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Paleotectonic controls on the distribution of Quaternary deformation in the southern Precordillera, Central Andes (31°30´-33° sl)

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INTRODUCTION

The higher seismic hazard zone at the eastern side of the Andes on the Pampean flat slab segment, is located between 31° and 33° S latitude. The hazard seismic zoning map of this region derived from the historical and instrumental seismic record (INPRES 1977). The greater likelihood of human and property loss and damage of critical structures such as major dams of that region is concentrated in Precordillera and its adjacent piedmont environment (Fig.1a). However, little attention has been focused on the geologic investigation of Late Quaternary deformation including distribution, kinemtic analysis and paleoseismological history of major active faults.

In this paper, the distribution of Late Quaternary structures from southern Precordillera (31°30'S to 33°S) is analysed. Based on the identification and mapping of new evidences of Quaternary deformation in that region, geometric patterns of Quaternary fault reactivation and higher density of Quaternary ruptures along regional shear zones were determined. The presence of major paleotectonic and paleogeographic features in the area seems to play a considerable role in the distribution and control of Quaternary structures.

NEOGENE STRUCTURE OF PRECORDILLERA

The Precordillera is a first order morphotectonic unit located between 27°S and 33°S, on the southern flat slab segment of the Central Andes (Fig.1a). It result from contractional and transpressive deformation on foreland basin as a consequence of gradual flattening of Nazca plate in the last 20Ma. The western margin and part of the eastern edge of Precordillera coincide with ancient suture zones related to the colisional tectonic history during Paleozoic times. The central segment of Precordillera, between 28° and 31° 30´ S latitude, is a thin-skinned fold-and-thrust belt which verges eastward. On the other hand, the northern and southern sections of Precordillera, has developed above or near regional oblique megashear zones and paleogeographic features. Consequently, those regions exhibits a more complex structure characterized by a combination of contractional and strike-slip tectonics. Particularly, the Southern Precordillera unit (31°30´ to 33° SL), is the result of the interference of Late Cenozoic andean deformation with the northwest trending rift structure of Triassic Cuyana basin (Fig 1b). There, the tectonic inversion of extensional half-grabens is locally associated with thrusting of Terciary synorogenic sequences and with the reactivation of northwest striking Paleozoic fractures.

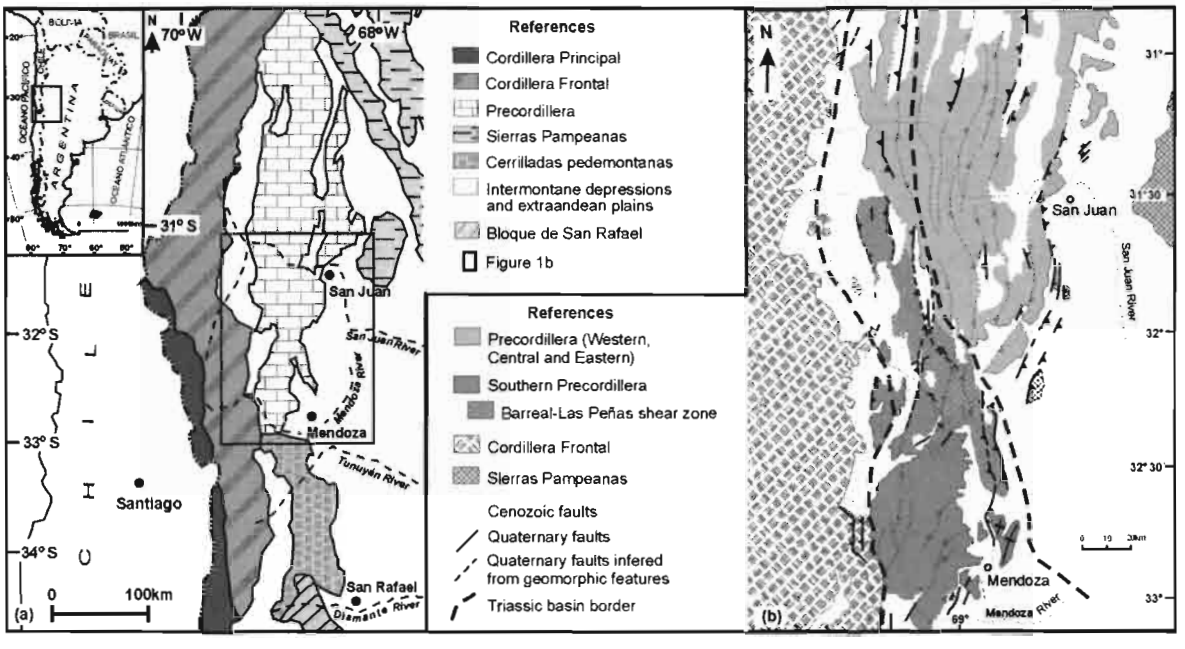

Figure 1. (a) Morphotectonic units at the eastern side of the Andes on the Pampean flat slab segment. (b) Map showing the Barreal-Las Peñas shear zone (northern edge of Southern Precordillera) and the location of Triassic Cuyana basin.

The northern margin of Southern Precordillera is defined by a 25-km-wide, 125-km-long zone of Late-Cenozoic deformation. That zone is a left-lateral transpressive belt striking N30°W, that crosses the entire Precordillera from Barreal valley in the northwest to Pampa de la Travesía at southeast. It consists of five large faulted blocks with a pronounced en-échelon geometry bounded by northwest striking tear fault systems (Fig.1b and 2).

EVIDENCES OF QUATERNARY DEFORMACIÓN

In the central section of Precordillera (30°-31°30´S), Late Quaternary ruptures generally result from the reverse and oblique rejuvenation along segments of range-front faults. Another evidences are commonly exposed at intermontane basins as fault scarps developed in alluvial fans of piedmont areas (Cortés et al. 1999). As a consequence of strain partitioning in this section of Precordillera, middle to upper Pleistocene sediments (Siame et al. 1997) have been displaced along the 120-km-long right-lateral El Tigre fault (Bastías and Bastías 1987).

South of 31°30'S, several geomorphic and structural evidences of Quaternary deformation have been observed on the active front at eastern border of Precordillera (Fig.1b). There, the piedmont environment has been disturbed by folding and the uplift of backthrusted basement blocks (Costa et al. 2000, Verges et al. 2000).

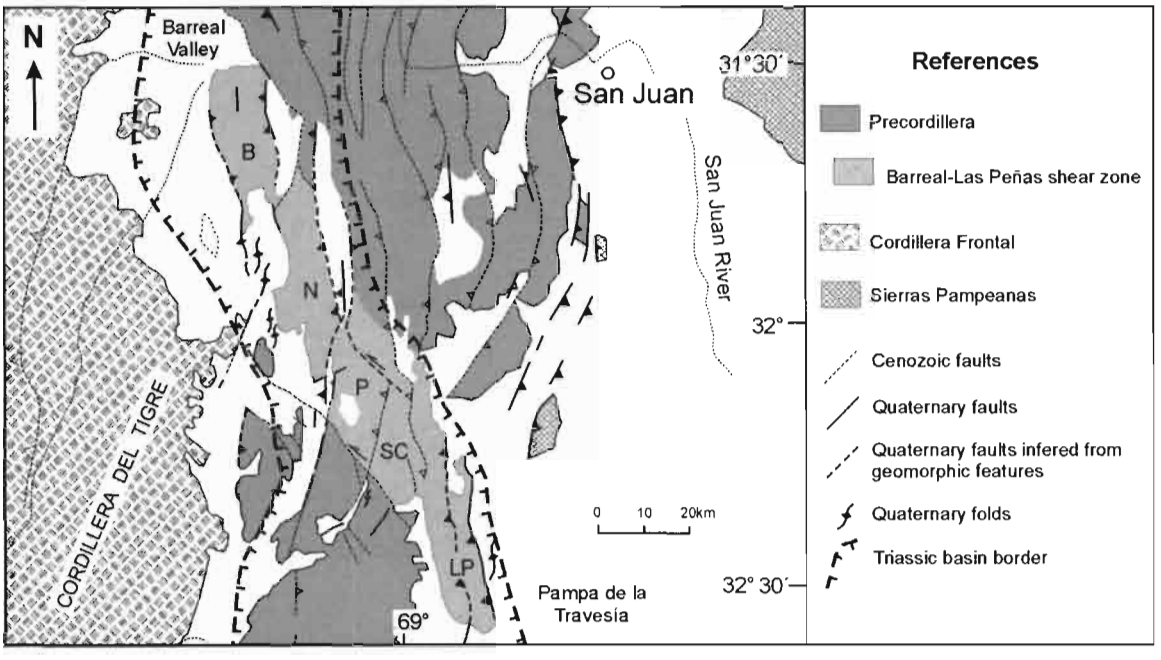

Figure 2. Distribution of Quaternary structures in the Barreal-Las Peñas shear zone. B:Barreal block, N: Naranjo block, P: Peñasco block, SC: Santa Clara block, LP: Las Peñas block.

Another surficial expressions of Late Quaternary deformation on the active front are fault scarps and fold systems which verges eastward (Bastías et al. 1993, Mingorance 2000).

New data from ongoing investigations show oblique deformation belts with a high concentration of Quaternary structures. In Southern Precordillera, more than 70% of that features are associated with the Barreal-Las Peñas shear zone (Fig. 1b and 2). Range front segments of Barreal, Naranjo, Peñasco, Santa Clara and Las Peñas faulted blocks exhibits geomorphic and structural evidences of Late Quaternary deformation. Several blocks (Barreal, Naranjo and Las Peñas) are bounded by reverse north-south and north-northwest striking faults. Growth folds and composite fault scarps seems to be localized by faults splaying off the main range-front-faults at depth. Geomorphic criteria and morphometric indices indicate a high tectonic activity in most of those mountain fronts (Fig.2). Active lateral propagation process at the tip point of some of these faults (Barreal and Las Peñas faults) are surficialy expressed as open folds and drainage anomalies on alluvial sediments (Costa et al. 2000, Cortés and Cegarra 2004). Barreal-Las Peñas shear zone is bounded, specially in its southern edge, by northwest striking Paleozoic strike-slip fault systems. Rejuvenated sections of these systems exert a strong control on the structural segmentation of Quaternary tectonic activity along north-south mountain fronts of Southern Precordillera (Fig.2). In Barreal-Las Peñas shear zone, northwest striking left-lateral zones undergoing tranpression are evidenced by en-échelon folds and structural highs developed on piedmont bajadas (Cortés and Cegarra 2004).

PALEOTECTONIC CONTROL ON THE DISTRIBUTION OF QUATERNARY STRUCTURES

Structural and geomorphic evidences of Late Quaternary deformation in Southern Precordillera show an heterogeneous spatial distribution. It has observed a greater concentration of those features in Barreal – Las Peñas shear zone. Another Quaternary structures are located in the orogenic front at eastern piedmont margin of Precordillera. Most of that spatial distribution is controlled by large paleotectonic features. A first order control in that area is exert by Triassic rift structure. In fact, between 31°30′ and 32°30′ S the Barreal-Las Peñas shear zone coincides with a part of northeastern edge of Cuyana basin rift. That section of the basin, is an oblique anisotropy for the Neogene and Quaternary deformation. Farther south, the longitudinal structural segmentation of Late Cenozoic faulted range fronts is promoted by Paleozoic northwest-striking fault systems displayed across the Southern Precordillera.

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