NEOTECTONICS ON THE WESTERN FLANK OF THE DOMEYKO CORDILLIER AND CENTRAL DEPRESSION (NORTHERN CHILE)

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INTRODUCTION

In northern Chile, Neogene debris flows and alluvial fans are trapped in the Central depression, also known as the Longitudinal Valley, part of the Atacama arid area. This depression presents an NS trend and an average EW width of 70 km (Figure 1). On its western flank, the Central depression is bounded by the Coastal Cordillera and the Atacama Fault system. On its eastern flank runs the Domeyko fault zone, a NS trending fault system that controls much of the structure of the Chilean Precordillera. (Mortimer, 1973). The Cenozoic was characterized by an important magmatic activity along volcanic arcs, migrating step by step towards the East up to its present-day location, along the Western cordillera. Although the timing and kinematics of the Domeyko fault system is poorly constrained, studies suggest that the Domeyko fault system was active during the life-span of Eocene-Lower Oligocene magmatic arc, showing both important strike-slip and shortening composants (Reutter et al., 1991; Tomlinson et al., 1993).Based on the relationships between tectonics and morphology, this paper aims to demonstrate the presence of active faulting and folding, lying along the piemont of the Precordillera and the Central Depression, and cutting trough the Recent alluvial deposits (Figure 1). It also discusses relative chronology between the intermittent rivers and the tectonic normal scarps.

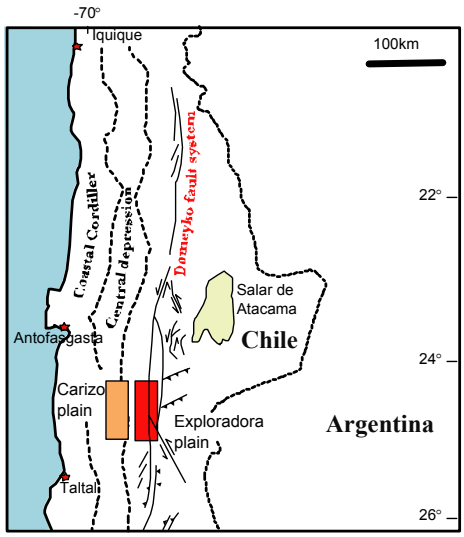

Figure 1: Respective locations of normal faulting (dark) and folding along the western flank of the Precordillera.

BASIN INFILLING MORPHOLOGY

The Central Depression is bounded on the west by the Coastal Cordillera, which separates the Depression from the Pacific Ocean since the Neogene. Throughout the Neogene, the Depression acted as a significant drainage basin for water input from the east that flowed into the area without reaching the sea. In the Exploradora and Carizo plains, between 25°S and 26°S, alluvial fan systems reach dimensions of kilometer wide and tens of metres in thickness. The topography responsible for this drainage arrangement was partly generated during the Upper Palaeogene, as a result of the Incaic orogenic phase (lower alluvial complex; Sáez et al., 1999). From this time to the Pliocene (Mortimer, 1973; Riquelme et al., submitted), the Central Depression was an endorheic area, and the Coastal Range acted as a barrier to drainage to the sea. North or south of this area, the development of large-scale salars and evaporitic deposits took place during the Neogene, mostly from Upper Miocene to Recent (Hartley and Chong, 2002). The basin fill in Pampa Exploradora and Carizo comprises a sequence of Neogene to Quaternary continental deposits, more than 300 meters thick. The neogene sequence correspond fluviatil conglomerats (Atacama gravels). The upper surface covers an erosional paleotopography that developed in the previously deformed sediments. Some volcanic layers, mostly ignimbritic flows are interstratified in the sedimentary sequence. A 10.2±0.9Ma old ignimbrite (Tomlinson *et al.*, 1993) can provide the oldest age for the Atacama gravels formation. Previous studies (Alpers and Brimhall, 1988, 1989) suggest that desertification in the Atacama region began at 14 Ma during global climate desiccation. Sedimentologic data from middle Miocene to upper Pliocene formations in the modern Atacama desert indicate that a semi-arid climate persisted from 8 to 3 Ma, punctuated by a phase of increased aridity at ca. 6 Ma (Hartley and Chong, 2002). In those plains, large coalescing and dissected alluvial fans, deposited by streams coming directly from the Precordillera, cover the valley floor. These alluvial deposits cover between 60% and 70% of the Central depression. Oldest abandoned surfaces are dissected and partly covered by inter-bedded debris flows and fluvial gravels, which are incised by intermittent rivers. The Quaternary recent alluvial fans interact with the preexisting drainage. A short, narrow and steep drainage network develop as range perpendicular watersheds came from the higher Precordillera. Well-developed desert pavements and big darkly varnished pebbles (50-100cm large) cover the oldest preserved surfaces of the fans, indicating that some surfaces are stable over long time periods..

MORPHOTECTONICS

1/ Normal Faulting and EW extension in the Pampa Exploradora (Figure 2)

The Exploradora fault (Figure 2) zone forms a network of more or less NS striking, parallel normal faults. The fault scarps are almost continuously distributed along the Precordillera. They are usually developed in the Atacama gravel deposits cutting through the intermittent river beds. The tectonic escarpements intersect the pre-existing drainage and cause the river deflection or interruption (Figure 2).

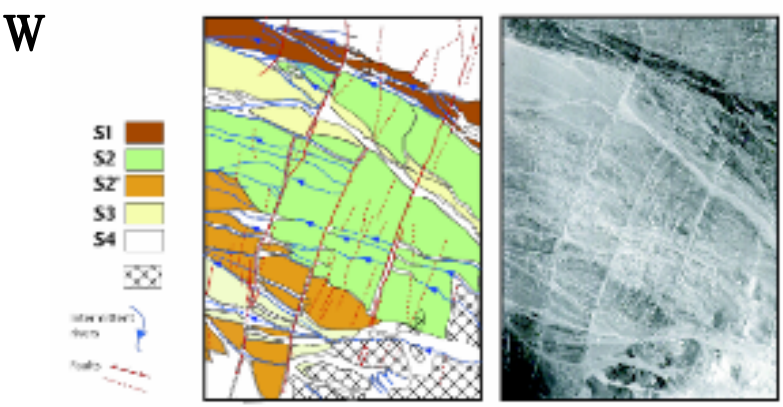

Figure 2: Aerial photography and interpretation of the normal faulting area, in the Pampa Exploradora around 3500 m of altitude.

Figure 2, based on the analysis of aerial photographs and sattelite images shows that the fault segments offset at least four alluvial fan generation (4 nested surfaces, Figure 2) that deposited at the piemont of the Domeyko cordillera in the Exploradora plain. These segments form small vertical and sometimes composite scarps about 2 meters high, The dip direction of which, (toward the East), never change along strike Mapped from an air photo enlargement and field work , Figure 2 focuses on some of the normal faults. The successive surface deposits are cut by three main normal fault scarps, parallel, East dipping, nearly perpendicular to the dry river runoff that dissects the fans surfaces. The vertical throws become smaller as the offsett surface gets younger. The faults also affects the most recent sediments deposited inside the intermittent valleys. This attests of the ongoing activity of the faults during the fan emplacement and dissection phases. No lateral offset can be systematically identified along these fault traces.

2/ Folding and NW-SE compression in the Pampa Carrizo (Figure 3)

To the west, and topographically lower (2000m), the Carrizo plain shows the same surface deposits: the Atacama gravels. Some evapotitic deposits can also be recognized of the top of the alluvial deposits (Figure 3).

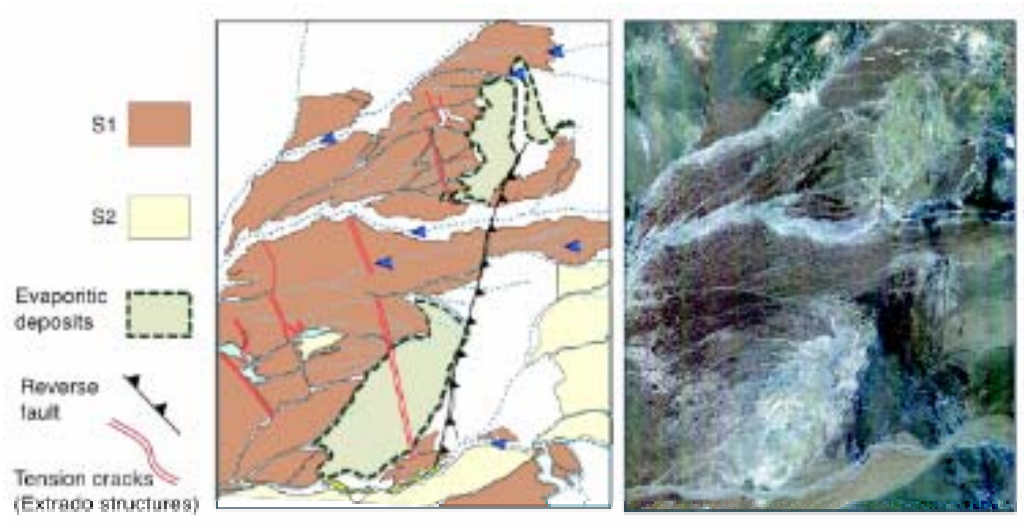

Figure 3: Aerial photography and interpretation of the folding area, in the Pampa Carrizo around 2000 m of altitude.

These two most recent surfaces are affected by an undescribed NE-SW fold system, outcropping under the Atacama gravels, that has been recently activated (Figure 3). A recent field trip has evidenced a number of

normal faults and tension cracks that cross a network of intermittent channels. This secondary fault set can be recognized, with a more NS trend than the fold direction. The Carrizo normal fault zone comprises short, parallel and antithetic fault scarps, very different from what is observed in the Exploradora first area, and we interpret them as extrado structures.

CONCLUSIONS

Clear-cut signs of neotectonics were not previously described in this region, and the known seismic activity is low. But two constrasting tectonic regimes can be distinguished in the study area, as already observed in the north of Chile (Victor, 2000). We propose here a new hypothesis in favor of neotectonic activity in the region of the Central depression. A NW-SE compressional regime in the lower part of the Central depression (Pampa Carizo) seem to predate or at least to coexist with a NW-SE extensionnal regime (Pampa Exploradora), present-day active, in the upper part of the Central depression (Figure 4). This could be reconciliated in one single model, either the normal faulting and folding could be the result of a regional tilting to the West of the whole Andean chain.

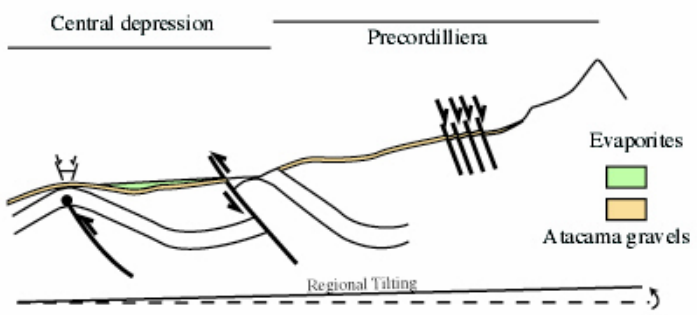

Figure 4: Proposed interpretation to explain both extension and compression evidences of deformation in the Andean Precordillera.

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