45 mm

SUBMERGED WOODS OF UPPER PLEISTOCENE AGE AT SAN MATÍAS GULF: A SEA LEVEL CURVE FOR NORTHERN PATAGONIA

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1. INTRODUCTION

Sea level responses differently in relation to local tectonics, isostasy and/or geoidal changes. However, the water balances between Precipitation and Evapotranspiration can also produce significant changes comparing different regions.

In this paper, a radiocarbon dating performed from wood fragments from trees extracted from the bottom of San Matías Gulf, is reported. Considering the paleogeographic and biogeographical significances of this dating, a sea-level curve is here proposed for Northern Patagonia, confirming a sea-level jump that occurred about 11,000 years ago.

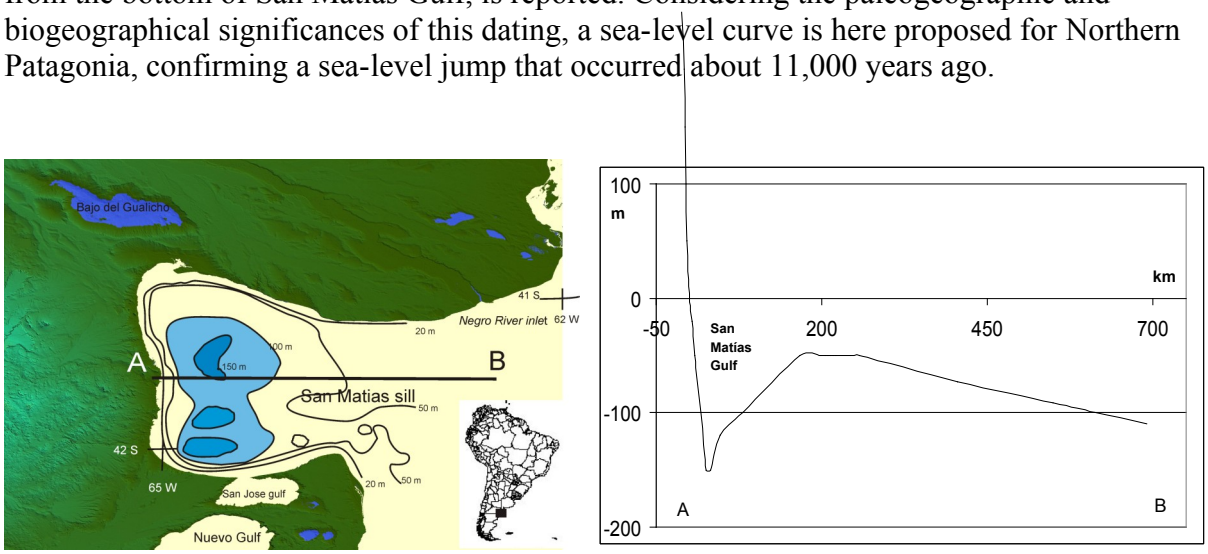

Fig. 1. a) Digital elevation model of northeastern Patagonia highlighting depressions below mean sea level with the bathymetry of San Matías Gulf. b) Altimetric profile of the gulf and its sill.

2. SETTING

The San Matías Gulf is about 18,000 km^2 (Galiardini and Rivas 2004) without any significant input of freshwater. It is a deep depression where 55% is below the 100 m isobath, with a sill of 60 m depth (Gagliardini et al 2005). The gulf has two maximum depths below 160 m in the middle (Pierce et al. 1969). Conversely, the San José Gulf is shallower (80 m at maximum) and communicated with the San Matías Gulf by a very dynamic outlet (Amoroso and Gagliardini 2010). In Northern Patagonia, there other emerged depressions below mean sea level without any supply of water discharge (Bajo del Gualicho, Gran Bajo Valdés, Salina La Piedra). There are several evidences of a sea-level highstand for the last 6000 years and a regional uplift was inferred about 0.08 mm/year (Guilderson et al. 2000). The region has a semiarid to arid climate with mean temperatures of 15°C and yearly precipitation around 250 mm. Two vegetational zones dominate: a dry forest ("Espinal") dominated by several species of the genus *Prosopis, Schinus longifolia*, *Condalia lineata* and *Celtis spinosa*. The Monte is dominated by shrubs of *Larrea divaricata* and *L. cuneata* but also containing trees of *Prosopis* (Schäbitz 1994). The gulf has a macrotidal semidiurnal regime with maximum flood and ebb currents located at the southern portion of the entrance to the gulf (Tonini et al. 2006). These currents have explained the asymmetric pattern of a sand-wave field towards the E and NE, and recorded from the European radar ERS (Gagliardini et al. 2005).

3. METHODS

A Sac-C MMRS image form September 23, 2009, was processed. A Digital Elevation Model (DEM) was downloaded from a SRTM (Shuttle Radar Terrain Model) web site (http://srtm.csi.cgiar.com). This model has a ground spatial resolution of 90 m and helped to recognise some depressions from this region characterised by plateaus. This information was handled with the Global Mapper v.7.04 (www.globalmapper.com).Bathymetric data was sampled from chart H4 of the National Hydrographic Survey. The wood fragments, similar to the shrubs of present vegetation, were collected from 70 m depth, and were dated at the LATYR radiocarbon lab (University of La Plata).

4. RESULTS

The wood was dated in 11,310 ± 150 years BP (12,793-13,458) with an estimated $^{12}C/^{13}C$ ratio of -24 ‰ ± 2 (LP 2384). A sea level curve of Northern Patagonia has been drafted compiling this radiocarbon dating with other data from the same region: Bahía Blanca (Farinatti 1985; Grill and Quattrocchio 1996; Spagnuolo 2005), Anegada Bay (Weiler 2000), San Blas Bay (Trebino 1987; Rutter et al. 1989), San Matías Gulf (Codignotto and Aguirre 1993) and Engaño Bay (Monti 2000), including the radiocarbon datings perfomed from shells collected from the continental shelf (Guilderson et al. 2000). This information is confirming that the maximum highstand occurred about 6000 years, and that the region has a very slow tectonic uplifting trend, more similar to Tahiti than Barbados (Fig. 2).

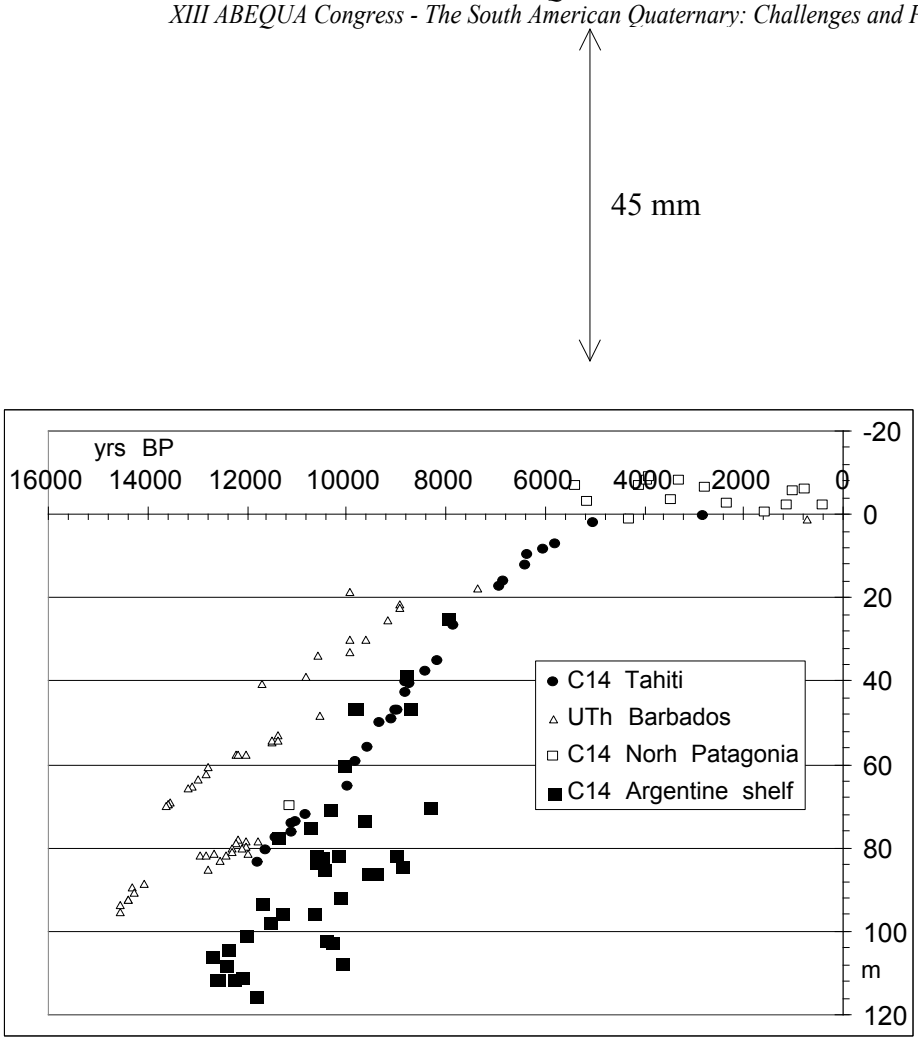

Fig.2. Postglacial sea-level curves from Tahiti (circles; sensu Bard et al. 1996), Barbados (triangles; sensu Peltier and Fairbanks 2006) and the Argentine shelf (filled squares; sensu Guilderson et al. 2000). Empty squares correspond to references cited in the text and the dating of this paper.

5. DISCUSSION

The Postglacial transgression flooded restricted seas or gulfs in relation to the vertical position of their sills. Two significant jumps in this sea-level rise (MWP-1A and MWP-1B) were recorded about 14,000 and 11,500-11,000 years BP, respectively (Bard et al. 1996). While the 14,000 years jump was assigned to the collapse of the European Ice Sheet, the 11,000 years jump was proposed for the collapse of the Laurentide Ice Sheet (Fletcher and Sherman 1995). However, the magnitude of these jumps is difficult to infer as they were calculated assuming different uplifting rates (0.34 mm/yr for Barbados; 1.9 mm/yr for New Guinea) or subsiding rates (0.2 mm/yr for Tahiti). It has been that there was a cascade of water from the Sea of Marmara to the Black Sea about 8400 years BP, when the Bosporus strait was flooded by the Mediterranean Sea (Siddal et al. 2004).

The wood dated at the bottom of the San Matías gulf indicated that it was not submerged 11,300 years ago. Considering the sill of this gulf about 60 m, it should have been flooded 11,000 years ago during the MWP-1B jump (Fig. 3).

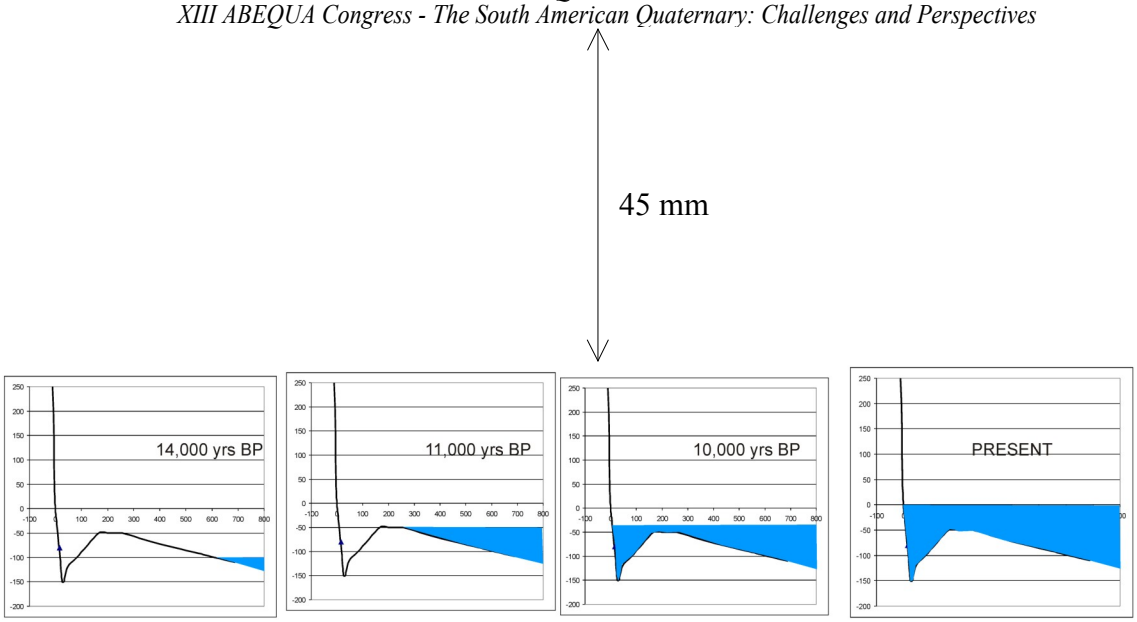

Fig. 3. Evolution of the sea level at San Matías Gulf. The gulf was flooded about 10,000 years when the sea level surpassed the sill.

6. CONCLUSIONS

1. The dating of wood fragments of 11,130 years BP is probing a rapid sea level rise affecting the San Matías Gulf.
2. During the minimum sea-level stand, the gulf has been occupied by a steppe on a depression below the sea level.
3. Water balances during the Upper Pleistocene were similar to present conditions, in regard that Evapotranspiration exceeded Precipitation.
4. While some tectonic depressions became flooded by the Postglacial Transgression (San Matías, San José, Nuevo gulfs), others remained emerged below present mean sea level (Bajo del Gualicho, Gran Bajo Valdés, Salina La Piedra).

REFERENCES

Amoroso, R. O. & Gagliardini, D. A., 2010. Inferring complex hydrographic processes using remote-sensed images: turbulent fluxes in the Patagonian gulfs and implications for scallop metapopulation dynamics. *Journal of Coastal Research* 26, 2, 320-332.

Bard, E., Hamelin, B., Arnold, M., Montaggioni, L., Cabioch, G., Faure, G. & Rougerie, F., 1996. Deglacial sea-level record from Tahiti corals and the timing of global meltwater discharge. *Nature* 382, 241-244.

Codignotto, J. O. & Aguirre, M. L., 1993. Coastal evolution, changes in sea level and molluscan fauna in Northeastern Argentina during Late Quaternary. *Marine Geology* 110, 163-175.

Farinati, E. A., 1985. Radiocarbon dating of Holocene marine deposits, Bahía Blanca area, Buenos Aires Province, Argentina. *Quaternary of S. America and Antarctic Peninsula* 3, 197-206.

Fletcher, C.H. and Sherman, C.E., 1995, Submerged shorelines on O'ahu, Hawai'i: archive of episodic transgression during the deglaciation? Journal of Coastal Research Special Issue No. 17, *Holocene Cycles: Climate, Sea Levels, and Sedimentation*, p. 141-152.

Gagliardini, D., Aliotta, S., Dogliotti, A. & Clemente-Colón, P., 2005. Identification of bed forms through ERS SAR images in San Matias gulf, Argentina. *Journal of Coastal Research*. 21(1): 193-201.

Gagliardini, D.A. & Rivas, A.L., 2004. Environmental characteristics of San Matías gulf obtained from Landsat – TM and ETM+ data. *Gayana* 68 (2 T I), 186–193.

Grill, S. C. & Quattrocchio, M. E., 1996. Fluctuaciones eustáticas durante el Holoceno a partir del registro de paleomicroplancton: Arroyo Napostá Grande, sur de la provincia de Buenos Aires. *Ameghiniana* 33, 4, 435-442.

Guilderson, T. P., Burckle, L., Hemming, S. & Peltier, W. R., 2000. Late Pleistocene sea level variations derived from the Argentine Shelf. *Geochemistry, Geophysics, Geosystems* 1, 2000G000098.

Isla, F. I., 1998. Holocene coastal evolution of Buenos Aires. *Quaternary of South America & Antarctic Peninsula,* A. A. Balkema, 11, pp. 297-321.

Monti, A. J. A., 2000. Edades ^{14}C y ciclicidad de la acreción en depósitos costeros elevados, Bahía Engaño, Chubut. *Revista de la Asociación Geológica Argentina* 55, 4, pp. 403-406. Buenos Aires.

Peltier, W. R. & Fairbanks, R. G., 2006. Global glacial ice volume and Last Glacial Maximum duration from an extended Barbados sea level record. *Quaternary Science Reviews,* 25, pp. 3322-3337.

Pierce, J. W., Siegel, F. R. & Urien, J. M., 1969. Topografía submarina del Golfo San Matías. *VI Jornadas Geológicas Argentinas*. Buenos Aires, III, pp. 127-140.

Rutter, N., Schnack, E. J., Fasano, J. L., Isla, F. I., Del Río, L. & Radtke, U., 1989. Correlation and dating of Quaternary littoral zones along the Patagonian coast, Argentina. *Quaternary Science Reviews* 8, pp. 213-234.

Schäbitz, F., 1994. Holocene climatic variations in Northern Patagonia, Argentina. *Palaeogeography, Palaeoclimatology, Palaeoecology* 109, pp. 287-294.

Siddall, M., Rohling, E. J., Almogl-Labin, A., Hemleben, Ch., Meischner, D., Schmelzer, I. & Smeed, D. A., 2003. Sea-level fluctuations during the last glacial cycle. *Nature* 423, pp. 853-858.

Siddall, M., Pratt, L. J., Helfrich, K. R. & Giosan, L., 2004. Testing the physical oceanographic implications of the suggested sudden Black Sea infill 8400 years ago. *Paleoceanography* 19, PA1024, doi:10.1029/2003PA000903.

Spagnuolo, J. O., 2004. *Evolución de la región costera-marina de Punta Alta, provincial de Buenos Aires*. Unpublished Thesis, Universidad nacional del Sur, B. Blanca 269 pp.

Tonini, M., Palma, E. & Rivas, A., 2006. Modelo de alta resolución de los golfos patagónicos. *Mecánica computacional* XXV, pp. 1441-1460.

Weiler, N. E., 2000. *Evolución de los depósitos litorales en bahía Anegada, Provincia de Buenos Aires durante el Cuaternario Tardío*. Unpublished thesis, University of Buenos Aires, Buenos Aires, 184 pp.