

**VERTICAL MOTIONS INFERRED FROM PLEISTOCENE SHORELINE
ELEVATIONS IN MEJILLONES PENINSULA, NORTHERN CHILE:
SOME REASSESSMENTS.**

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RESUMEN: Los intentos de determinación de la velocidad de levantamiento reciente de la península de Mejillones (costa norte de Chile) produjeron resultados muy diferentes según los autores: de 33,000 a 70 mm/10³años. Se confirma que, en la parte nor-oriental de la península, los movimientos verticales cuaternarios tuvieron una amplitud total de sólo 220 m y que la tasa de levantamiento ha probablemente ido disminuyendo durante el Pleistoceno, desde ca. 250 hasta 70 mm/10³años.

KEY WORDS: Neotectonics, vertical movements, Quaternary shorelines, Chile

INTRODUCTION

The 50 x 20 km Mejillones Peninsula (Fig.1) constitutes a salient faulted block that interrupts the N/S-oriented Coastal Escarpment of the northern Chilean coast and disrupts the steep continental margin of the South-American plate, precisely in the area where the Peru-Chile Trench shows its greatest depth (8,060 m). For these morphostructural characteristics and because the Mejillones Peninsula is located at the latitude where some Central Andean structural domains are the most widely developed (Precordillera and "Depresión preandina" with the Salar de Atacama), there is much concern to understand the structure and tectonic evolution of this anomalous block.

The Mejillones Peninsula shows much evidence of Plio-Quaternary deformation: large crustal faults, block tilting, tectonic scarps cutting Quaternary alluvial fans and marine deposits, and deformed abrasion platforms. The preservation of sequences of Pleistocene regressive shorelines (NW, NE and SE sectors of the peninsula) indicates that some steady uplift motions (and not only fault-controlled deformation) also occurred during the Quaternary.

Up to now, strongly discrepant estimates of recent vertical motions have been proposed by investigators who made preliminary field observations and/or geochronological analyses on some of the Pleistocene coastal units of the peninsula. The estimates of mean uplift rates for the late Quaternary (=last 125,000 y) vary by as much as one, or even two, order(s) of magnitude! Such a discrepancy is beyond acceptable

limits for neotectonic studies in a key area like the Mejillones Peninsula:

ESTIMATES OF VERY HIGH LATE QUATERNARY UPLIFT RATES

A few authors estimated mean uplift rates over 2000 mm/10³y of the peninsula during the late Quaternary. First, Okada (1971) interpreted that, since the last interglacial high seastand, some sectors of the peninsula had been uplifted at a mean rate of 3000 mm/10³y. Craig (1988) hypothesized that up to 200 m of uplift motions might have occurred since the Holocene sea level maximum (ca. 6000 BP), in the area south of the bay of Mejillones; such a motion would imply a mean rate of about 33,000 mm/10³y in the second half of the Holocene. Lately, Armijo & Thiele (1990) assumed that up to 280 m of uplift was produced since the last interglacial highstand (average rate of 2400 mm/10³y).

These interpretations are based on unwarranted assumptions, since the last interglacial (or Holocene) deposits were not positively identified. Craig's interpretation was based on radiocarbon results (in the range 38,000-25,000 BP) from shells collected in +200 m-elevated coastal deposits, although ¹⁴C results over 25,000 BP should not be trusted without special screening. Okada (1971) and Armijo & Thiele (1990) observed three major sets of marine terraces and abrasion platforms in the peninsula and simply assigned the lowest one (supposed elevation range: +30/+280 m), which included the Mejillones sequence of shorelines, to the last interglacial high seastand. They did not take into account neither the early work of Herm (1969) nor any result of more recent chronostratigraphic studies on the Pleistocene coastal deposits of the area (Radtke, 1985, 1987a, 1987b; Leonard et al., 1987, 1988; Hsu et al., 1989).

CHRONOSTRATIGRAPHIC AND GEOCHRONOLOGICAL AVAILABLE DATA

In a pioneer work on the major sequence of regressive shorelines located south of Mejillones (Fig.3), Herm (1969) interpreted that these conspicuous coastal deposits had been formed during two distinct episodes of high sealevel (Serena I and II) in the Early Pleistocene. Herm (1969) showed that the limit between remnants of the two transgressions was traceable on aerial photographs and was figured by a seacliff at ca.+80/90 m. He also pointed out that the oldest Pleistocene marine features in the area SE of Mejillones were preserved at +220/+200 m.

In the mid-eighties, were performed the first attempts to identify remnants of the last interglacial highstands along the coast of northern Chile. Radtke (1985, 1987a, 1987b) used Th/U and ESR (Electron spin resonance) methods, while Leonard et al. (1987, 1988) and Hsu et al. (1989) developed the first aminostratigraphic studies in northern Chile. Through these dating techniques, the mentioned authors showed that, in Mejillones-El Rincon area (Fig.3), the last interglacial coastal deposits crop out at the top of the modern seacliff, at an elevation below +15 m, and that the local uplift rate was of the order of 70 mm/10³y for the late Quaternary (Radtke, 1985; Leonard et al., 1988). NE of the bay of Mejillones, the 125 ka shoreline was found at +35 m at Hornitos (Fig.2)(Radtke, 1985), and at +40 m, 20 km N of Hornitos (Leonard & Wehmiller, 1991). These data suggest mean uplift rates of 240-250 mm/10³y for the narrow coastal plain at the foot of the Coastal Escarpment.

The highest late Quaternary uplift rate determined in the region (500 mm/10³y), and based on tentative identification of the last

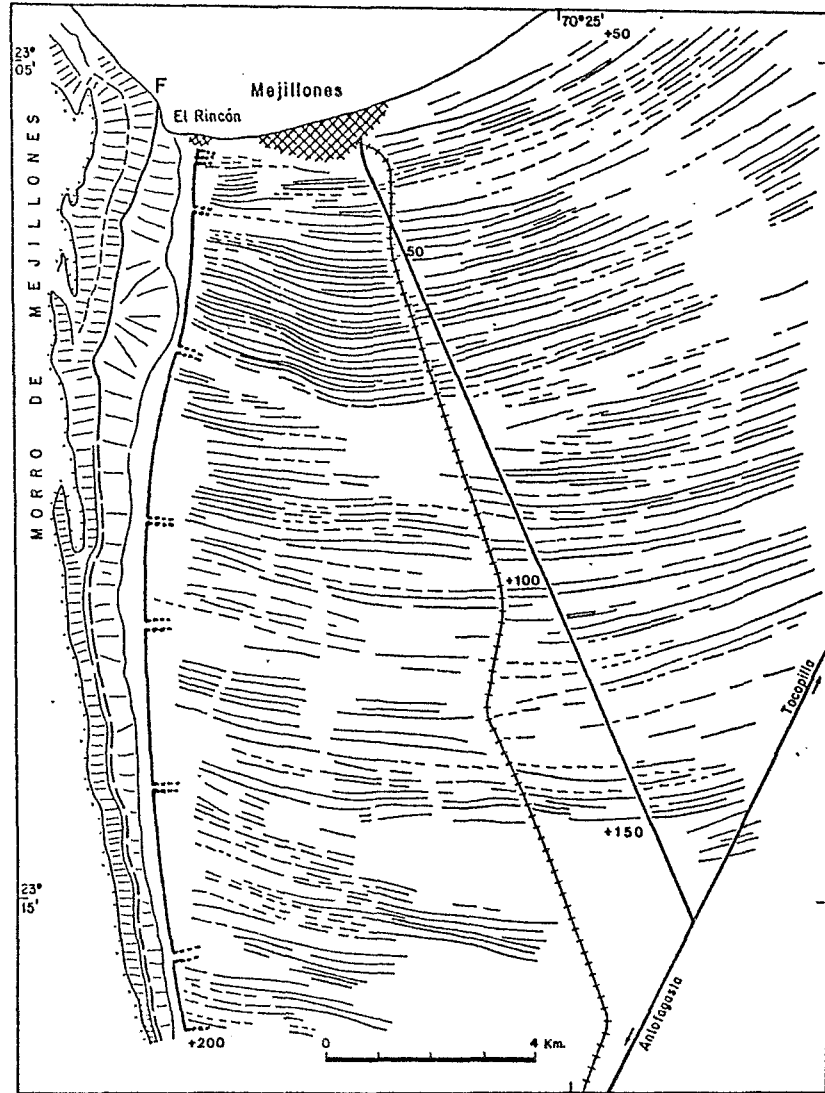
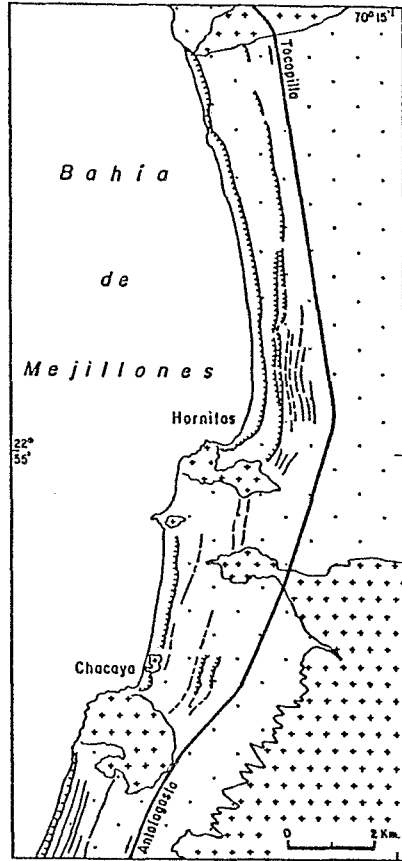
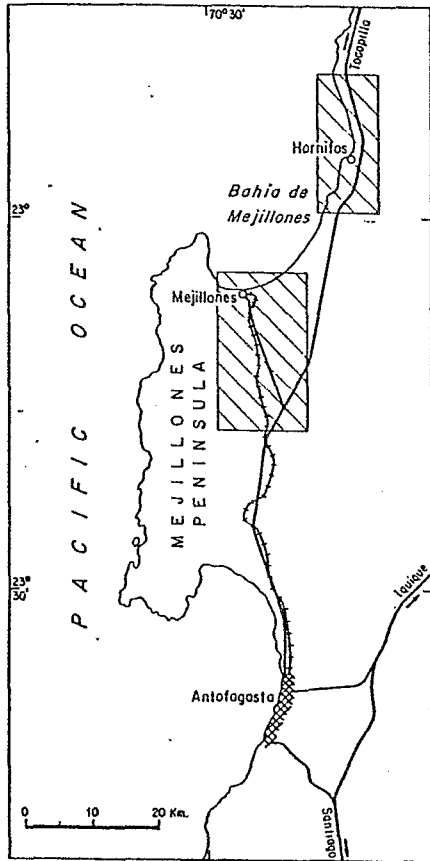


Fig.1.- Location map of the study area.

Fig.2.- Late and (late) Middle Pleistocene shorelines in Hornitos area: the 125 ka and 220 ka shorelines are found at +35 and +50 m.

Fig.3.- The sequence of Middle and Early Pleistocene shorelines preserved in the Mejillones graben. Indicated sets of shorelines might correspond to successive episodes of interglacial high seastands.

interglacial deposits, were found on the northern headlands (Punta Angamos) of Mejillones Peninsula (Leonard et al., 1988).

DISCUSSION AND CONCLUSION

Preliminary observations made in the framework of a program involving detailed mapping and chronostratigraphic analyses of Pleistocene coastal deposits in Mejillones Peninsula (Agreement ORSTOM/Univ. de Chile-Santiago/CSIC-Madrid/GEOTOP-Montréal), lead to the following comments:

- Near El Rincon, the 125 ka and 220 ka shorelines were identified at +15 and +31 m (Radtke, 1985). These two youngest terraces postdate the Mejillones sequence of shorelines.

- The sequence of closely spaced beach ridges preserved on a gently sloping surface, between ca. +200 m and the modern seacliff along the bay of Mejillones (Fig.3), is of Middle-Early (?) Pleistocene age.

- The sequence actually consists in a series of sets of beach ridges (Fig.3) which seem to correspond to successive sedimentation cycles coeval with high seastands. Current studies aim to determine whether each set of shorelines represent eustatically controlled encroachments of the sea (during a series of interstadial and interglacial episodes) in a regime of steady uplift, or if episodic tectonic motions were also involved.

- SE of Mejillones, the Pleistocene marine limit is located at about +200 m at the foot of the Coastal Escarpment, i.e. at the same elevation than the highest regressive shorelines of the sequence. If the oldest of these beach ridges were formed around 1 My ago, the overall mean uplift rate in the area would be about 200 mm/10³y.

- Vertical motions in the graben of Mejillones probably decreased through time, from about 250 mm/10³y to 70 mm/10³y in the Late Quaternary. Morphological characteristics of the shoreline sequence suggest that the apparently steady uplift motions involved deeply seated crustal (thermal?) mechanisms.

- Obviously, the western sector of Mejillones Peninsula was more strongly deformed and experienced higher uplift rates than the Mejillones area. Nevertheless, it still remains to be established whether the highest abrasion surfaces, found between +400 and +600 m, are of Pleistocene age or older.

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