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Relative sea-level changes during the Holocene in the Río de la Plata, Argentina and Uruguay: A review

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ABSTRACT

This study critically reviews the relative sea-level (RSL) data from the Río de la Plata (RDP) (Argentina and Uruguay) in order to analyze the Holocene RSL changes in this region and thus capture the general trend illustrated by both the data and the high-degree polynomial regression analyses which show good agreement with the ICE-6G_C (VM6) model. The previously inferred Holocene sea-level histories reconstructed from palynological and diatom records from the northern and the southern RDP are also compared to the RSL curves proposed in this work. Analysis of the RSL database revealed that the RSL rose to reach the present level at or before c. 7000 cal yr BP, with the peak of the sea-level highstand c. +4 m between c. 6000 and 5500 cal yr BP (depending on the statistical method used) or at c. 7000 cal yr BP according to the ICE-6G model prediction, gradually falling after this time to the present position. The subaerial data tell a consistent story for the last 6000 years for the RDP but the subsurface data are not in agreement with these data or with the glacial isostatic adjustment (GIA) predictions. Since much of the subaerial data come from shells on beaches, beach ridges and storm beaches, they cannot be strictly interpreted as RSL index points. It seems likely that the predicted curves are somewhat high and could be overestimated. The "smooth" model of the late Holocene sea-level decline is in close agreement with both the GIA model predictions and the reconstruction of RSL from palynological and diatom records. The models provide no evidence to suggest that there has been a significant trend of change in the speed of sea-level fall or oscillations during the falling stage system tract. The non-parametric regression model, the GIA predictions and the trend inferred by palynological and diatom data trace out a slow sea-level fall for the last c. 6000 cal yr BP. We critically assessed published Holocene sea-level data from the RDP to produce a Holocene RSL curve of sufficient quality to provide a location in this area for testing theoretical models for the Atlantic coast of South America.

1. Introduction

Several sea-level reconstructions are available from the region on the border between Argentina and Uruguay (28° to 38° S; Fig. 1) along the east coast of the South American continent. Holocene sea-level history has been reconstructed for different areas of Buenos Aires province (e.g. Isla, 1989; Aguirre and Whatley, 1995; Cavallotto et al., 1995; Gómez and Perillo, 1995; Isla and Espinosa, 1998; Gómez et al., 2006) and Uruguay (Bracco et al., 2011, 2014; Martínez and Rojas, 2013, 2014). With the exception of the work by Gómez et al. (2006) and Bracco et al. (2011) who have indicated a negative relative sea-level (RSL) oscillation around 2650 ^{14}C yr BP in Bahía Blanca estuary (Fig. 1) and a negative short-term oscillation at c. 4500 cal yr BP for the Uruguayan coast (Fig. 2) respectively, other publications have proposed a simple regressive trend to the present position after the emplacement of a maximum Holocene highstand. In works in which RSL curves have been proposed, these have been constructed using a simple qualitative approach, with the exception of the work by Martínez and Rojas (2013) in which a non-parametric smoothing technique was employed. However, the

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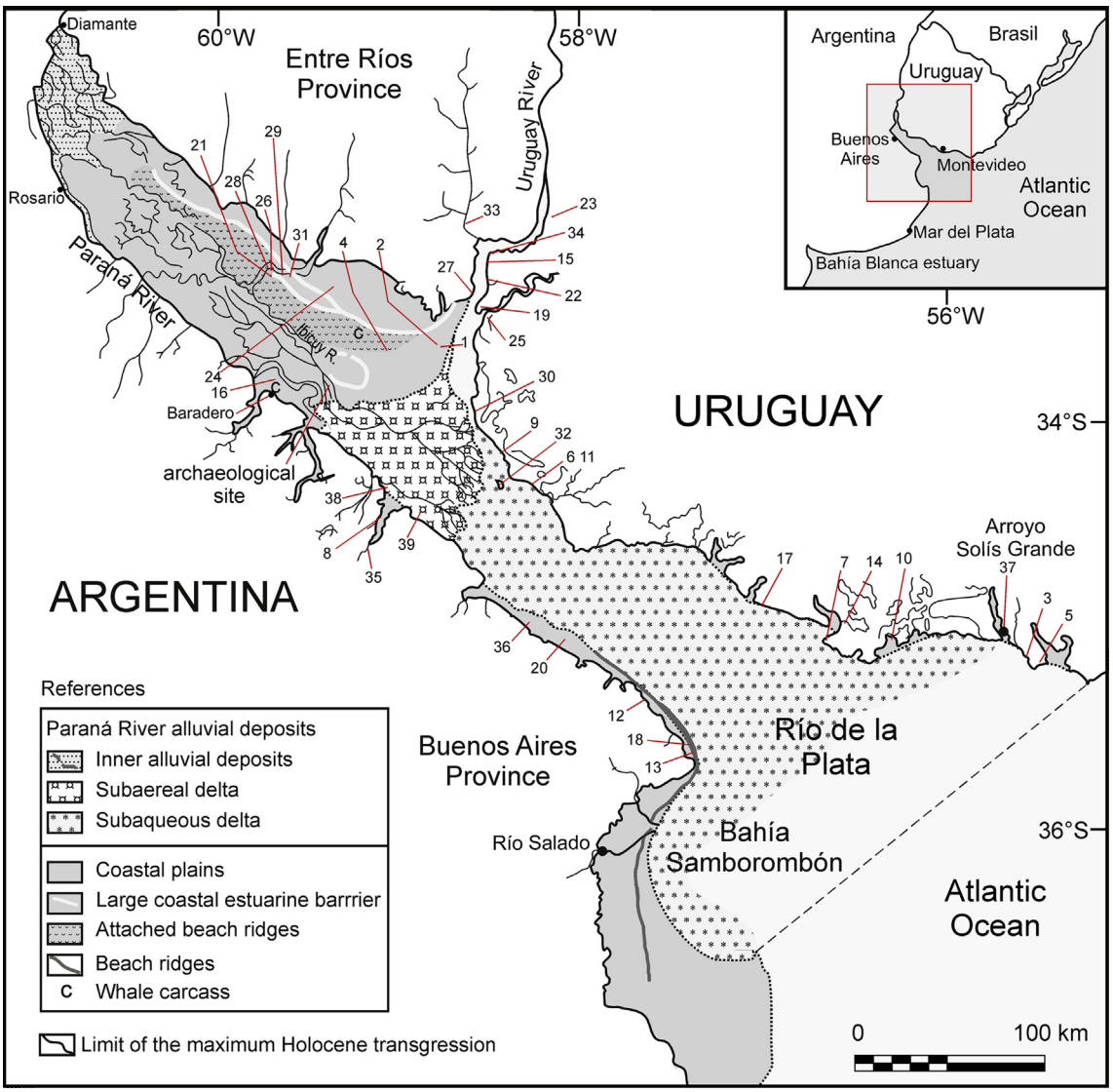

Fig. 1. Location map showing the Rio de la Plata and the sites from index points where obtained (Table 1). Regional geomorphologic map modified from Cavallotto (2002) and Colombo et al. (2014).

timing and amplitude of the mid-Holocene highstand and regressive trend of the RSL on the border between Argentina and Uruguay are not well resolved, partly because of the varied RSL reconstruction methods used and also because the data used in the reconstruction of the curves came from different environments. The only evidence of late Pleistocene sea-level variation for the Argentine Shelf is that provided by Guilderson et al. (2000). However there is some question as to whether their data is actually indicative of sea-level at all.

Particularly for the Río de la Plata (RDP), a Holocene RSL curve was presented by Cavallotto et al. (2004) based on 14 uncalibrated ^{14}C ages from selected samples from the southwestern coast of the RDP (Argentina). This RSL curve was re-plotted by Gyllencreutz et al. (2010) using the same index points and qualitative approach but using the calibrated ages. It shows rising sea-levels following the Last Glacial Termination (LGT), reaching a RSL maximum of +6.5 m above present at c. 6500 cal yr BP, followed by a stepped regressive trend towards the present (Fig. 2a). On the other hand, Holocene RSL curves for the Uruguayan coast that include data from both the northeastern RDP and the Atlantic coast have been reconstructed by Bracco et al. (2011, 2014) and Martínez and Rojas (2013, 2014). These curves show some discrepancies concerning the timing and magnitude of the mid-Holocene highstand and the regressive trend (Fig. 2b). However, none of these authors have taken into account the fact that the RDP history might have been different from the Uruguayan oceanic coast during the Holocene. They rather served to revive the controversy between smooth (linear) and oscillating mid- and late-Holocene sea-level curves for southern South America (e.g. Angulo et al., 2006; Gómez et al., 2006).

Rostami et al. (2000) demonstrated that RSL predictions to the north of 36°S in the Atlantic Ocean of South America based upon the ICE-4G (VM2) deglaciation model, are reasonably well predicted by the theory. However, Milne et al. (2005) suggested that the data considered for sea-level predictions were of relatively poor quality and for that reason they did not use them in constraining their models for South America. We will argue herein that the data for this region are actually of rather high quality.

As significant differences exist in the interpretations of the sea-level curves from the RDP (Argentina and Uruguay), we decided to

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