ANDEAN TECTONICS AND CRUSTAL SHORTENING : THE ANDES OF ACONCAGUA AND THEIR STRUCTURE

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RESUMEN: Se enfatiza la notable disimetría del llamado sinclinorium volcanígeno andino, cuya ala oriental cabalgó fuertemente hacia el Este la faja plegada e imbricada externa; mientras el ala occidental descanza tranquilamente sobre el basamento de la Cordillera de la Costa. El equivalente a nivel de zocalo del acortamiento registrado en la cobertura lleva a considerar el total despegue del ala oriental del sinclinorium y admitir la existencia de una zona de sutura crustal mayor profunda hacia al Oeste. Así, regulando las relaciones de convergencia entre ambos basamentos

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A synthesis of the results along a transect through the Andes at the latitude of Aconcagua (32°40' S) shows the following.

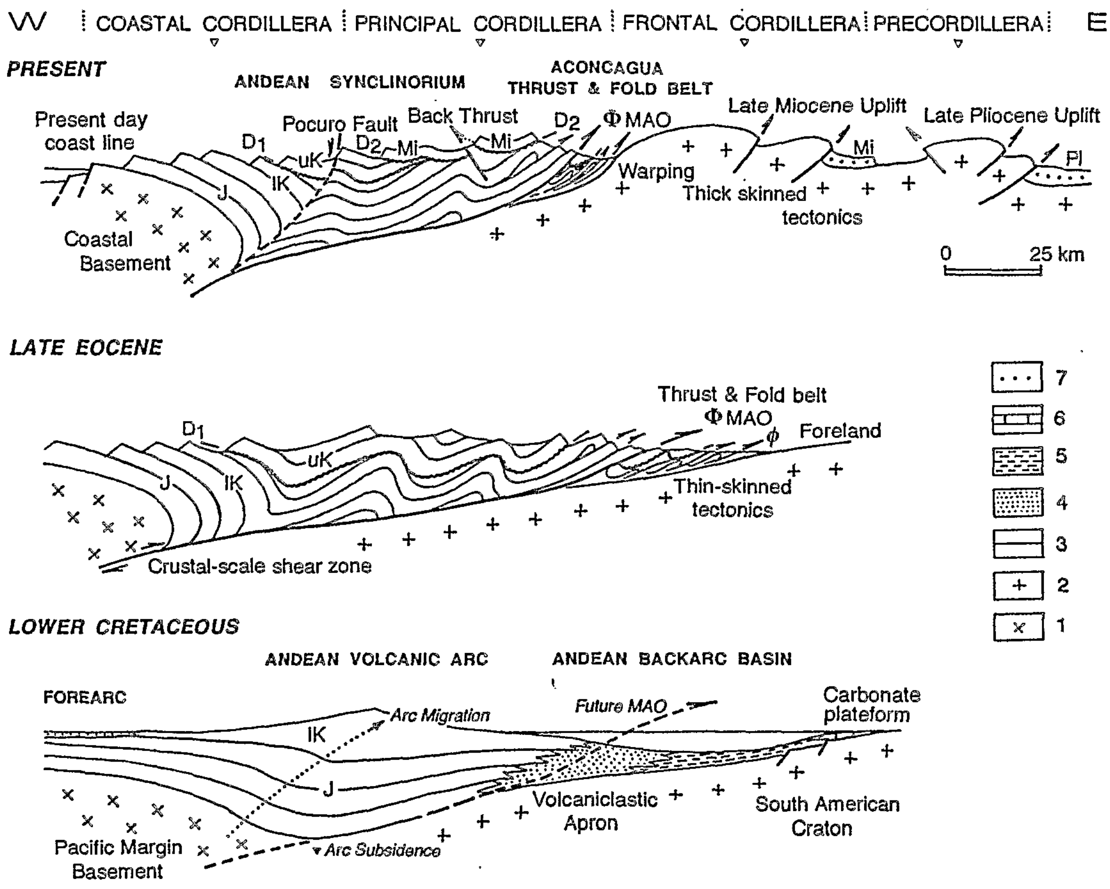
If we disregard post-Miocene deformation, essentially responsable for the uplift of the Frontal Cordillera and Precordillera units (the most external part of the chain characterized by a thick-skinned tectonics), it remains that the main andean tectonics for the left set Coastal Cordillera-Principal Cordillera is restricted to the eastern slope of the Main Range (argentinian flank) and concentrated within a narrow thin-skinned easterly tapering fold-and-thrust belt known as the Aconcagua imbricate zone (MPODOZIS & RAMOS 1989).

This zone of imbricate thrusts and related folds has undergone a general detachment above the oxfordian gypsum (Yeso Principal) (VICENTE 1972). It represents the collapse of the previous Mesozoic andean back-arc basin which has been tectonically prograded eastward over the edge of the relatively undeformed craton. It is a typical trailing imbricate fan since the thrust with the maximum eastward slip (Main Andean Overthrust, MAO),is at the back and brings the volcanics of the andean arc over the external zone.This MAO is a typical backarc thrust which marks the basic tectonic boundary between internal (western) and external (eastern) zones in the Andes (VICENTE 1970). The stratigraphic record of deformation within the belt indicates the tectogenesis of this back arc basin occured progressively eastward in 3 successive stages between the Upper Cretaceous and the Lower Miocene. They are namely the classical peruvian (Coniacian-Santonian), incaic (Late Eocene) and pehuenche (Late Oligocene) tectonic events.

The amount of shortening of the detached cover of the Fold and Thrust Belt.is about 75%. Keeping in view a present width of 20 km, this implies at least 50 km of shortening. Obviously, such a shortening within the sedimentary cover must have been balanced by a crustal shortening of the same order at a deeper crustal level located further West.

Westward, the structure of the Mesozoic and Paleogene volcanic series of the andean arc domain shape a huge synclinorium (the Andean Synclinorium) characterized by a remarkable asymmetric pattern contrarily to LEVI and AGUIRRE's (1981) opinion. Dispite its thickness, the eastern limb appears concentrically folded and shows an increase in tightness and asymmetry of folds eastward as we get closer to the MAO indicating a clear vergency to the East. In contrast, the western limb is simply homoclinal resting stratigraphically on the coastal basement. This synclinorium appears as a major structural feature of the Andes since it involves a volcanigenous serie which thickness is close to 20,000 m in the Coast Range (THOMAS 1958) and about 7-8,000 m in the Main Range. This implies a deepening of the basement below the axis of the synclinorium confering to it, in depth, a very likely pinched shape, seeing the general increase of dip of the series with age and the various unconformities separating the formations. The intrinsic asymmetry of the system.explains the hidden behaviour of the insular substratum and suggests a major crustal buckling in shear context.

Considering the western extension of the essentially undeformed basement of the Frontal Cordillera under the imbricate zone, the amount of shortening of this zone and the basic eastward overthrust of the eastern edge of the synclinorium, we are to extend the MAO much further West (practically over the synclinorium axis). That implies a complete regional detachement of the eastern flank of the synclinorium and its draping over the edge of the cratonic foreland. Besides, this is evidenced by the proper geometry of the folded volcanics of the chilean flank of the Main Range. That means the existence at the rear, on a level with the basement, of a major zone of crustal shearing controlling the relationship between the genuine arc basement i.e. the one of the Coast Range and that of the Foreland. In a word, we must accept a major underthrusting of the western edge of the South American craton beneath the Coastal basement. This constitutes a kind of subduction with an east vergency involving andean continental crust (A-subduction type of BALLY 1975, 1981). However, considering the depth reached by the through of the synclinorium, we question if a portion of the necessary 50 km of crustal shortening is not absorbed in some ways by a continuous deformation within the basement.However, according to this model, the Aconcagua fold and thrust belt should represent nothing but the most frontal and surficial bearing of a major structure involving the main eastward overthrust of the coastal basement driving forward, as a scraper, the huge asymmetric volcanogenic andean synclinorium with its frontal imbricate fan of cover wedges. That structural device shows similarities with typical continental accretionary wedge with frontal damping. The andean originality derives from the striking synclinorium and its basal shear zone which acts as a large scraper acting ahead of the coastal basement



Interpretative palinspatic reconstruction (Lower Cretaceous and Late Eocene) based on a synthetic cross-section (uppermost section ; vertical scale not respected) of the Andes of Aconcagua (32°40' S).

(1) Arc basement (coastal basement) ; (2) Foreland basement (South American craton) ; (3) Arc volcanics ; (4) Volcaniclastics ; (5) Lutites ; (6) Carbonates ; (7) Continental red beds (Foreland molasses) ; J : Jurassic ; lK : Lower Cretaceous ; uK : Upper Cretaceous ; Mi : Miocene ; Pl : Pliocene ; D_1 : Upper Cretaceous unconformity ; D_2 : Lower Miocene unconformity ; Φ : Main Andean Overthrust (MAO).

It appears that the noticeable crustal subsidence related with the arc building occurs at the biginning of the crustal buckling which developed from the Upper Cretaceous under the convergent system and evolved in crustal shearing. The thermal differencies between the crust of the magmatic arc (hot) and that of the foreland (cold) would favour the relative underthrusting of the foreland basement beneath the coastal one and should result into the eastward andean polarity of structures. In addition the uplift of the Frontal Cordillera after the Late Miocene Quechua phase which brought its basement to culminate close to 7,OOO m (C° Mercedario), has produced a significant straightening of the frontal imbricate and a general warping of the eastern part of the synclinorium accompanied by several backthrusts This suggests that the thrusts were previously much more reclined and low-angle.and therefore, that the original system may have been more tangential.

To sum up, the andean tectonics of the Main Cordillera can be viewed as the consequence of a large net crustal convergence between the sialic arc basement of the Pacific Margin and the South American Craton. That implices the existence of a major suture below Central Chile.

Since this structural pattern is also recognized in Peru (VICENTE 1989), we open on a very homogeneous geotectonic model for the Marginal Andes. In this respect, the differential of shortening observed along the strike of the Andes for the Main Range appears to be directly related to the previous width and degree of Mesozoic subsidence of the backarc basin i.e. to the amount of previous stretching and thinning of its continental crust.

At last, we wonder if the significant zone of normal faulting, known as the Pocuro Fault (CARTER & AGUIRRE 1965) which limits to the West the Principal Cordillera and controls the relations with the Central Valley to the South, can be interpreted as the emergence of a late reactivation as listric fault of the earlier crustal shear in the mainly tensional context affecting the chilean margin since Middle Tertiary.

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