STRUCTURE OF THE EASTERN CORDILLERA IN NORTHERN ARGENTINA

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INTRODUCTION

The structure of the most southerly segment of the Eastern Cordillera, located between 22° and 27° S in northern Argentina, clearly distinguish it from those extending northward in Perú and Bolivia. This segment of the Eastern Cordillera developed over an ancient west-verging faultbelt belonging to the Ocloyic orogen (late Ordovician-Silurian) and over Cretaceous rift basins which are oblique to the strike of the Cenozoic Cordillera, therefore it shows notable along-strike differences in its stratigraphy and structure. The Proterozoic basement was intensely involved in Cenozoic folding. It is a foldbelt where most of the anticlines, cored by Proterozoic basement (Figures 1-A and 1-B), were thrust and imbricated by the younger than 1,5 Ma Diaguita movements. Some of the early Paleozoic and the late Cretaceous structures were reactivated and inverted, and sometimes transported pasively to the surface by the Cenozoic thrusts, therefore some of the structural complications are inherited from older tectonic orogenies.

STRUCTURE

Between 22° and 24° S lat the Eastern Cordillera is a fold and thrust-belt with a predominantly eastward vergence (Figure 1-1). The west verging structures croping out at its west border are in fact older Ocloyic structures transported passively to the surface (Figure 1-2). This segment consists mainly of folds of Precambrian basement covered unconformably by thick Cambrian (Meson Group) and Ordovician (Santa Victoria Group) marine strata (Turner, 1960) (Figure 1-A and 1-B). The Tertiary and late Cretaceous successions are scarcely developed. South of 24° S lat, the Eastern Cordillera displays double-vergence, its western edge is thrust over the tectonic depression of the Calchaquí Valley and its eastern edge is thrust over the Subandean Ranges. South of 25° S lat, the Eastern Cordillera undergoes a pronounced change: the Proterozoic basement plunges under the late Cretaceous (Salta Group) successions; the early Paleozoic strata thinned out and the Cretaceous strata are lying directly over the Proterozoic basement. The Cretaceous-Tertiary continental rocks attain a combined thickness greater than 4000 m. This part of the chain consists of major folds developed in these Cretaceous and Tertiary continental successions. It coincides with a pronounced structural depression where the axis of the basement- involved folds located northward are plunging to the south and those located southward plunge to the north. The southern end of the Eastern Cordillera (south of 26° S lat) is an anticlinorium which plunges at its both ends, made up of basement folds with a thin Cretaceous-Tertiary cover (Figure 1-A).

The shortening decreases southward from 40%, measured in some cross-sections of the Quebrada de Humahuaca, to 25% at its southern end. The reconstructions of the deep structure based on surface data and on interpretation of seismological data allow to postulate a regional décollement surface about 20 km deep. (Grier 1990; Cahill et al. 1992). The décollement surface of the Subandean Ranges seems to be higher , therefore it could be a ramp below the boundary between Eastern Cordillera and Subandean Ranges (Figure 1-3).

The present-day structure is the result of several superposed tectonic movements, starting in late Cretaceous, and the reactivation of ancient Paleozoic structures. This chain developed over a west verging fault belt belonging to the foreland of the Ocloyic orogen (Mon, 1993). Probably the Ocloyic faults were partially reactivated coinciding with the west-verging backthrusts of the western edge of the Eastern Cordillera. It seems that there is a correlation between the west-verging tendency and the intensity of the Ocloyic deformation. The Ocloyic deformation decreases northward in the same way as does the double vergence. The Cretaceous successions cover unconformably the older rocks; they are lying over the Precambrian basement and different Paleozoic levels. Because of the long stratigraphic hiatus it is impossible to establish the age of the movements represented by this unconformity, which may be attributed to the Ocloyic movements as well as to the younger Precretaceous movements. Upper Miocene red beds lie unconformably over the late Cretaceous beds and the older rocks indicating a folding episode between the Upper most Cretaceous and the Upper Miocene. They can be attributed to the Pehuenche movements (Salfity et al. 1984; Jordan & Alonso, 1987). The most intense movements occurred between Upper Pliocene and Pleistocene, when the pronounced uplifting of the chain produced the sedimentation in intramontane basins of thick fanglomerates beds yielding isotopic ages of 1,5 Ma (Marshall et al. 1982). These beds are overriden by Cretaceous and Proterozoic basement plates. That signifies that these segments of the Eastern Cordillera were thrust over the products of its own erosion at very recent time. These last movements belong to the Diaguita orogeny. Probably the folding of the Eastern Cordillera started with fault-propagation folds which later were dislocated by the younger Diaguita thrusts. After Marrett et al.(1994) and Claudohous et al. (1994) this young thrusting episode is not represented northward of 22° 30' where it is replaced by normal and strike slip faults. This cinematic change could be associated to major crustal variations (Allmendinger et al. 1993; Whitman et al. 1993).

The Eastern Cordillera rides over the cover of the Subandean Ranges by major thrusts set en echelon (Figures 1-A; 1-3). This tectonic edge coincides with a paleogeographic boundary represented by the west termination of the Silurian and Devonian successions of the Subandean Ranges. These successions are absent in the Eastern Cordillera. North of 24° S lat, the west margin of the Eastern Cordillera is marked only by a morphological change with the Puna. The Puna has internal drainage and the drainange of the Eastern Cordillera flows to the Atlantic basins. South of 24° S lat, the west edge of the Eastern Cordillera is thrust over the Tertiary succssesions filling the tectonic depression of the Calchaquí Valley. Southward the eastern belt of the Eastern Cordillera has a sudden termination at 27° S lat, the west belt has a transitional passage with the Pampean Ranges (Figure 1 A).

CONCLUSIONS

Southward of 22° S lat, near the boundary between Argentina and Bolivia, the Proterozoic basement reaches the surface and becomes the main component of this part of the chain. The sedimentary cover, made-up of Paleozoic, Cretaceous and Tertiary beds, was folded together with the basement. Folding took an important part in the deformation of this segment of the Eastern Cordillera. Major thrusting is related to the late movements of the tectonic evolution, dislocating the folds already formed. In this segment of the Eastern Cordillera there are not major décollements and lateral tectonic transport as those described northward, in Bolivia (Sempere et al, 1988; Kley & Gangui, 1993). Probably this segment represents the outcrops of the deep basement thrust sheets postulated by Kley & Gangui, 1993 in the subsurface of southern Bolivia. The tectonic movements become younger from north to south; the late Oligocene-early Miocene movements described in Bolivia (Sempere et al. 1990) are replaced southward by late Miocene-Pliocene movements. The 9 Ma thrusting episode reported by Cladohous et al. 1994 in the Altiplano continued until 1,5 Ma or even younger times (Mon et al. 1993; Marrett et al. 1994). The major thrust designated as "Cabalgamiento Andino Principal" (Semp[ere et al. 1988) was not identified in the surface southward of 22° S lat, but the "Cabalgamiento Frontal Principal" (Sempere et al. 1988} can be clearly recognized, it represents the boundary between the Eastern Cordillera and the Subandean Ranges.

FIGURE 1. 1 - A. Regional schematic map. 1 - B. Map of basement-involved folds at both sides of the Humahuaca valley. 1-1; 1-2 and 1-3 cross-sections of the east-verging segment of the Eastern Cordillera, in cross-section 1-2 are represented west verging ocloyic (Lower Paleozoic) structures transported passively to the surface. Proterozoic basemet, horizontal lines; undifferentiated Lower Paleozoic, solid points; Upper Cretaceous, vertical lines; Tertiary, open points.

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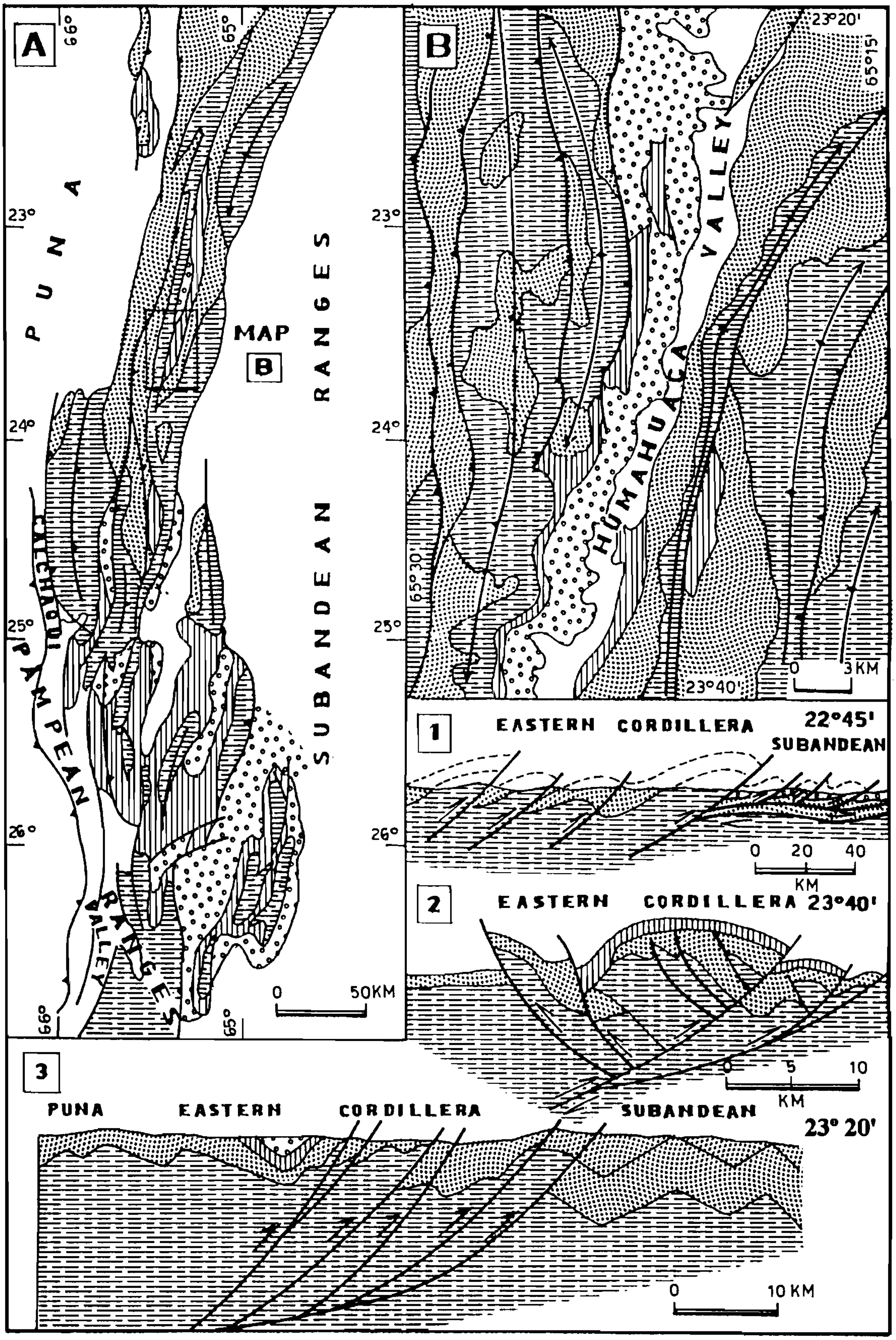
A
B
PUNA
SUBANDEAN RANGES
MAP B
PAMPEAN RANGES
CALCHAQUI VALLEY
0 50KM
HUMAHUACA VALLEY
23°20'
65°15'
65°30'
23°40'
0 3KM
1
EASTERN CORDILLERA
22°45'
SUBANDEAN
0 20 40 KM
2
EASTERN CORDILLERA 23°40'
0 5 10 KM
3
PUNA
EASTERN CORDILLERA
SUBANDEAN
23° 20'
0 10 KM