THE VALLE FÉRTIL FLOWER STRUCTURE AND ITS RELATIONSHIPS WITH THE PRECORDILLERA AND PAMPEAN RANGES, (30-32°S, ARGENTINA).

Eduardo A. Rossello [1,2], Marcos E. Mozetic [1,3], Peter R. Cobbold [4], Marc de Urreiztieta [4], Denis Gapais [4] & Oscar R. López-Gamundí [5]

(1) Dpto. de Ciencias Geológicas, Universidad de Buenos Aires, Pabellón II, 1428 Buenos Aires, Argentina.
(2) CONICET
(3) BHP Petroleum Argentina Inc.
(4) Géosciences-Rennes (UPR 4661-CNRS) Campus de Beaulieu, 35042 Rennes Cédex, France.
(5) TEXACO Inc., Central Exploration Department. 4800 Fournace Place, Bellaire 77401-2324 Texas, USA.

KEY WORDS: Valle Fértil, Argentina, flower structures, ramp basins, Andean foreland.

INTRODUCTION

The Andes result from oblique subduction of the oceanic Nazca plate beneath the continental South America plate (Fig. 1). Between 27°S and 32°S, the Andean Cordillera trends N-S and lies above a subhorizontal segment of the descending Nazca plate (Fig. 1). From the Chile trench towards the foreland, the mountain belt consists of a series of N-S trending structural units: the Coastal Cordilleras, the Principal Cordillera (inactive volcanic arc), the Frontal Cordillera, the Precordillera and the Sierras Pampeanas. This work deals with the foreland basin geometry between the Precordilleran fold and thrust belt and the westernmost basement uplifts of the Sierras Pampeanas.

Between 29° and 33° S, East of the Precordilleran thrust front, the NW-SE trending Desaguadero-Valle Fértil fault marks the western boundary of the Pampean ranges (Fig. 1, VF). In the foreland, in successive compressional basins alternate with basement uplifts, bounded by high-angle thrusts (Jordan & Allmendinger, 1986). Five structural domains can be identified from West to East (Rossello *et al.*, 1995): (1) the Precordilleran thrust front, (2) a proximal foreland basin, (3) the intervening Valle Fértil basement high, (4) a distal foreland basin and the Pampean Ranges. Our description of compressional structures is based on field observations and seismic data.

PRECORDILLERAN THRUST FRONT

In the Precordillera (Fig. 2) a series of east-verging thrust sheets involving Early to Lower Paleozoic sediments, overthrust intercalated Neogene deposits (Beer *et al.*, 1990). The amount of bulk regional shortening across this segment of the Andes may 65-70% (Allmendinger *et al.*, 1990). Asymmetric anticlines westwards verging alternate with tight synclines. On the western margin of the Precordillera, the upper Tertiary cover (younger than 15 Ma., Beer *et al.*, 1990) reaches a thickness of 4 km within the Valle de Iglesia. The Precordilleran front is thrust over the Tertiary foreland detrital deposits (Fig. 2).

PROXIMAL FORELAND BASIN

The immediate foreland basin (Bolsón Bermejo, Fig. 2) is filled with Neogene syn-orogenic deposits reaching a thickness of 7,000 m (confirmed by wells). These 14-2.3 Ma detrital sequences are upward coarsening (Johnson *et al.*, 1987, Beer & Jordan, 1989). The Neogene sedimentary cover forms fault-propagation folds and lies unconformably, either on the Paganzo Group sequences (to the East) or on lower Paleozoic sediments (to the West). The Bermejo basin is a roughly symmetric ramp basin. It deepens towards the West under the Precordilleran front (Zapata & Allmendinger, 1996) and is overthrust on its eatern margin by the Valle Fértil Ranges. Furthermore, in the middle of the basin the top of the crystalline basement is symmetrically kinked (Fig. 2) and emerges locally at the surface in the Sierra Pie de Palo area (Fig 1, PL).

INTERVENING BASEMENT HIGH, VALLE FÉRTIL-SIERRA MORADA

Within the foreland, the Valle Fértil Range has an anomalous NW-SE trend. It is an assemblage of crystalline basement blocks, locally covered by folded Paleozoic rocks to the North (Paganzo Group). These blocks are bounded to the West by high-angle westward verging thrusts. In detail, the structure consists of (1) *en échelon* N 170 trending left-lateral thrusts, (2) associated N-S fold hinges and culminations, (3) conjugate right-lateral faults trendin N 070 and (4) normal faults trending N 120. Hence, the eastern margin of the Valle Fértil system is a major transpressional left-lateral wrench zone. Faulting involves the crystalline basement and can be interpreted in cross-section as a positive flower structure (Harding, 1990), verging towards the West. This structure probably reactivated Triassic normal faults. Along the abrupt western margin of the Valle Fértil Ranges, the vertical offset of the top of the basement is at least 7,000 m according to seismic information (Fig. 2). On the eastern margin, an erosional surface exposed on the top of the range (Jordan *et al.*, 1989) dips gently eastwards, beneath the sediments of the Villa Unión-Pagancillo Basin.

DISTAL FORELAND BASIN

East of the Valle Fértil Range is the distal domain of the Andean foreland. The Villa Unión-Pagancillo basin is filled with Neogene detrital sequences which rest unconformably on the upper Paleozoic deposits of the Paganzo Group. This asymmetric ramp basin deepens eastwards, the base sloping 10° to 15°, from the Sierra Valle Fértil-Sierra Morada to the Famatina-Sañogasta Ranges. The depocenter reaches a depth of 4,000 m. Surface geology (Malizia *et al.*, 1995) and sub-surface data indicate a thinning of the Tertiary sequences towards the East. The eastern edge of the basin is bounded by a thrust fault along the Famatina-Sañogasta Ranges.

PAMPEAN RANGES

The Sierra de Famatina-Sañogasta are made of crystalline basement. The interface between the basement and the sedimentary cover is the erosional surface mentioned above. This interface is locally overlained by sequences of the Paganzo Group and sedimentary remnants attributed to the Neogene. Thick-skinned tectonics characterize the Pampean Ranges. Uplifted blocks of basement are bounded by high-angle thrusts (Jordan & Allmendinger, 1986). These regional faults results in large vertical offsets of the top of the basement. The highest basement outcrops are on the Famatina range (6,250 m a.s.l.). In surrounding Neogene basins, sediments reach thicknesses of several thousand meters (10 km in Quebreda la Troya basin). Consequently, the vertical offset locally exceeds 10 kilometers.

CONCLUSIONS

The foreland basin, 200 km wide between 29° and 32°S, is of ramp type. The eastern margin is against the Famatina-Sañogasta Ranges. The central sector is uplifted and emerges at the surface along the left-lateral Valle Fértil wrench zone. This major regional fault divides the foreland into two asymmetric basins. According to the geometry and sedimentary characteristics of the Neogene cover, the Andean foreland basin is of typical ramp style (Cobbold *et al.*, 1993).

ACKNOLEDGEMENTS

This study was carried out as part of (1) a research program funded by the EEC : "Andean tectonics of Argentina" (CI1*-CT93-0091 AR) and (2) a research project of the University of Buenos Aires UBA 1994-1997 (Ex 003).

REFERENCES

Allmendinger, R.W., D. Figueroa, D. Snyder, J. Beer, C. Mpodozis & B.L. Isacks, 1990. Foreland shortening and crustal balancing in the Andes at 30 S Latitude, Tectonics, 9 (4), 789-809.

Beer & Jordan 1989. The effects of Neogene thrusting on deposition in the Bermejo Basin, Argentina. Journal of Sedimentary Petrology, v. 59, 330-345.

Beer, J.A., R.W. Allmendinger, D.E. Figueroa & T.E. Jordan, 1990. Seismic stratigraphy of a piggyback basin, Argentina. AAPG Bull 74 (8), 1183-1202.

Cobbold, P.R., P. Davy., D. Gapais,, E.A. Rossello., E. Sadybakasov, J.C. Thomas, J.J. Tondji Biyo, M. de Urreiztieta. Sedimentary basins and crustal thickening. In: S. Cloetingh, W. Sassi, F. Horvath and C. Puigdefabregas (Editors), Basin Analysis and Dynamics of Sedimentary Basin Evolution. Sedimentary Geology, 86 (1993) 77-89.

Harding, T.P., 1990. Identification of wrench faults using subsurface structural data: criteria and pitfalls. AAPG, Bull. 74 (10), 1590-1609.

Johnson, A.T., T.E. Jordan, N.M. Johnson, & C.W. Naeser, 1987. Magnetic polarity stratigraphy, age, and tectonic setting of fluvial sediments in the eastern Andean foreland basin, San Juan province, Argentina. International Association of Sedimentologists, Special Publication, 8, 63-75.

Jordan, T.E. & R.W. Allmendinger, 1986. The Sierras Pampeanas of Argentina: a modern analogue of Rocky Mountain foreland deformation. American Jour.nal of Sciences, 286, 737-764.

Jordan, T.E., P. Zeitler, V. Ramos & A.J.W. Gleadow, 1989. Thermochronometric data on the development of the basement peneplain in the Sierras Pampeanas, Argentina. Journal of South American Earth Sciences, 2 (3). 207-222.

Malizia, D.C., J.H. Reynolds & K.D. Tabbutt, 1995. Chronology of Neogene sedimentation, stratigraphy, and tectonism in the Campo de Talampaya region, La Rioja province, Argentina. Sedimentary Geology 96, 231-255.

Rossello, E.A., M.E. Mozetic, P.R. Cobbold & M. de Urreiztieta, 1995. El límite entre Precordillera y Sierras Pampeanas (Andes centrales de Argentina): consecuencias tectónicas y topográficas regionales. *IX° Congreso Latinoamericano de Geología (Caracas).* Actas Microregistradas.

Zapata, T.R. & R.W. Allmendinger, 1996. Thrust-front zone of the Precordillera, Argentina: a thick skinned triangle zone. AAPG Bull , 80 (3), 359-381.

Figure 1.

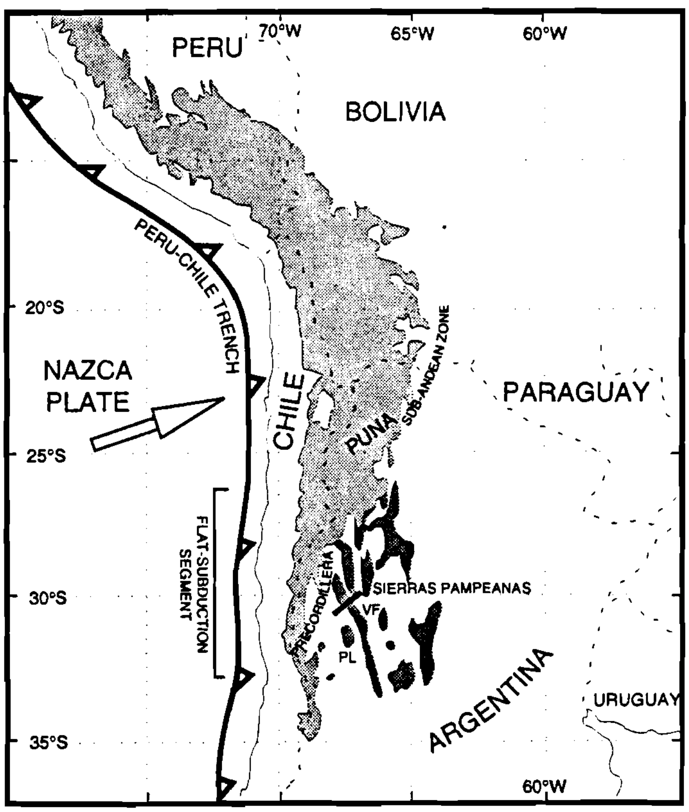
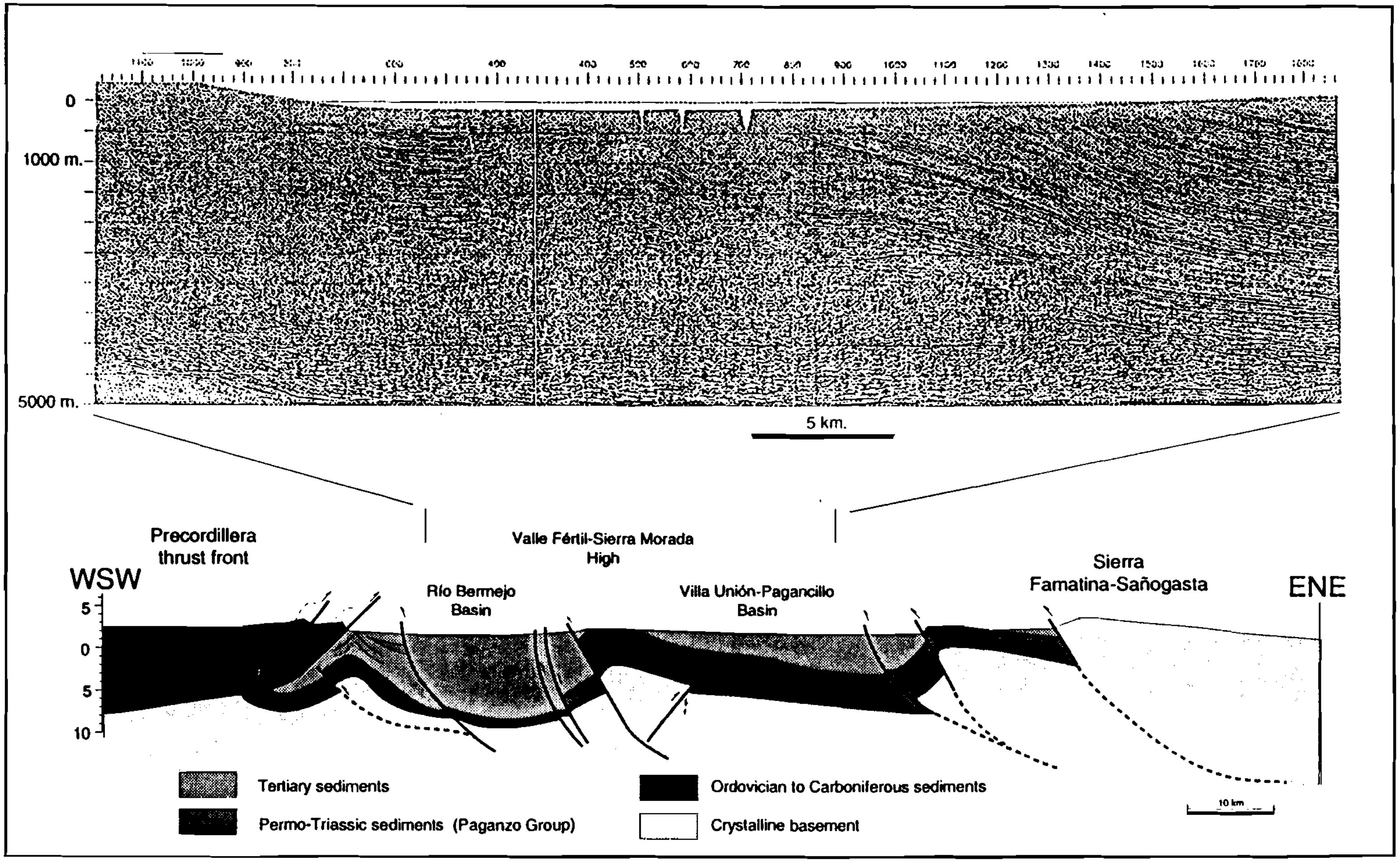


Figure 2.


0
1000 m.
5000 m.
5 km.
Precordillera
thrust front
Valle Fértil-Sierra Morada
High
WSW
Río Bermejo
Basin
Villa Unión-Pagancillo
Basin
Sierra
Famatina-Sañogasta
ENE
5
0
5
10
Tertiary sediments
Permo-Triassic sediments (Paganzo Group)
Ordovician to Carboniferous sediments
Crystalline basement
10 km