TIME CONSTRAINTS OF THE ANDEAN DEFORMATION ALONG THE CENTRAL ANDES OF ARGENTINA AND CHILE (32°-33°S LATITUDE)

Victor A. RAMOS (*) and José M. CORTES (*)

(*) Departamento de Ciencias Geológicas, Universidad de Buenos Aires, Ciudad Universitaria, (1428) Buenos Aires, Argentina

RESUMEN: Las restricciones temporales en el desarrollo de la faja plegada y corrida de la Cordillera Principal, el levantamiento y la deformación de la Cordillera Frontal, así como el de la Precordillera, cuando se comparan con sus depósitos sinorogénicos, indican que el período principal de acortamiento orogénico de los Andes Centrales a estas latitudes abarca desde el Mioceno inferior (circa 22 Ma) al reciente.

KEY WORDS: Central Andes, Tectonics, Synorogenic deposits, Tertiary, Quaternary.

INTRODUCTION

The analysis of the synorogenic deposits in a corridor from the Pacific coast to the Mendoza city shows a series of broken foreland basins that indicate a continuous shifting of the orogenic fronts. New radiometric ages of the volcanic arc rocks and the interfingered tuffs of the synorogenic deposits portrayed a main Late Cenozoic episode of deformation as responsible for the crustal shortening and uplift of the Principal Cordillera, the Frontal Cordillera, and the Precordillera.

GEOLOGICAL SETTING

At these latitudes, the Andes are composed by a series of parallel cordilleras separated by Tertiary synorogenic deposits. The rocks involved in the deformation of the different cordilleras are mainly Mesozoic in the Principal Cordillera, Late Paleozoic to Triassic in the Frontal Cordillera, and Early Paleozoic in the Precordillera. This distribution is the result of two facts: 1) a series of distinct detachment levels that from west to east correspond to Late Jurassic gypsum, Late Carboniferous shales, and Early Ordovician marls; 2) The amalgamation of different Paleozoic terranes which produced major crustal boundaries.

THE SYNOROGENIC DEPOSITS

The synorogenic deposits are distributed east of the Aconcagua fold-and-thrust

belt, the Uspallata valley, and the foothills of Mendoza-Sierra de Las Peñas (see figure 1).

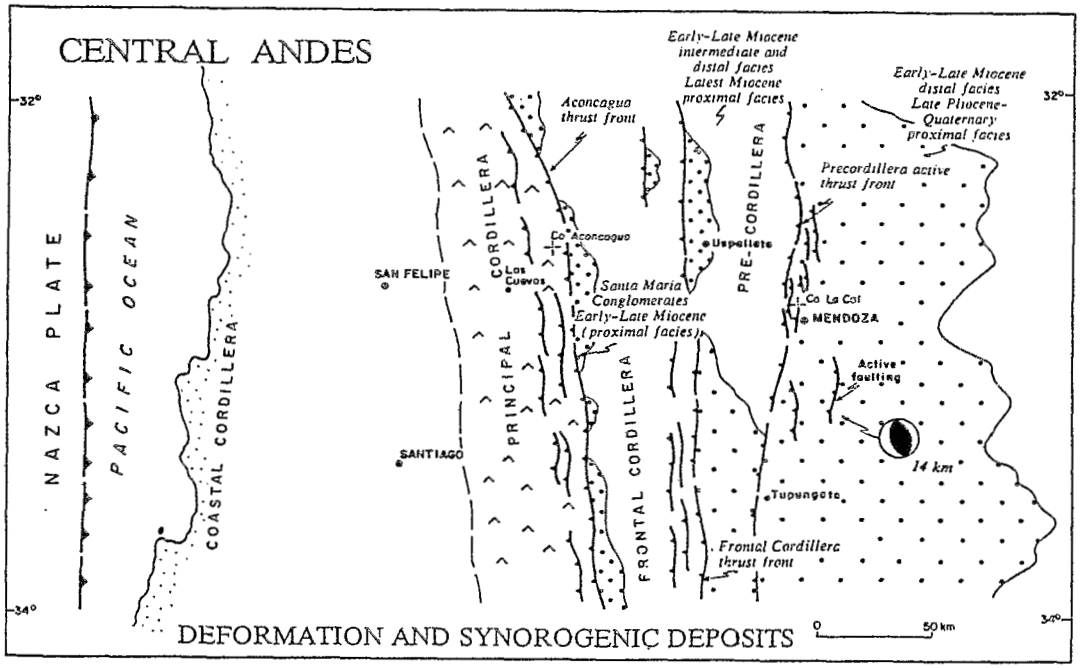

Figure 1: Main thrust fronts with distribution of proximal to distal synorogenic deposits, Central Andes of Argentina and Chile (modified from Ramos, 1988).

a) The Aconcagua fold-and-thrust belt

The volcanic arc rocks in the western side of this region show in the Chilean side, a major angular unconformity where 20.4/16.6 Ma old rocks (Rivano et al., 1990) of the Farellones Formation overly older volcanic sequences. These ages together with the cooling age of post-tectonic granitoids in the Argentine side (Ramos and Cingolani, 1989) of 21.6 Ma indicate the beginning of the shortening at approximately 22 Ma at these latitudes. The migration of the volcanic activity from the Chilean side to the Aconcagua area as a result of the beginning of the shallowing of the subduction zone (Jordan et al., 1983), produced an angular unconformity between volcanic rocks of 15.8/8.9 Ma and different sedimentary and volcaniclastic Mesozoic deposits (Ramos et al., 1991).

At the same time that the fold-and-thrust belt was deformed, a series of synorogenic deposits were accumulating east of the Aconcagua area. The westernmost proximal facies of the Santa María Conglomerates, with boulders up to one cubic meter show a coarsening upwards sequence. The basal beds are mainly composed by Mesozoic limestones and sandstones clasts with some interfingered tuffs, while towards the top volcanic andesitic breccias and pyroclastic flows are dominant. The younger ages of this sequence indicate active sedimentation up to 8.1 Ma (Ramos et al., 1990) while towards the west the arc activity was ceasing due to the shallowing of the subduction zone (Kay et al., 1987).

b) The Uspallata valley

The Frontal Cordillera at these latitudes has been uplifted almost as a single block during Late Miocene times, by a series of imbricated thrusts that bound to the west the Uspallata valley (Cortés, 1993). As a result of that, an extensive Early Miocene peneplain has been uplifted up to 6,000 meters a.s.l.

The synorogenic deposits between the Frontal Cordillera and the Precordillera

record two unconformably overlying sequences. The oldest one can be correlated with the Mariño Formation (Cortés, 1993), and has been deposited prior to 11.4 Ma. The sedimentary facies indicates distal to intermediate fluvial deposits for the Miocene. The youngest one includes proximal facies of Late Miocene to Pliocene age, and has been erroneously correlated with the Late Pliocene Mogotes Formation.

c) Precordillera foothills

The thrust front of Precordillera is at present the most active seismotectonic zone of the Andes at these latitudes. Focal mechanisms of intraplate earthquakes indicate crustal shortening at 14 km depth (Triep, 1987). The east-verging thrust front affects Latest Tertiary, Pleistocene, and Holocene deposits. Quaternary terraces are tightly folded and blind thrusts (Bettini, 1981) developed within the Cenozoic cover are doming the present surface.

The synorogenic deposits display three major angular unconformities; one between the Mariño Formation and previous Early Tertiary-Late Cretaceous sag deposits; other between the Mogotes Formation (3.8 to 1.2 Ma, Yrigoyen, 1993) and older Miocene units, and the third between latest Pliocene and Pleistocene deposits.

This Late Pliocene-Early Pleistocene deformation was also responsible for the final uplift of the Sierra de San Luis (Costa, 1992) the westernmost Sierras Pampeanas at these latitudes.

CONCLUSIONS

The new data constrain the main period of shortening of the Andes between the base of the Early Miocene (approx. 22 Ma) and the Present. Although there is a shifting of the thrust front to the east associated with the migration of the magmatic activity, related to the shallowing of the subduction zone, this activity was episodic and discontinuous as recorded by the synorogenic deposits.

This shortening could be linked to an increase of the convergent rate as previously proposed by several authors (Pilger, 1984; Ramos, 1988). This increase was due to the break-up of the Farellones plate and the formation of the Nazca and Cocos plates around 25 millon years ago.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the funding from projects UBACYT-Ex 066 and PID CONICET/93.

REFERENCES

BETTINI, F.H., 1981. Nuevos conceptos tectónicos del centro y borde occidental de la Cuenca Cuyana. Asociación Geológica Argentina, Revista 35(4): 579-580, Buenos Aires.

CORTÉS, J.M., 1993. El frente de corrimiento de la Cordillera Frontal y el extremo sur del valle de Uspallata, Mendoza. XII° Congreso Geológico Argentino, Actas (in press).

COSTA, C.H., 1992. Neotectónica del sur de la Sierra de San Luis. Universidad Nacional de San Luis, Tesis Doctoral (unpublished), 1-390, San Luis.

JORDAN, T.E., B. ISACKS, V.A. RAMOS and R.W. ALLMENDINGER, 1983. Mountain building in the Central Andes. Episodes, 1983(3): 20-26, Ottawa.

KAY, S.M., V. MAKSAEV, R. MOSCOSO, C, MPODOZIS and C. NASI, 1987. Probing the evolving Andean lithosphere: Mid-late Tertiary magmatism in Chile (29° -30°30'S) over the modern zone of subhorizontal subduction. Journal Geophysical Research, 92(B7): 6173-6189.

PILGER, R.H., 1984. Cenozoic plate kinematics, subduction and magmatism: South American Andes. Journal geological Society of London 141: 793-802.

RAMOS, V.A, 1988. The Tectonics of the Central Andes; 30° to 33°S latitude. In Processes in Continental Lithospheric Deformation, S.Clark y D. Burchfiel (eds.), Geological Society America, Special Paper 218: 31-54.

RAMOS, V.A. and C. CINGOLANI, 1989. La Granodiorita Matienzo: intrusivo mioceno de la Alta Cordillera de Mendoza. Asociación Geológica Argentina, Revista 43(3): 404-408, Buenos Aires.

RAMOS, V.A., D. PÉREZ and M.B. AGUIRRE-URRETA, 1990. Geología del Filo de Zurbriggen, Aconcagua, Mendoza. XI° Congreso Geológico Argentino, Actas II: 361-364, San Juan.

RAMOS, V.A., F. MUNIZAGA and S.M. KAY, 1991. El magmatismo cenozoico a los 33°S de latitud: geocronología y relaciones tectónicas. VI° Congreso Geológico Chileno, Actas I: 892-896, Santiago.

RIVANO, S., E. GODOY, M. VERGARA and R. VILLARROEL, 1990. Redefinición de la Formación Farellones en la Cordillera de Los Andes de Chile Central (32°-34°S). Revista Geológica de Chile 17(2): 205-214, Santiago.

TRIEP, E.G., 1987. La falla activada durante el sismo principal de Mendoza de 1985 e implicancias tectónicas. X° Congreso Geológico Argentino, Actas I: 199-202, Tucumán.

YRIGOYEN, M.R., 1993. Los depósitos sinorogénicos terciarios. En Geología y Recursos Naturales de la provincia de Mendoza. XII° Congreso Geológico Argentino, Relatorio (in press), Buenos Aires.