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Violante R. A.*

Geomorphology and Coastal Evolution during the Last Interglacial Maximum Sea-Level Highstand in the Atlantic Littoral of the Pampean Region, Argentina

*Argentina Hydrographic Office, Department of Oceanography, Division of Marine Geology and Geophysics. Av. Montes de Oca 2124 (C1270ABV) Buenos Aires, Argentina. E-mail: violante@hidro.gov.ar

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Introduction

Late Cenozoic eustatic changes have played a major role in the modelling of coastal and nearshore regions of the marginal areas of the Pampas facing the Southwestern Atlantic Ocean, in eastern Argentina. Particularly, the regions located south of the de la Plata river mouth (between 35ºS-38ºS, figure 1) are in a privileged position as they are included into a subsiding but tectonically stable basin, in a low-energy and microtidal setting with a low-gradient relief. These conditions, along with the large sediment availability, induced the region to be highly sensitive to sea-level fluctuations, and as a result, to store very complete sedimentary records as well as good evidences of shorelines displacements.

Submarine and coastal geophysical and geological surveys undertaken in the area, based on underwater high-resolution and low-penetration shallow seismic, side-scan sonar, echosounding and grabs and piston-cores sampling, as well as classical terrestrial field-works including the drilling of several boreholes, allowed to recognize five depositional sequences ranging from Pliocene to Holocene and to describe them from the seismic-stratigraphic, morpho-stratigraphic, litho-stratigraphic, lithofacial and sedimentological viewpoints, each of them being the consequence of a separate transgressive-regressive cycle (Parker et al., 1999). The two younger sequences (respectively Holocene and late Pleistocene in age) are the best preserved and recorded ones, and hence its highstand facies lying in the coastal plains provide valuable evidences for understanding littoral dynamic, coastline behaviour, paleoclimatic changes and paleoenvironmental aspects, as well as for carrying out comparative

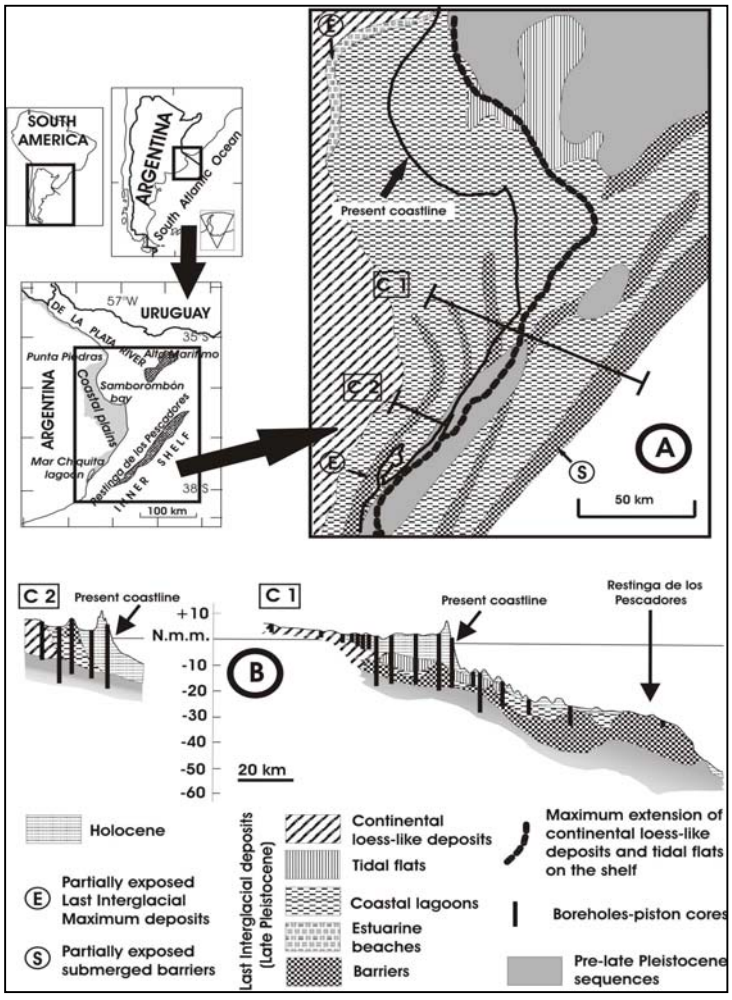

Figure 1. A: Paleogeographical map at a time shortly after the Last Interglacial Maximum highstand (Holocene cover as well as regressive late Pleistocene continental deposits are not shown). B: Cross-sections showing the whole stratigraphical situation. References are the same for both the map and the cross-sections.

studies between the postglacial and the Last Interglacial Maximun sea-level highstands including neotectonic implications. Knowledge of highstand coastal processes, deposits and morphological features also contribute to interpretate paleo-shorelines evolution during lower-than-today sea-levels positions, particularly for not well preserved pre-late Pleistocene sedimentary sequences.

With these objectives, the present contribution summarizes the updating knowledge of the Last Interglacial Maximum highstand in the area.

The Last Interglacial Maximum highstand

Before focusing on the Last Interglacial Maximum, it is necessary to give a short description of the whole marine sequence deposited during the late Pleistocene last marine transgression. It extends both onshore and offshore with a thickness of 6-12 m and is covered by Holocene deposits except where exposed in outcrops in the coastal plains between Samborombón bay and Mar Chiquita lagoon at +3/+5 m above present sea-level as well as in the inner shelf in sites such as Alto Marítimo and Restinga de los Pescadores, two presently submerged relict geomorphic features at depths of -10 to -30 m respectively (figure 1). The sequence is composed of distinct facies such as shallow-marine muddy sands, littoral fine sands, barrier-beach shelly sands, lagoonal clays and silts, muddy tidal flats and continental loess-like deposits. Stratigraphic relationships as well as seismic/litho-facies distribution enable to interpretate that the unit was deposited during a full transgressive-regressive cycle as evidenced by the shoaling upwards vertical sequence (transgressive shallow-marine sediments underlying regressive barrier-beaches, coastal lagoons and eolian deposits). Thus, the unit comprises transgressive, highstand and forced regressive facies. The stratigraphical position of the sequence allows to consider it as evolved during the last marine event occurred during the Pleistocene (Violante and Parker, 1992, Parker et al., 1999). Its highstand levels were probably deposited during isotopic stage 5e as supported, besides many ^{14}C datings that are beyond the limit of the method, by two aminoacids racemisation analysis of shells from an outcrop located near Mar Chiquita lagoon (Violante and Parker, 1992) and one U/Th dating yielding an age of around 120 ka B.P. coming from shells contained in beach facies in a stratigraphically equivalent unit exposed 270 km southwest of the working area in another geological setting (Isla et al., 2000). Although it is evident that more datings and isotopic determinations are still lacking in order to deffinitively confirm the age, it is believed that the information arisen from the present knowledge is highly reliable.

Highstand deposits lie in the coastal areas associated to two different energy settings (figure 1), one of relative higher energy level in the open-marine environment at the Atlantic coast, and the other one of a relative lower energy level in the more restricted estuarine environment around Samborombón bay at the mouth of the de la Plata river. The first ones, open-marine deposits in the Atlantic shore, show ridge-like morphologies parallel to the coastline with sedimentary structures and lithofacies typical of littoral barriers-lagoons systems. The barriers, whose outcropping beach facies reach an altitude of around +3/+4 m (cross-section C2 in figure 1), are constituted by yellowish brown sands bearing shells fragments, mollusks valves in living position and evidences of bioturbation by burrows of Callianassa sp.; faunal assemblages, bedding structures and textural-mineralogical characteristics indicate a littoral to beach environment. These sediments gradually grade further inland into low-lying deposits of grayish to greenish brown very fine sands and silts with hashed shells fragments, arranged in a fining-landwards grain-size sequence and capped by lenses of laminated silts and clays; these characteristics allow to interpretate the deposits as corresponding to a protected lagoon environment partially connected to the sea through tidal inlets open across the barrier, with development of tidal creeks during its final stages of evolution. Both the barriers and the lagoons are covered by silty eolian deposits and partially by a paleosoil.

These depositional features represent the topographically highest evidences of a regionally developed barrier complex extended seawards, in which six individual barriers sub-parallel to the present shoreline were identified by seismic and coring information in a staircase arrangement (cross section C1 in figure 1) with maximum altitudes of +5 m (the one above described exposed in the coastal plains), -2 m (in the subsurface of the coastal plains) and at -7, -15, -25 and -30 m in the inner shelf (Parker et al., 1990, Violante et al., 2001). Barriers are composed of sandy to shelly sediments and are separated to each other by lagoonal muddy lithosomes; the bodies located at depths less than -15 m are covered by tidal flats and eolian sediments, and the presence of relicts of buried paleosoils is suspected from sedimentological evidences found in submarine cores that sampled the Pleistocene-Holocene boundary in the inner shelf (Violante and Parker, 2000, Violante, 2002). The lithofacial relationships indicate that the barrier complex evolved during the regressive event following the Last Interglacial Maximum sea-level highstand.

On the other hand, lower energy level sediments found at the coasts of Samborombón bay, near the de la Plata river mouth (figure 1), which lie at an altitude of +3 m, are morphologically featureless and consist of greenish sandy silts with valves of molluscs, whose textural characteristics indicate deposition in a low-energy beach associated to an estuarine environment.

Concluding remarks

Stratigraphical, geomorphological and sedimentological evidences reveal that Last Interglacial Maximum highstand deposits from the open-marine coasts off the Pampas region evolved as barriers-coastal lagoons systems, whereas near the de la Plata river mouth they evolved in lower-energy estuarine environments. Following the Last Interglacial Maximum, the regressive event was accompanied by prograding processes as a result of the large sediment availability resulting from the source of previous transgressive deposits that remained as relicts on the shelf surface. At the marine shore, successive barriers-lagoon systems formed at each new shoreline accompanying the

sea-level fall, whereas eolian deposits progressively capped the systems that remained inland unaffected from the marine action, at the same time that pedogenetic processes occurred there.

The potential of preservation resulting from variables such as the positive deposition-erosion balance, as well as the incompetence of the coastal retreat resulting from shoreface erosion during the post-LGM transgression to completely rework the records of the preceeding regresive event, was high enough to preserve the barriers systems.

Since barriers-coastal lagoons formation characterized also the littoral evolution during the Holocene highstand (Violante and Parker, in press) in a similar way as it occurred during the late Pleistocene (not only in the study area but also in the northern Patagonian coasts, where described by Weiler, 1993) this resequence of environments, different from the depositional pattern that seems to have dominated during pre-late Pleistocene times (when barriers were not formed as far as is presently known), suggests that a new sedimentation style was installed in the northern areas of the argentine littoral since the Last Interglacial Maximum. It is believed that since then the appropiate conditions for barriers formation were settled in terms of the correct combination of sea-level fluctuations rate, coastal morphology, sediment availability, longshore transport, accretion processes, wave energy and tidal range. However, it can not be discarded the possibility that this set of conditions could had been installed previously if it is considered that transgressive facies preceeding the Last Interglacial Maximum can actually represent the relicts of transgressive barriers systems totally reworked by coastal processes, as it is well known to have occured during the Holocene.

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