THE ALTIPLANO : A PROVINCE OF INTERMONTANE FORELAND BASINS RELATED TO CRUSTAL SHORTENING IN THE BOLIVIAN OROCLINE AREA

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Resumen

El Altiplano comprende fajas plegadas y corridas, zonas de transcurrencia y cuencas intramontanas de antepaís, todos elementos relacionados entre ellos en el tiempo y en el espacio. Esta complejidad se debe a la posición del Altiplano en el corazón del oroclino boliviano.

Key words : Altiplano; foreland basins; thrust belts; wrench-faults; stratigraphy.

The Altiplano-Puna is an enigmatic high plateau, 200 km-wide and 1500 km-long, with a mean altitude of 3650 m (1). Though it constitutes a major peculiarity of the central Andes and, more particularly, of the Bolivian orocline area, its origin is far from being fully understood, partly because of scarcity and dispersion of information. Recent integration of geological and geophysical data (many of them unpublished and borrowed from the Bolivian oil company Y.P.F.B.) within the central Andean geotectonic issue has led to the proposal of a new model (2).

Based on tectonostratigraphic grounds, we distinguish a complex "western belt" of terrains (not terranes) separated from an "eastern belt" by the Intra-Andean Boundary Fault (FLIA) (fig. 1). Though it runs in an area mostly covered by recent rocks, the existence and position of the FLIA are inferred from very strong stratigraphic differences between these belts, some geological data in less covered areas of Perú, zones of high gravity gradient, and preliminary magneto-telluric data. In our model, part of the western belt was underthrust beneath the eastern one (2). This underthrusting

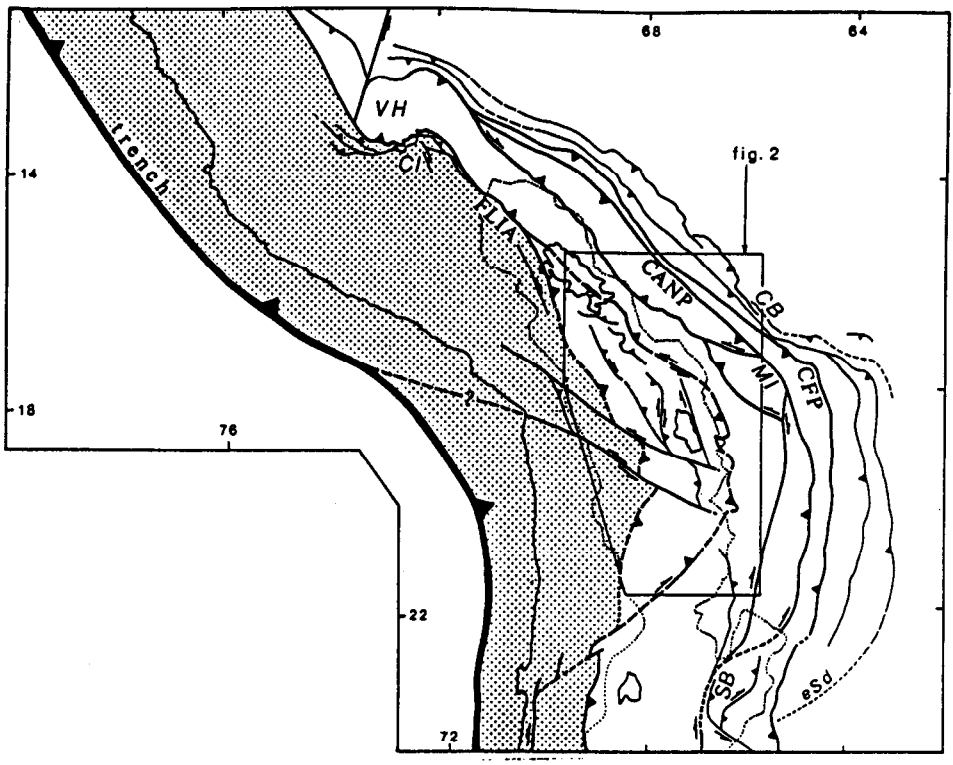

Fig.1. Simplified structural map of the Bolivian orocline. Dotted area:"western belt";deformed area in white:"eastern belt" (see text).Thin dot line:drainage boundary of the Altiplano-Puna. CANP:Main Andean Thrust; CFP:Main Frontal Thrust; FLIA:Intra-Andean Boundary Fault; CB:Chapare buttress; CI:Cuzco indenter; MI:Mizque (crushed) indenter; SB:Susques buttress; VH:Vilcabamba hinge (2); eSg:edge of Subandean deformation.

caused the Bolivian orocline to develop in the eastern belt by inception of the Main Andean Thrust (CANP) system (fig. 1), in an asymmetrical self-indentation of the South American margin (2, 3).

This Late Oligocene major tectonic crisis resulted in the "jump" of the Andean deformation front from a location west of the Altiplano to an eastern position related to the CANP system (3). During the Eocene-Middle Oligocene time span, the Altiplano had been part of the external foreland basin of the paleo-Andes. Because of the jump of the deformation front, it became locked in the Late Oligocene between the main magmatic arc and the rising Cordillera Oriental, and has evolved in an endoreic setting since then. At all Neogene stratigraphic levels, proximal facies as alluvial fans and braided rivers deposits grade into lacustrine facies which may include locally thick evaporites.

The structure of the Altiplano is quite complex. It includes fold-thrust belts, wrench-fault zones, and intermontane foreland basins passing laterally to pull-apart basins (fig. 2), all related to one another in space and time.

A major part of the "morphological Altiplano" is located within the Ulloma-Coipasa-Uyuni tectonostratigraphic unit (UCU). South of the Coipasa strip (fig. 2), the Uyuni domain is a NNE-trending, E-verging, mostly covered fold-thrust belt, separated from its related foreland basin (the Lípez basin) by the Khenayani thrust system (SFK) (4). North of the Coipasa strip, the Ulloma domain is a NNW-trending complex basin, structured by mainly W-verging faults. Its northern half functioned as the foreland basin of the SW-verging Huarina fold-thrust belt (FPCH) (3). More to the south, the basin seems to have been controlled by "alternating" transtensional and transpressional conditions. The Coipasa strip is bounded by 2 subparallel, WNW-trending, left-lateral wrench-fault zones. The complex NNW-trending Sevaruyo-Chita fold-thrust belt (FPCSC) originated in an area of the strip rich in Cretaceous gypsum and halite, in relation with the left-lateral movements of both its boundary faults.

The complex history of the Altiplano includes 2 main periods of continuous deformation approximately during the 27-19 Ma (3) and 11-5 Ma intervals. Deformation developed in the fold-thrust belts and wrench-fault zones, and, to a lesser degree, in the basins (foreland thrusts; push-ups). Relative tectonic and magmatic quiescence reigned between 19 and 16 Ma.

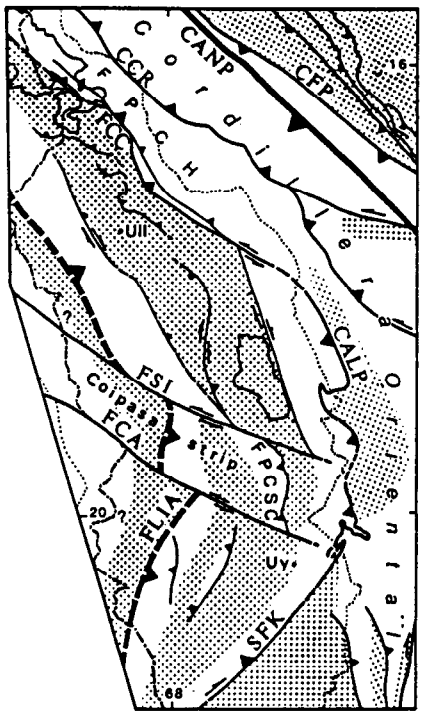

Fig.2. Structural sketch-map of the Bolivian Altiplano and adjacent regions. Dotted areas: main areas of thick Late Oligocene-Neogene accumulations (approximate). Thin dot line: drainage boundary of the Altiplano. Dashed lines: political borders-.CALP: Main Altiplanic Thrust; CCR: Cordillera Real Thrust; FCA:Chita-Arica fault zone; FCC:Coniri thrust front FSI:Sevaruyo-Incapuquio fault zone; SFK:Khenayani fault system; FPCH:Huarina fold-thrust belt (SW-verging) ; FPCSC:Sevaruyo-Chita fold-thrust belt (E-verging). Ull:Ulloma; Uy:Uyuni. Other abbreviations:see fig.1.

Activation of felsic explosive volcanism at about 11 Ma is noteworthy.

Crustal thickening below the Altiplano, which is thought to represent crustal shortening (1,5), probably originated in the underthrusting at the FLIA of part of the western belt, i.e. in the Bolivian orocline development (1,2). Because the Altiplano lies in the heart of the orocline, its tectonic evolution may be regarded as the "inner" record of the oroclinal bending. Thus the importance of chronology and structural geology in studying the Altiplano is crucial to define the steps taken by the deformation in the orocline area. As a consequence, the simplistic vision of the Altiplano functioning as a tensional trough should be abandoned.

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