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Neogene stratigraphic architecture and tectonic evolution of the Mejillones Peninsula (northern Chile) based on a new 1:50,000 geological map

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Introduction

The study area encompasses the entire Mejillones Peninsula in northern Chile (Fig. 1). The peninsula has been undergoing fault-controlled extension since early Miocene (Hartley and Jolley, 1995). East-west extension and latest Pliocene to Pleistocene regional uplift have been linked to subduction tectonic erosion and subcrustal accretion of material removed at the trench, respectively (Delouis et al., 1998; von Huene et al., 1999; Hartley et al., 2000). Extension has resulted in the formation of two main halfgraben basins bounded by N-S trending, east-dipping normal faults: the Caleta Herradura-Pampa del Aeropueto (CHPA) basin to the west and the Pampa de Mejillones (PM) basin to the east. Detailed study of map-scale stratal geometries and stratigraphic bounding surfaces has enabled us to develop a Neogene stratigraphic framework of these sedimentary basins that can be used to reconstruct the history of subsidence and faulting.

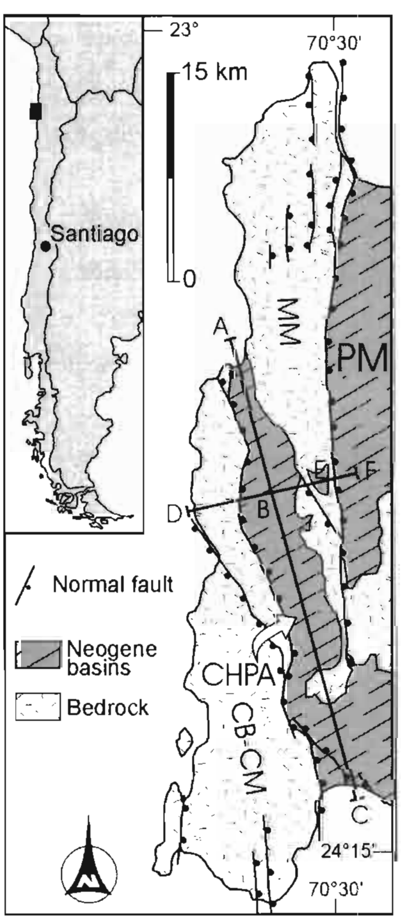

Figure 1. Schematic structural and location map of the Mejillones Peninsula. A, B, C, D, E, F, refer to locations indicated in Figure 2. MM, Morro Mejillones block; CB-CM, Cerro Bandurrias-Cerro Moreno block; PM, Pampa Mejillones basin; CHPA, Caleta Herradura-Pampa del Aeropuerto basin.

For this study we have adopted the nomenclature proposed by Niemeyer et al. (1996). According to them, five Neogene formations compose the major stratigraphic units of these basins: the Miocene Caleta Herradura Fm, the early Pliocene Cerro Bandurrias Fm, the late Pliocene Cuesta del Burro and La Portada Fms, the Pleistocene Mejillones Fm. These units sit unconformably on a complex pre-Cenozoic basement composed of Paleozoic metamorphic rocks (Jorgino Fm), Jurassic volcanic rocks (La Negra Fm), and Cretaceous clastic rocks of the Way Group (Flint et al., 1986).

The bulk of the ~400-m-thick Caleta Herradura Fm is exposed at Caleta Herradura (site A in Fig. 1). It is a westerly dipping monocline interposed between the metamorphic basement (Paleozoic Jorgino Fm) below and the shallow-marine and alluvial fan deposits of the Cerro Bandurrias and Mejillones Formations above and comprises a predominantly shallow-marine arenaceous succession with minor intercalations of sandy mudstones, diatomites, and conglomerates. Evidence from the calcareous nannoplankton (Mai, 1984), the faunal composition of the pure diatomite at the top of the Caleta Herradura Fm (Krebs et al., 1992), and from the planktonic foraminiferal content of the entire unit (Ibaraki, 2001), indicate that these strata span from late early to latest Miocene. The ~100-m-thick, early Pliocene Cerro Bandurrias Fm occurs at the immediate hanging-wall of the basin-bounding fault where it defines a gently north plunging asymmetric syncline possibly induced by normal drag against the fault. Beds consist of burrowed, shallow marine sandstones interfingering with footwall-derived shallow marine to subaerial conglomerates and breccias, and minor amounts of diatomites. The late Pliocene Cuesta del Burro Fm is up to ~40-m-thick and composed of coarse, bioclastic sand, whitish diatomites and, mainly along the base, by evaporite rocks. In the Caleta Herradura-Pampa del Aeropuerto basin these sediments rest unconformably on those of the Cerro Bandurrias Fm and are well exposed in the center of the peninsula (site b) where activity on the extensional faults of the western margin of the basin has progressively moved eastward during Pleistocene. As a result, basin fill successions have been transferred from hangingwall to footwall positions, and progressively uplifted and exposed. In the Pampa de Mejillones basin it crops out both at the footwall and hangingwall of the basin-bounding fault and lies directly on the sediments of the Way Group. In the Mejillones Peninsula the Pleistocene record consists of a series of marine terraces carved on footwall blocks, which pass into extensive sets of beach ridges at the hangingwalls. Geometry of beach ridges indicates northward regression in the Pampa de Mejillones and in the northern part of the Caleta Herradura-Pampa de Mejillones basin and southward regression in the southern part of the Caleta Herradura-Pampa del Aeropuerto basin. Pleistocene deposits do not occur in the center of the peninsula, suggesting that this area was subaerially exposed during this time.

Neogene evolution of the Mejillones Peninsula

A new 1:50,000 geological map of the Mejillones Peninsula displays relationships between the various units listed above and the substrate. This, along with the observation that footwall topography decreases southward, suggest that the Neogene history of the Mejillones Peninsula involved a complex interplay between sea-level changes and tectonic and indicate that basin-bounding faults propagate from north to south (Fig. 2).

During the Miocene only the northernmost portion of the Caleta Herradura-Pampa del Aeropuerto basin was flooded by the sea. This area was an embayment where the shallow-marine Caleta Herradura Fm was deposited. During early Pliocene, as the rifting continued and the fault segments propagate southward, the sea flooded also

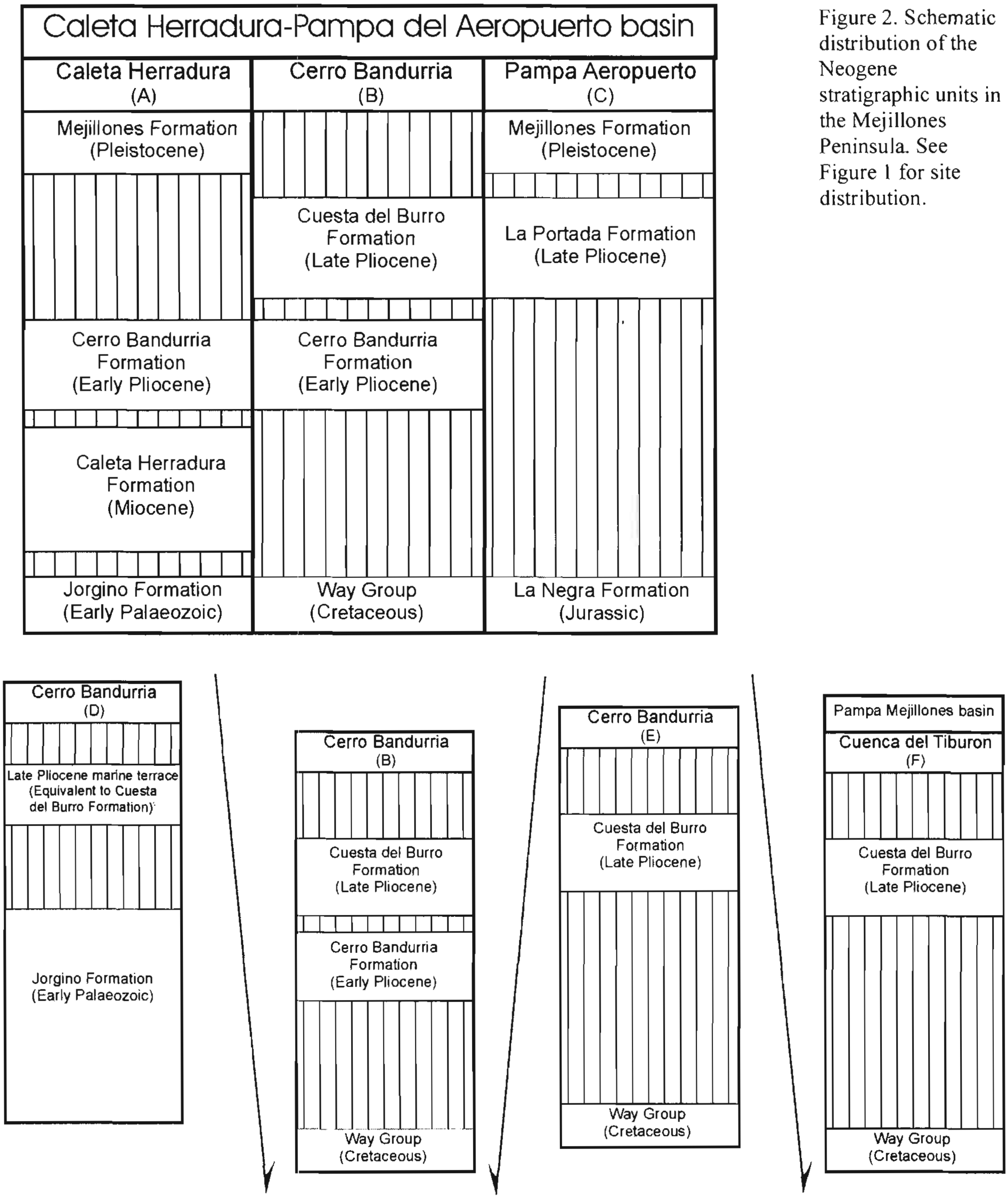

Figure 2. Schematic distribution of the Neogene stratigraphic units in the Mejillones Peninsula. See Figure 1 for site distribution.

the central part of the CHPA basin and the Cerro Bandurrias Fm was laid down. At this time the central part of the PA basin and, likely, the southernmost portion of the CHPA basin were still subaerially exposed. Both the Cerro Bandurrias-Cerro Moreno and Morro Mejillones footwalls remained attached to the mainland and formed two elongate peninsulas.

The fault segments continued to grow throughout the late Pliocene and the CHPA was completely flooded. Both the Cerro Bandurrias-Cerro Moreno fault block and Morro Mejillones fault block became separated from the mainland and formed footwall islands. The CHPA and the PA basins became interconnected. Shallow marine sediments were deposited both on footwall and hangingwall of basin-bounding faults (Cuesta del Burro Fm). During Pleistocene, because of the regional uplift, both footwall and hangingwall of basin-bounding faults were uplifted. The latter, because of hangingwall subsidence, at rates lower than those of the former (Cantalamessa et al., 2004). The central portion of the CHPA basin became subaerially exposed, and a series of marine terraces and sets of beach ridges were formed in footwall and hangingwall areas, respectively (Ortlieb et al., 1996; Radke, 1987; Ratusny and Radtke, 1988).

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