils has been done only for remains *in situ* collected on the section of the creek located northward the bridge between Santa Vitória do Palmar and Hermenegildo. Southwards, fossils could be found only on the creek's bed, so removed from its original position by erosional processes along the banks. During the winter, the water level raises and the fossiliferous layer keeps sunk and consequently under erosional processes. During the summer, the layer becomes exposed again. These fossils have been known and studied for decades (Paula Couto, 1939a,b, 1953, 1975, 1979; Cunha, 1959; Soliani Jr, 1973; Oliveira, 1992). The fossils belong to extinct mammals from several groups (Fig. 5), which allow establishing biostratigraphic correlation with Pleistocene deposits in Uruguay and Argentina (Ubilla, 2004). The presence of *Equus* sp fossils indicates that this fauna is of Lujanian age according to the land-mammal ages of Pascual (1965). According to Rocha de Oliveira (2001), the Pleistocene fossil mammals from the state of Rio Grande do Sul exhibit more relationship with the Pampean fauna in Argentina and northern Uruguay than with Brazilian fauna.

Among the fossils from the Chuí creek there is a predominance of medium- to large-sized herbivores, in comparison with carnivores and small vertebrates. Although the fossil mammals from the Chuí creek are the same from submerged deposits along the Rio Grande do Sul continental shelf, these deposits contain fossils of organisms, such as rodents (Rodrigues, 2003) and birds (Lopes *et al.*, submitted),

which have not been found in the Chuí creek banks yet. Their absence might be a result of either the lack of detailed sampling of small fossils, or hydraulic selection of these remains.

The fossils from the Chuí creek are fragile and light-coloured, although they become dark-coloured when exposed to the water. These remains exhibit different preservation patterns, ranging from small, unidentifiable fragments (Fig. 6) to large and complete bones (Fig. 7). The fossils occur in three degrees of articulation: I) Articulated (Fig. 8); II) Disarticulated but associated; and III) Isolated. All these features, plus the presence of different skeletal parts represented by the three Voorhies Groups, suggest that these remains come from several different source areas, located at different distances from the present deposition site. The great amount of unidentifiable fragments exhibiting plain fracture patterns, typical of post-fossilization breakage, indicates that these fossils have suffered considerable degree of re-working, probably due to their removal from the original deposition site and transportation to the present fossil site. The lacking of evidences of scavenging suggests that the carcasses were rapidly covered by water and/or sediment after the death.

The fossil assemblage from the Chuí creek is polyspecific and polytypic, therefore its origin as result of catastrophic mass mortality or predatory action is excluded. Probably, it is an attritional assemblage, constituted by accumulation of fossils from various source areas and different ages (Lopes *et al.*, submitted).

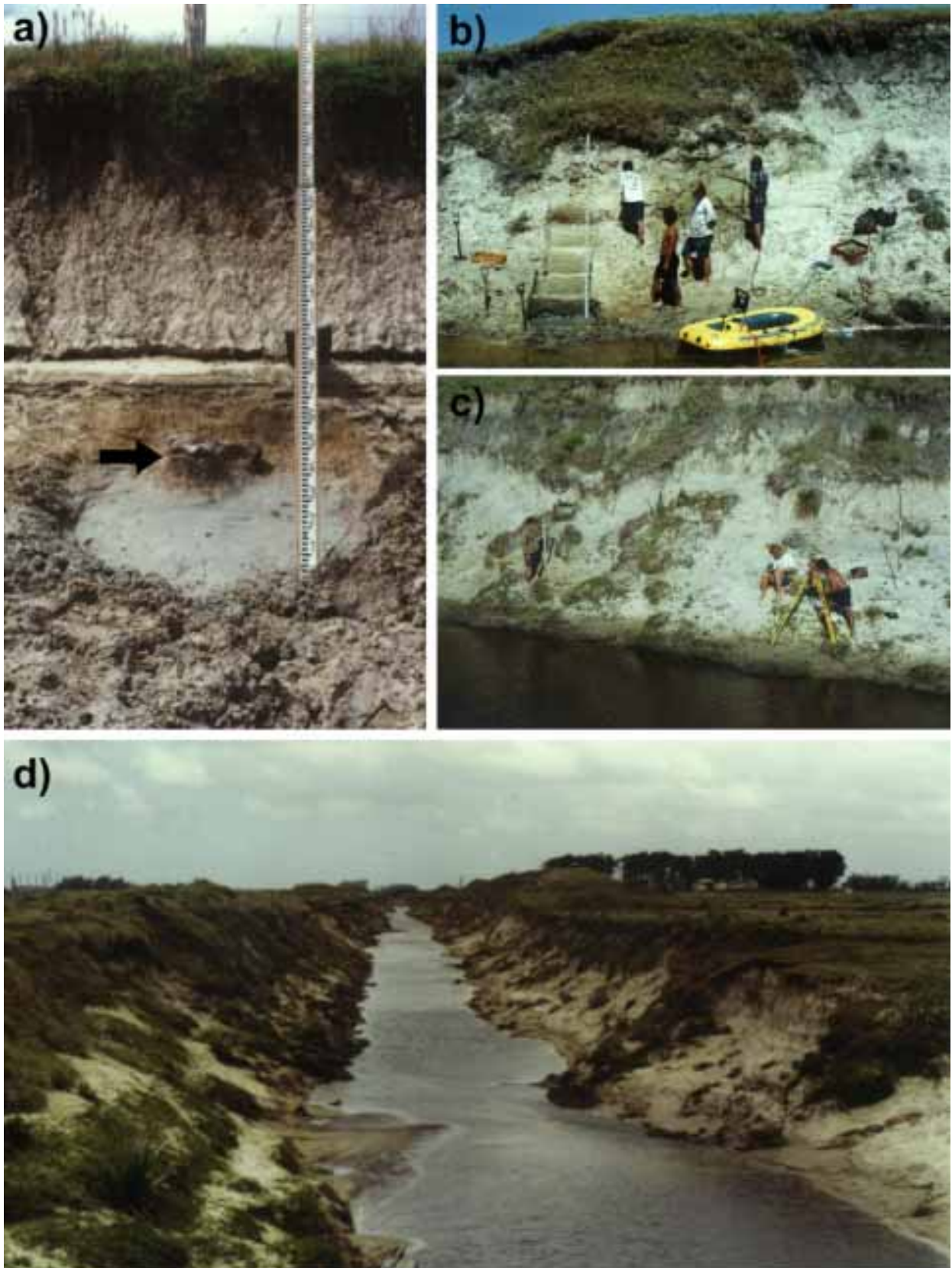


Figure 5 – Banks of Chuí creek: a) Fossil of a ground sloth (indicated by arrow), in the contact between beach (at the base) and lacustrine sediments; b) and c) Research activities; d) Panoramic view of the banks (Photos: Lopes 1999, 2000)

The taphonomic features on these fossils suggest that they have been subject to one cycle of deposition-erosion-transportation-redeposition after death at least. Nowadays, they are being re-exposed and

transported due to erosional processes along the banks. Unfortunately, they could not survive to this new cycle because of their physical fragility.



Figure 6 – In situ fossil fragments (Photo: Lopes, 2002)

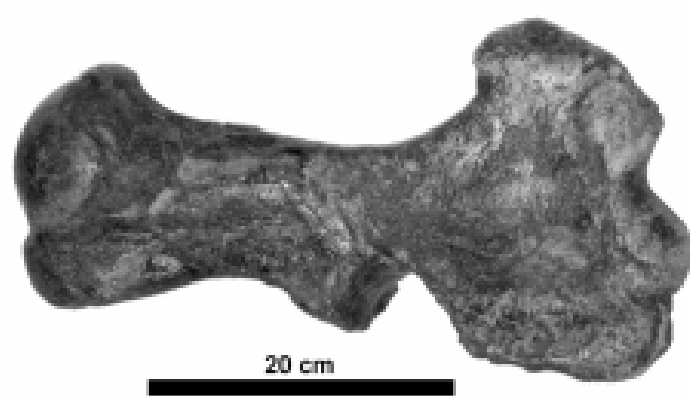


Figure 7 – Complete humerus of a giant sloth (Photo: Lopes, 2003).



Figure 8 – Articulated vertebrae of Lestodon sp., a giant sloth (Photo: Lopes, 2001).

SITE PROTECTION

The Chuí creek flows through several farms along the coastal plain, and its waters are pumped to irrigate rice croppings between the months of november and february.

The fossiliferous deposits of the Chuí creek are under no one kind of legal protection. In spite of this, people who live nearby respect and protect the remains, either by keeping fossils at home or taking them to the local museum of Santa Vitória do Palmar.

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