

A SEARCH FOR PALEOCEANOGRAPHIC AND PALEOCLIMATIC CHANGES DURING THE LAST 2,000 YEARS IN NORTHERN CHILE

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The extreme aridity of the coastal desert of northern Chile is the result of a singular interaction of oceanic and atmospheric processes. The northbound cold Humboldt Current and the eastern branch of the SE Pacific anticyclonic cell combine their effects to strongly reduce the evaporation of water from the Pacific Ocean and, furthermore to limit the transfer of humid air inland. Additional orographic factors (the 700 to 1,000-m-high Coastal Scarp of northern Chile on one hand, and the Andes Cordillera on the other) strongly reinforce the arid conditions in the heart of the Atacama desert, in the Pampa del Tamarugal and the central valley. In spite of the phenomenon referred to as « invierno boliviano », or « invierno altiplánico » which brings some rainfall to the northeasternmost part of the Chilean territory, the blocking of humid air from the Amazonian and Atlantic regions is particularly effective, and seems to have remain so, for a long time during the Quaternary.

At an interannual time scale, the current climate and oceanographic conditions of northern Chile are altered by the El Niño-Southern Oscillation system. Though, the El Niño conditions do not provoke systematically rainfall in the arid northern Chile, in the same way that they induce excess precipitation on the coast of northern Peru, or in central Chile. A historical analysis of the rainfall events during the last two centuries in northern Chile (Ortlieb, 1994,1995) showed that El Niño years may be « rainy » (not more than a few cm of precipitation, in any case!) but not always. The impact of the El Niño phenomenon is stronger and more straightforward along the coastal region (onshore, as well as in the nearshore and offshore areas). The elevation of nearshore sea surface temperatures and the reduction of primary productivity affect seriously the marine life and the whole trophic chain along the north Chilean coast.

In the bay of Mejillones (23°S), we investigated the possibility that relatively shallow marine sediments (about 100 m depth) provide some record of former oceanic conditions, and subsequently of climatic fluctuations. A series of Phleger cores, several decimetres (up to one meter) long were collected in 1993. The first results (1994-95) obtained in the PALEOBAME program (ORSTOM-Univ.de Antofagasta) were encouraging since it was confirmed that hypoxic conditions, found on the bottom of the bay (below a 50 m depth) strongly limited the bioturbation and were thus favourable for a sedimentary record of former oceanographic conditions. The dark greenish muds are most often grossly laminated and the stratification is well preserved in the cores. The sediments are rich in organic matter and contain abundant diatoms, foraminifers, and fish remains. Variations of relative abundance of phyto- and zooplankton, and of fish scales, through regular sampling every cm downcore, are being investigated in several cores from the western and central part of the 15 km wide bay. Preliminary radiocarbon dating (on bulk de-carbonated sediment) suggests sedimentation rates in the order of 250 mm/10³ y (but locally of as much as 500 mm/10³ y). These rates are very high if it is taken into account that they reflect a strong productivity. The terrigenous input in the bay is essentially limited to eolian sediments, because the extreme aridity practically prevents any runoff.

On-going research aims to reconstruct paleoenvironmental conditions, and their variations, with a decadal-to-centennial resolution, in the course of the last few thousand years. These studies thus tend to detect variations in the oceanic circulation pattern and in the intensity of the local upwelling system (Punta Angamos). Preliminary results (Ortlieb *et al.*, 1994, 1995) from the first cores suggested that the sedimentary record of Mejillones Bay may have registered a cold-water episode and beforehand, warmer-than-present conditions. During the latter episode, sardine replaced anchovy (as observed during present-day strong El Niño events) while the water column was stratified and the sea bottom was submitted to an intensified hypoxia (large predominance of *Bolivina seminuda* among the benthic foraminifers). Based on the chronological framework of the cores, it was suggested that the former, cooler, episode be correlated with the Little Ice Age, and the latter episode with the Warm Medieval Interval. More work is needed to characterise the distinct oceanographic regimes which may have existed in the bay in a recent past, and to identify the signature of these variations in the sedimentary record for each group of bioindicators under consideration (pelagic fishes, planctonic and benthic foraminifers, diatoms and silicoflagelates).

In spite of their preliminary character, the current studies on a time scale as short as the last millennia constitute a new line of investigation along the South-American Pacific coast. Altogether, the exceptional aridity of the bordering continent, the existence of an nearby upwelling centre, a particular geographic disposition of the embayment with respect to the dominant currents, a shallow depth, and the hypoxic conditions of the bottom, make of the bay of Mejillones a particularly suitable site for the reconstitution of some variations, at the decadal scale, of circulation patterns in the eastern Pacific Ocean and of paleoproductivity, which in turn can be related to paleoclimatic changes of the last centuries and millennia.

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