BASEMENT FAULTING AND INVERSION OF THE NW NEUQUÉN BASIN, ARGENTINA.

Jacqueline L.M.Booth and Mike P.Coward

Department of Geology, Imperial College, Prince Consort Road, London SW7 2BP, England.

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INTRODUCTION.

The Neuquén Basin lies to the immediate east of the Andean Cordillera in Argentina, between the latitudes of 35° and 41°S. It formed as a back-arc extensional basin during the Late Triassic and Early Jurassic, open to the Pacific at its northwestern margin. The Mesozoic and Cenozoic sedimentary infill reaches a thickness of 7km (Vergani et al., 1995), a lengthy period of thermal subsidence (Aalenian to Albian) succeeding the initial rifting (Norian to Toarcian). Inversion of the generally north-south trending normal faults in the western half of the basin began in the Eocene, uplifting several sizable basement blocks above surface level. One of the largest of these blocks is the Cordillera del Viento in the northernmost part of Neuquén Province. The results of field studies, the analysis of seismic lines and Landsat TM images, and palaeomagnetic data from around this range and to the north in Mendoza Province will be presented here.

STRATIGRAPHY

Recent works on the stratigraphy have analyzed it using sequence stratigraphic divisions (e.g. Legarreta and Gulisano, 1989). The Jurassic to Early Tertiary succession can be separated into ten mesosequences, the first two of which make up the Norian to Toarcian synrift, lying on a basement of Carboniferous to mid-Triassic volcanics (Choiyoi) and clastics. The mesosequences begin with a continental clastic unit, then a transgression to give platform and deeper basin deposits, followed by gradual progradation of marginal facies from the south and east towards the northwest. The termination of several mesosequences reveal basin dessication and hypersalinity, the evaporite horizons having since been utilized as detachments during inversion.

Sediment thicknesses increase greatly towards the northwest of the basin, a large depocentre originally being located in the Chos Malal area (Figure 1), although amalgamation of the isolated half-grabens in response to thermal subsidence did not occur until the mid Jurassic (Vergani et al., 1995). Following the subsidence during the later Mesozoic, the loading by the Andean magmatic arc in the Tertiary produced a narrow foreland basin along the Chilean border.

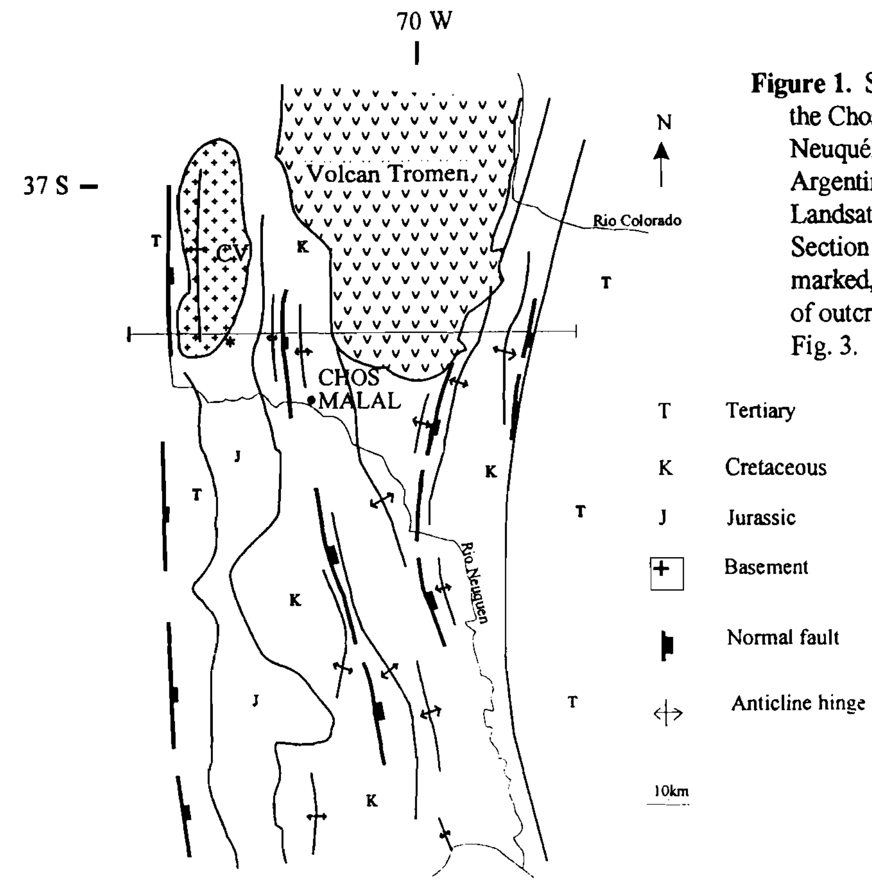

Figure 1. Sketch map of the Chos Malal area of Neuquén Province, Argentina, based on Landsat™ image. Section line for Fig.2 marked, * shows locality of outcrops shown in Fig. 3.

STRUCTURE

A variety of structural styles are observable in the area around Chos Malal (Figures 2&3). Field sections made across this region show large-scale basement involvement in the compression, but in a thick rather than thin-skinned style (which would utilize low-angled thrusts); significant changes in fold wavelength; multiple detachments and backthrusting.

The Cordillera del Viento is interpreted as an inversion of a large west dipping half graben in which significant increases in the synrift Los Molles Formation (Toarcian) thickness occur. Uplift of the basement on high angle reverse faults (50°-70°) has produced a broad anticline, movement on the west-dipping thrust passing into backthrusts at the base of Los Molles. At the outcrop scale a brecciated band, 15m thick, of these shales is found above the basement (Choiyoi Group), with top-to-the-west shear sense in highly deformed beds. Structures here show mesoscale inversions (Figure 3) which provide a good analogue for the Cordillera del Viento anticline. Why forward propagation of the thrust should be transferred to antithetic motion here at the pre to synrift boundary may be explained by the elasto-plastic, non-viscous nature of overpressured shales (Los Molles is one of the source rocks for the overlying sandstones), in which localized shear zones can form but complete decoupling around the fault cannot (Verschuren et al., 1996). It is equally feasible that these backthrusts represent inversion of secondary normal faults, formed during the Pliensbachian-Toarcian rift phase, giving an inherited weakness to this unit.

Fifteen kilometres to the east along section, and less well constrained, is the Las Macinas anticline. This can be related to the structural inversion of another smaller half-graben of similar polarity (normal displacement approximately 500m). Thrust movement has been transferred from the steep palaeo-normal fault to footwall

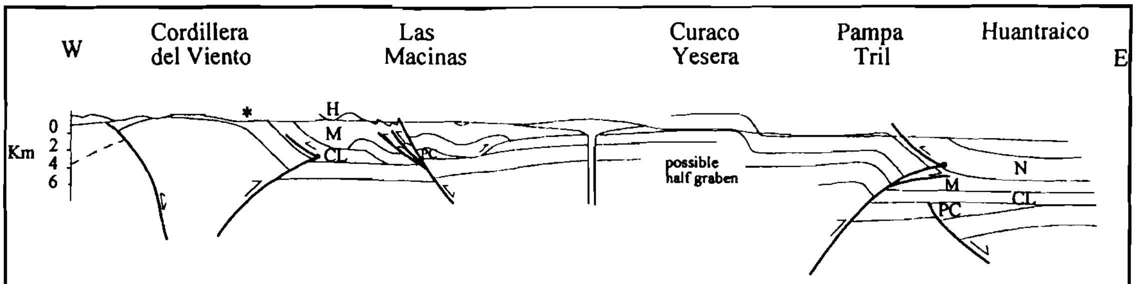

Figure 2. Sketch section showing the structures along a W-E transect from the Cordillera del Viento to Filo Morado (see Fig. 1 for location). Sequences - PC: Pre-Cuyo; CL: Cuyo and Lotena; Mendoza Supersequence; N: Neuquén, (all are mesosequences unless stated). * marks location of outcrops shown in Fig.3. No vertical exaggeration.

shortcuts, evidenced by overturned folds at the surface in the Huitrín Formation. Foreland-directed thrusting out of the graben occurs at the pre-synrift boundary, possibly in response to back-rotation of the normal fault about an horizontal axis.

To the east of Las Macinas there is a change from west to east fold vergence and an increase in fold wavelength and asymmetry, reflecting a change in inversion style. The Curaco Yesera del Tromén and Pampa Tril monoclines have very gently dipping backlimbs of 10-15km length and short, hooked forelimbs. Wells drilled through Pampa Tril show basement at a depth of 1470m (Viñes, 1990). This fold may have formed as a basement-involved fault propagation fold localized on the underlying normal fault - the short Huantraico Rift, beneath the syncline of the same name. Earlier interpretations of this structure have reconstructed it with hidden duplexes in the triangle zone between the two folds, (Viñes, 1990, and Ploszkiewicz, 1987). The Huitrín salt horizon which forms the top of the seventh mesosequence (Aptian) becomes active as a detachment in this structure. It acts as a slip horizon backthrusting the western limb of the Huantraico syncline over the monocline forelimb.

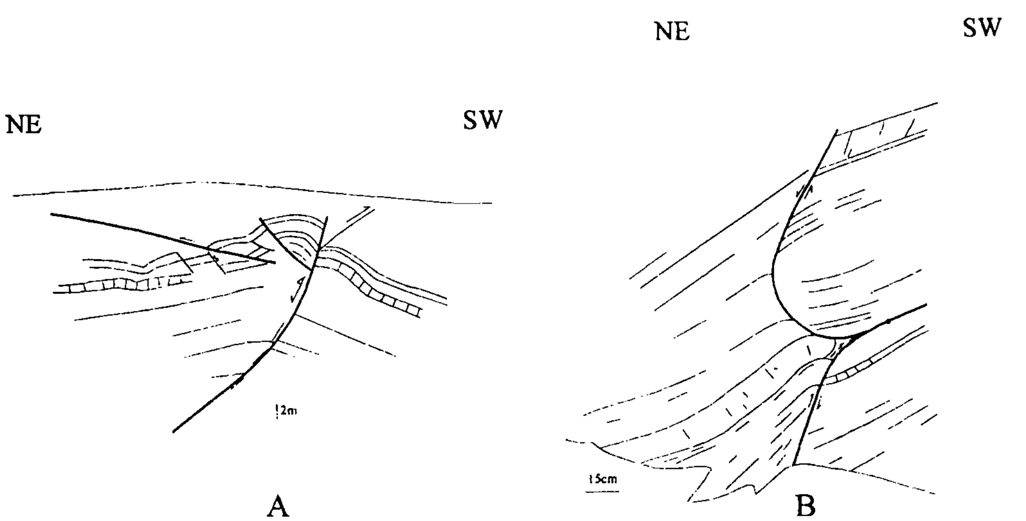

Figure 3. Meso-scale inversion structures within the Los Molles Formation. A: Inverted normal fault showing expulsion of the hanging-wall, with possible reworking of earlier antithetic faults. B: Incipient Ile flottante footwall shortcut of a palaeo-normal fault. Footwall cut-offs on lower thrusted segment are 70° - 80°, identical to those preserved in the uninverted fault.

This is the eastern limit of the Andean deformation front, the undeformed external parts of the basin lying in the foreland. Basement involved thrusting of similar geometry is also characteristic of the fold and thrust belt margin to the north towards Malargüe in Mendoza Province.

CONCLUSIONS

The role of basement in affecting the structural style of the Neuquén fold and thrust belt has been significant. Shortening across the area has been in the order of 20%, and occurred mostly during the Oligocene and Miocene in response to easterly-directed compression from the Andean chain, though possibly including a component of ridge-push from the South Atlantic ridge.

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