QUATERNARY MORPHOSTRATIGRAPHY AND VERTICAL DEFORMATION IN MEJILLONES PENINSULA, NORTHERN CHILE

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NORTHERN CHILE SUBDUCTION PLATE-BOUNDARY AND QUATERNARY UPLIFT MOTIONS

At subduction plate boundaries, it is commonly expected that relatively strong vertical motions occur. The coast of northern Chile, like that of southern Peru (Goy et al., 1992; Macharé & Ortlieb, 1992; Ortlieb et al, 1995a; 1996) did register such positive vertical deformation that is linked to the subduction of the Nazca plate below the South-American plate (Barazangi and Isacks, 1976). Emerged marine terraces are preserved along long stretches of the northern Chile coast (Radtke, 1989). Recent studies focused on the identification, age determination and morphostratigraphy of the remnants of Pleistocene shorelines, to decipher the neotectonic behaviour of the 1000 km-long coastal segment located south of the Peruvian border. The methodology points to a quantification of the vertical deformation, at a 10^5y scale, and to the detection of variations in local/regional uplift rates during the late and middle Quaternary. The study also deals with the determination of differential vertical movements between structural blocks, and the obtention of a chronostratigraphical framework for the reconstitution of Quaternary faulting activity in the coastal area..

At the present stage of the co-operative project, we completed a general reconnaissance of the Quaternary marine terraces in the whole study area, and realised detailed studies in the sector between Antofagasta and Hornitos (Ortlieb et al., 1995b, 1997). Geological, paleontological and geomorphological surveys in the Antofagasta-Hornitos region now provide a morphostratigraphical interpretation of the various types of coastal remnants: wave-cut terraces, beach ridges, marine deposits. Geochronological and geochemical analyses involving U-series dating, amino-acid stratigraphy and stable isotope measurements assess the chronostratigraphical framework currently being established (Hillaire-Marcel et al., 1995).

In the coastal sector between Antofagasta (23°30'S) and Iquique (20°S), the oldest Pleistocene marine remnants and Late Pliocene sediments are usually found at the foot of the Coastal Escarpment, at elevations of the order of +100 to +200 m (Ortlieb et al., 1995b). In this coastal region, Middle and Late Pleistocene marine terraces are often set in staircase disposition, with the oldest terraces covered

by alluvial fans. The most recent and best preserved terrace was formed during the last interglacial stage (isotopic stage 5, ca. 120 ka). The elevation of its inner edge varies from a few metres above present MSL (e.g. at Coloso, S of Antofagasta) to more than +40 m (asl) (Hornitos).

At Antofagasta, the vertical motions were relatively slow during Quaternary time (ca. 50 mm. 10^{-3} y) on the long range. North of Mejillones Peninsula the mean net uplift rate, for the whole Quaternary, is about 100 mm.10^{-3} y (Ortlieb et al., 1995b). However, looking in more detail, distinct tendencies were inferred. At Coloso (Antofagasta), the uplift rate appears to have diminished through time (no uplift in the last 125,000 y), while it increased at Hornitos and more to the north. Geochronological measurements on marine shells and morphostratigraphical considerations led to interpret that the Hornitos area was uplifted at a rate of 240 mm.10^{-3} y in the course of the last 330 ky (Ortlieb et al., 1997). It can be inferred that, in the Hornitos area and in a large sector of the northern Chile coast, between 20° and 23°S, vertical deformation was slow in Early Pleistocene/early Middle Pleistocene, and that it accelerated in late Middle Pleistocene/Late Pleistocene times.

MARINE TERRACES AND BEACH RIDGES IN MEJILLONES PENINSULA

Between Antofagasta and Hornitos, the peninsula of Mejillones registered strong Quaternary deformations. Large fracture zones that trend N-S and NW-SE, delineate a series of structural blocks which were vertically displaced by amounts reaching hundreds of metres, in the course of the last few million years. Some of these deformations are still active. The flat tops of several mesas, like Cerro Bandurria (+400 m), that clearly result from wave erosion, were classically interpreted as formed during the Quaternary (Okada, 1971; Armijo & Thiele, 1990). Actually, the sediments that cover these high-lying wave-cut surfaces include a typical nearshore Pliocene fauna (with *Chlamys vidali, Chlamys simpsoni, Ostrea ferrarisi, Fusinus remondi).* We interpret that some of the highest wave-cut terraces that surround Morro Mejillones, generally devoid of sedimentary and faunal remains, are also of Pliocene age.

The highest-lying Pleistocene marine deposit identified (on paleontological grounds) in the peninsula is located 2 km ESE from Morro Mejillones, at an elevation of +440 m (Ortlieb et al., 1995b) and close to the N-S trending Mejillones Fault. The strong deformation evidenced along Mejillones Fault (apparent vertical offset of the order of 500 m) most probably reflect altogether an extensional normal component related to the semi-graben structure of the northern peninsula and a net positive uplift motion.

In the central and eastern parts of the peninsula, the latest Pliocene and earliest Pleistocene marine deposits are commonly lying at elevations of the order of +200 to +220 m, thus suggesting that the amount of Quaternary uplift of the whole isthmus and eastern peninsula was not greater than about 220 m (Ortlieb, 1993).

Three large sequences of regressive beach ridges are preserved in the northern (Pampa Mejillones), northwestern (Caleta Herradura de Mejillones) and southern (Pampa del Aeropuerto) parts of the peninsula (Fig. 1). These series of exceptionally well-preserved coastal features cover wide, gently seaward sloping, surfaces that reach maximum elevations of ca. +220 m. Several discrepant chronostratigraphic interpretations were proposed for these beach-ridges (Herm, 1969; Okada, 1971; Ferraris & Biase, 1978; Armijo & Thiele, 1990; Ortlieb, 1993). For several geochemical and methodological reasons, it has been difficult up to now to establish the age of the ridges. Only recently, we obtained chronostratigraphic elements that suggest an (early) Middle Pleistocene age for some of the oldest sets of beach-ridges (Ortlieb et al., 1995b). The lateral correlation between the northern and southern beach-ridge series was based on the occurrence of a anomalous warm-water assemblage of mollusk shells (including: *Cerithium stercusmuscarum, Olivella* sp., *Prunum curtum, Turbo* cf. *T. fluctuosus, Bulla punctulata, Anomia peruviana, Arcopsis solida, Mactra velata, Ostrea megodon, Donax peruvianus* and *Trachycardium* cf. *T. procerum).* Geochronological data combined with geometric considerations led to propose that the « thermally anomalous molluscan assemblage » be

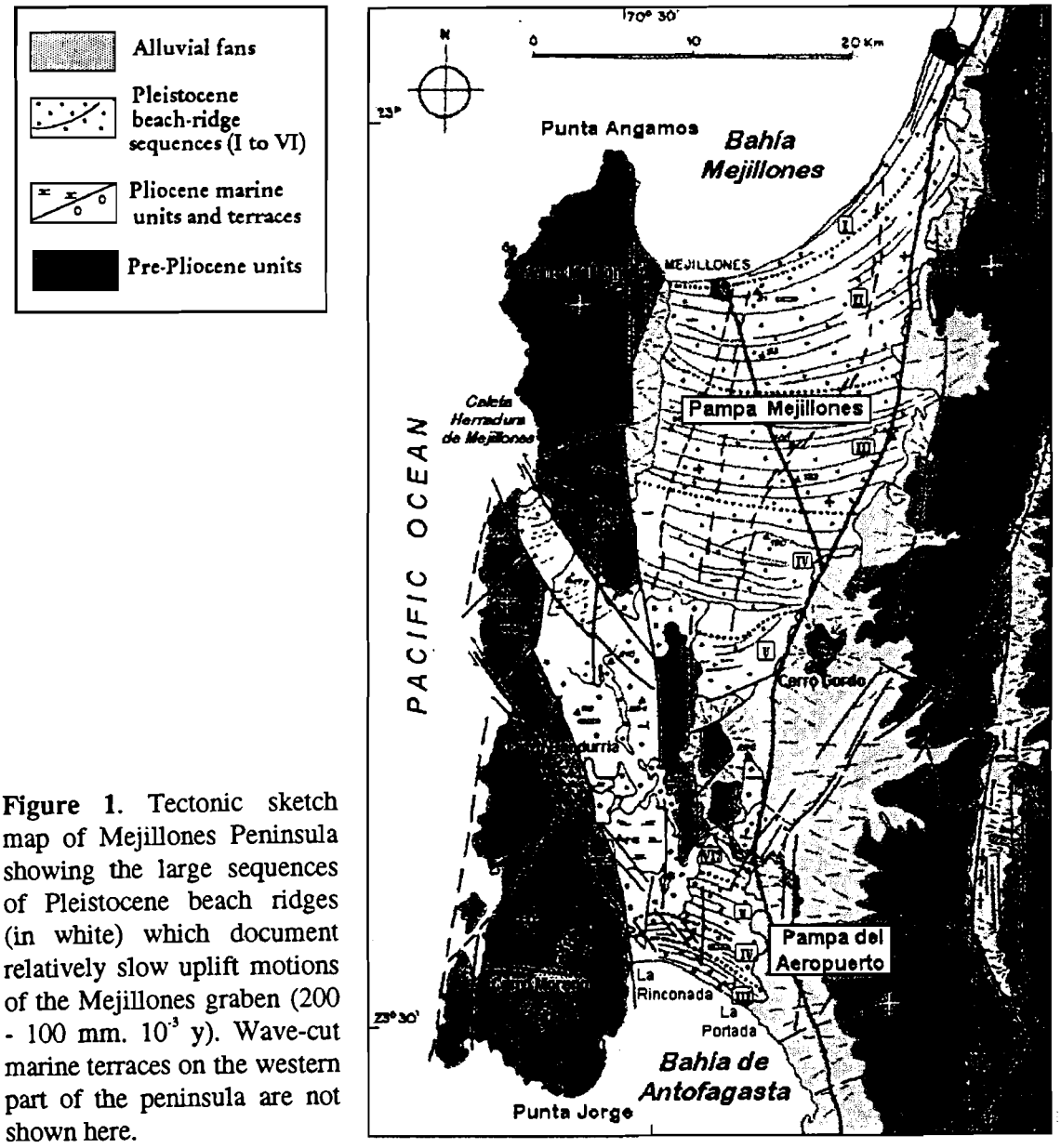

Figure 1. Tectonic sketch map of Mejillones Peninsula showing the large sequences of Pleistocene beach ridges (in white) which document relatively slow uplift motions of the Mejillones graben (200 - 100 mm. 10^{-3} y). Wave-cut marine terraces on the western part of the peninsula are not shown here.

assigned to the isotopic stage 11 high seastand (400 ka) (Ortlieb et al., 1995b). This chronostratigraphic interpretation suggests a higher uplift rate than previously proposed (Ortlieb, 1993) during the last half-million years, and much slower motions during the period late Pliocene- early Middle Pleistocene.

CONCLUSIONS

The peninsula of Mejillones is a composite crustal block that was uplifted by a mean net amount of the order of 200 m within the last 2 My or so. This motion was not significantly stronger than those registered in the coastal region north of Hornitos. Previous interpretations that implied more rapid uplift

motions of the peninsula were based upon unverified chronostratigraphic assumptions. The uplift of some faulted compartments of the western peninsula, which amounts to a maximum value of 240 m, seems to result from compressional deformation.

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