TERTIARY EXTENSIONAL FAULTING AT THE LOWER LOA VALLEY, NORTHERN CHILE (21-22°S)

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KEY WORDS: Central Andes, extensional faulting, Tertiary.

INTRODUCTION

The ductile strike-slip movements of the Atacama Fault System during Jurassic and Cretaceous are well documented (Hervé 1987b, Scheuber and Andriessen 1990, Scheuber *et al.* in press). On the contrary, the Tertiary kinematics of this fault system is less known, although some studies have been done (Armijo and Tiehle 1990, Hervé 1987a, Naranjo 1987, Véliz 1994). The aim of this contribution is to furnish new data regarding the Tertiary activity of the Atacama Fault System in its northern part (fig.1), both in the Coastal Cordillera (Salar Grande) and the western margin of the Longitudinal Valley (Salar de Llamara area, along the Lower Loa Valley). Special attention will be paid to the relationships between fault movements and stratigraphic units.

STRATIGRAPHIC UNITS

Uncomformably over the Paleozoic and Mesozoic rocks of the Coastal Cordillera four main stratigraphic units have been distinguished along the Lower Loa Valley (Cabrera *et al.* 1995):

1) At the bottom, covering a strong paleorelief, the **Loa Canyon Breccias Unit** crops out along the Loa Canyon and reaches a maximum observable thickness of 400 m. Clasts are heterometric, angular and of local provenance.

2) A **Red Alluvial Sandy-conglomeratic Unit** with interbedded anhydritic layers (Sáez *et al.* 1994) reaches several tens of m in thickness near Quillagua. This unit corresponds to distal alluvial fan deposits related to the Precordillera, and therefore it is part of a transverse alluvial system. It wedges out to the West. Jensen (1992) named this unit Hilaricos Fm. and tentatively correlated it to Sichal Fm. which is supposed to be Oligocene(?)-Miocene in age.

3) The **Diatomitic Fluvio-lacustrine Unit**, defined by Rieu (1975), is extensively described as Quillagua Fm. in Sáez *et al.* (1994) and Cabrera *et al.* (1995). Its detritic deposits have a southern origin and constitute a longitudinal fluvial system. The maximum observed thickness is 55 m. A cineritic level (**Aduana Cinerite**) related to the volcanism developed in the Alta Cordillera is found at the bottom of this unit. It is 6.8 My old (K/Ar method, Kiefer *et al.*, in press). Units 2 and 3 correspond to Quillagua Fm. from Jensen (1992).

4) The **Upper Evapotitic Unit** (Soledad Fm., Bobenrieth 1979) includes all the evaporites (anhydrites and halites) which are found at the top of the sequence, and comprises those infilling Salar Grande. The age of this unit may range from Oligocene(?) to Plio-Pleistocene.

STRUCTURE

From the survey carried out in the Salar Grande area and along the Loa Canyon the following features should be pointed out:

The structure of the Salar Grande basin is a N-S elongated half-graben defined by an extensional fault system. The main faults run along its western margin and the salt infilling the basin lies on the tilted and down thrown eastern block. The Salar Grande forms part of a tilted block structure which is well imaged by the present-day morfology; the N-S oriented hills have a steep eastern slope and a gentle western one (fig.2). The salt layers are horizontal and partially fill up the paleo-relief created by the mentioned N-S normal faults. Probably they lie on local breccias, like those outcropping SW of Salina Guanillos, which possibly may be correlated to the Loa Canyon Breccias Unit.

Along the Loa Canyon, from the coast to few km south of Quillagua, the described stratigraphic units are undeformed, filling up a vigorous paleo-relief developed on basement (Paleozoic and Mesozoic) rocks. This paleo-relief is asymmetric: steep slopes an gently inclined ones. This paleo-morphology is interpreted as the result of an extensional event which produced a tilted block system, the steep slopes corresponding to normal faults. The prevalent trends of the normal faults along the Loa Canyon are aproximately N-S and E-W resulting in a complex block system. Most part of the Loa Canyon Breccias Unit is undeformed. However, the lowest beds outcropping in the canyon close to an E-W fault show internal low-angle unconformities (fig. 3), evidencing their syntectonic deposition. Thus, it is concluded that the E-W extensional event, which individualized the Longitudinal Valley and the Coastal Cordillera, and also some smaller basins like Salar Grande in the Coastal Cordillera, occurred at the beginning of the sedimentatin of the Loa Canyon Breccias and stopped during the deposition of this unit (Oligocene-Early Miocene [?]).

The structures related to the described extensional event are cut by the normal fault system which defines the coastal scarp. Since the oldest marine terraces are Pliocene (Hartley and Jolley 1995), this faulting event probably occurred at the Miocene-Pliocene boundary. The small basin filled with breccias SW of Salar Grande, near Salina Guanillos, constitutes an example of early extensional structures cut by the coastal scarp system during latest Miocene times.

Some of the faults outcropping in the surveyed area show neotectonic or even present-day activity. However, most of the faults which led to the formation of the western margin of the Longitudinal Valley (Quillagua basin) and the Salar Grande basin developed mainly at the beginning of Loa Canyon Breccias deposition. Since then they have remained unactive as shown by the undisturbed younger deposits that seal them.

CONCLUSIONS

The relationships between the stratigraphic units and the normal faults evidence two main extensional phases during Tertiary:

The first one (Oligocene (?)-Miocene) developed in the Coastal Cordillera and Longitudinal Valley. It resulted in a tilted block structure which steps down towards the East. This phase is responsible for the formation of the western margin of the Longitudinal Valley and the associated lacustrine basins (Quillagua basin, Salar Grande).

The second one (Miocene-Pliocene) developed more to the West and gave rise to the Coastal Scarp Fault which throws down the western block.

Thus, during Tertiary, the E-W extensional activity migrated towards the West.

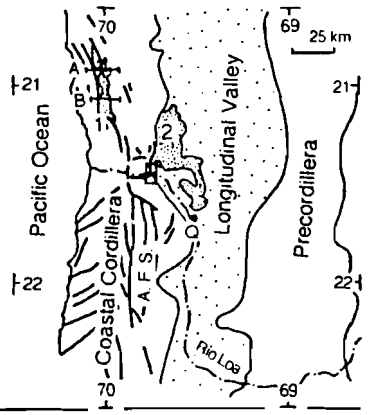
The preset-day Coastal Cordillera is a horst resulting from the superposition of both described brittle phases.

This contribution is part of the DGICYT PB94-0901 project and has been partially financed by the Comissionat per Universitats i Recerca, Generalitat de Catalunya (GRQ94-1048).

Fig.1.- Setting of the surveyed area.

A. F. S. Atacama Fault System
1. Salar Grande
2. Salar de Llamara
3. Quillagua

A and B: Cross-sections of fig.2.
Rectangle: Figure 3.



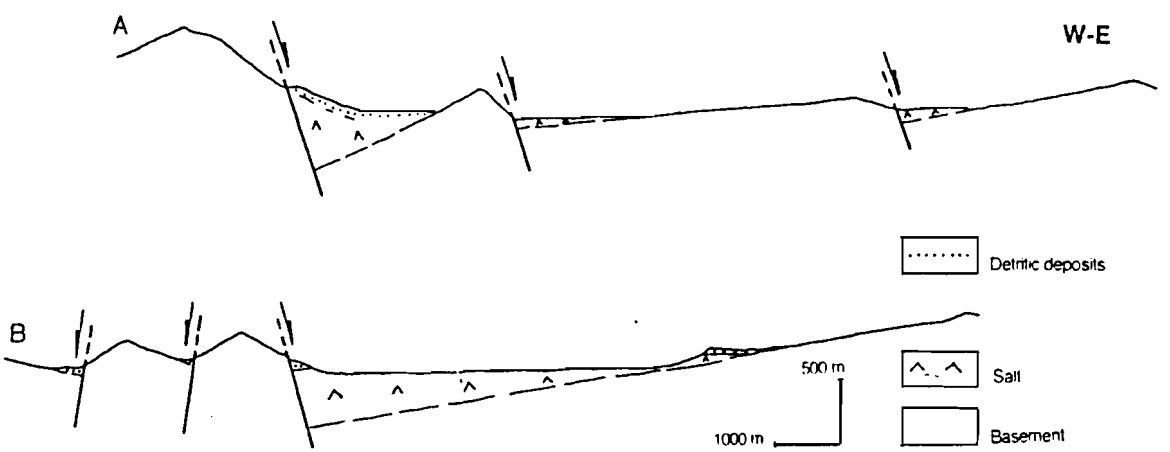


Fig.2.- Sections across Salar Grande (see location in fig.1).

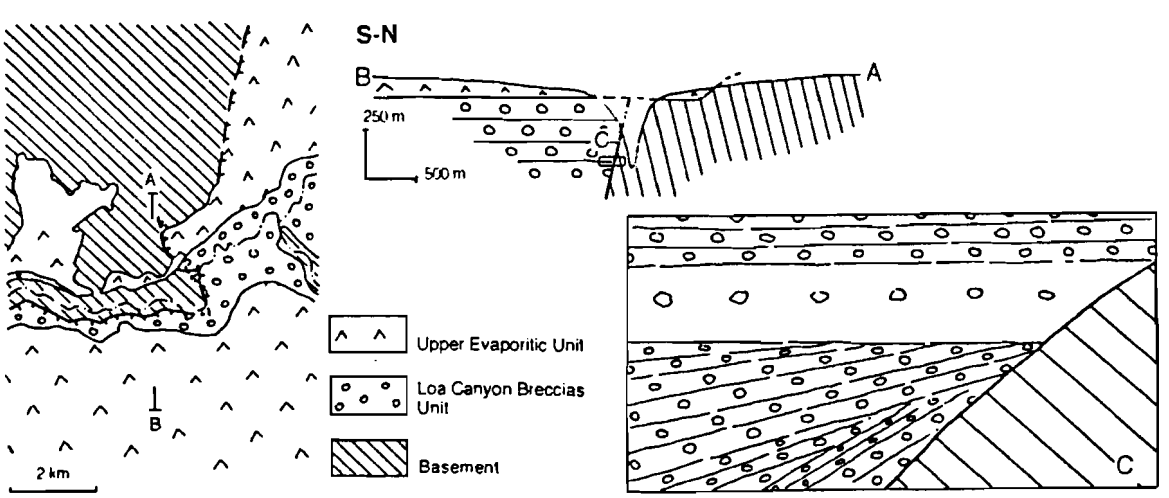


Fig.3.- Map and cross-section of the Loa Canyon (see location in fig.1). C. Internal low-angle unconformities in the Loa Canyon Breccias Unit (sketch after a photograph).

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