STRUCTURE AND KINEMATICS OF A FOOTHILLS TRANSECT, LAGO VIEDMA, SOUTHERN ANDES (49° 30' S)

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KEY WORDS : Southern Andes, Lago Viedma, fold-and-thrust belt, right-lateral wrenching.

INTRODUCTION

The Southern Patagonian Cordillera lies between 46°30' S and 55° S (Fig. 1). It first formed as a result of rapid convergence between the oceanic Nazca plate and continental South America. From 49 Ma to 25 Ma, the vector of relative motion trended approximately N010°. Since then, it has remained steady at N080° and the rate of convergence has been about 9 cm/a (Cande and Leslie, 1986; Pardo-Casas and Molnar, 1987). However, the Chile ridge collided with the Chile trench west of Tierra del Fuego at about 14 Ma (Cande and Leslie, 1986; Ramos and Kay, 1992) and rapidly moved towards the North. The Southern Patagonian Cordillera is now in the zone of convergence between the Antarctic and the South America plates. This convergence has been slower (about 2 cm/a) and directed more nearly East-West (Cande and Leslie, 1986).

Lago Viedma is a glacial lake (Fig. 1), on the eastern side of the mountains and at the northwestern edge of the Magellan Basin. This basin first formed during a Triassic rifting event (Uliana et al., 1989). It further developed as a foreland basin during Andean compression, from Albian to Oligocene times (Dott et al., 1982). A fold-and-thrust belt developed in the foothills at its western edge (Katz, 1972; Winslow, 1982; Ramos, 1989; Kraemer, 1993; Alvarez-Marrón et al., 1993).

Between Lago Argentino and Lago Viedma (Fig. 1), the main structures within the fold-and-thrust belt trend N to NNE and alternatively verge eastwards or westwards (Kraemer, 1993). Between 47° and 49°S, Ramos (1989) described passive roof duplexes, where a Paleozoic sequence underthrusts overlying Jurassic and Cretaceous sequences without emerging at the surface.

From changes in the associated pattern of sedimentation, deformation in the westernmost parts of the area could have started in the early Cenomanian (Riccardi and Rolleri, 1980; Wilson, 1983, 1991). In easternmost parts, deformation may have started in the Eocene, reaching a paroxism in the early to middle Miocene, when the Chile ridge collided with South America (Ramos, 1989; Ramos and Kay, 1992).

We have mapped a transect and drawn a section across the fold-and-thrust belt. It runs for 40 km along the northern shore of Lago Viedma, from the Miocene granitic intrusion of Monte Fitzroy (El Chaltén) in the West, to the undeformed foreland in the East (Fig. 2). The transect crosses Upper Paleozoic to Pliocene sediments. It yields new information on the structure of the fold-and-thrust belt and on the kinematics and timing of deformation.

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In section, folds and thrusts are thick-skinned in the West and thin-skinned in the East (Fig. 2). Between Cerro Fitzroy and the Rio de las Vueltas, Paleozoic marine sediments (Bahia La Lancha Formation), Jurassic volcanics (Tobífera or El Quemado Formation), Early Cretaceous marine shales (Rio Mayer Formation) and the Fitroy granitic intrusion have all been uplifted to the surface on steeply-dipping faults with reverse components, associated with folds of km-scale wavelengths. Exhumed Early Cretaceous shales display a low-grade slaty cleavage.

Eastwards from Cerro Faldeo, folds and thrusts within unmetamorphosed Cretaceous marine sandstones are thin-skinned, above a detachment within Rio Mayer shales, about 30 km long. The top of the Tobífera volcanics is inferred to be flat-lying beneath the shale detachment. There is no surface evidence for basement duplexes underlying the eastern part of our transect.

The folds in the Cretaceous sandstones are of chevron, kink or concentric styles, typical of flexural slip between regular layers. Structures verge either eastwards or westwards. Towards the eastern end of the section, fold wavelengths tend to be larger and amplitudes smaller, recording a decrease in the intensity of shortening. Depocentres in synclines and condensed sequences over anticlines and hangingwalls of associated reverse faults, all indicate that folding was synchronous with ongoing sedimentation. Shortening was thus already underway in the Middle to Late Cretaceous.

Magmatic rocks provide further constraints on the timing of deformation. In the hinterand, the Fitzroy granitic pluton is a shallow-level, syntectonic, multiple intrusion. A cooling age of 18 ± 3 Ma (Miocene) has been obtained by the method of K/Ar on biotites (Nullo et al., 1978). The edges of the pluton are vertical, but an associated granitic sheet has been thrust over intensely folded Rio Mayer shales. In the foreland, Pliocene plateau basalts, capping the sedimentary sequence, are flat-lying or only slightly tilted. However, basaltic feeder dykes, cutting Early Cretaceous shales, are sequentially offset to the east by slip between sandstone layers, indicating that deformation continued to accumulate after the Pliocene.

Evidence for active tectonics is provided by sharp escarpments associated with major reverse faults in the hinterland.

Restoration of sections, assuming both line and area balancing, yields an estimated shortening of only 6% for the Middle to Upper Cretaceous sandstones, but as much as 37% for the Early Cretaceous shales. This difference may reflect the way deformation has accumulated throughout time, or it may indicate an eastwards attenuation in space. However, such restorations should be treated with great caution, because of probable motions into or out of the plane of section.

There are several lines of evidence in favour of right-lateral wrenching parallel to the strike of the mountain belt. In the foreland, major faults are low-angle thrusts, trending NNW, obliquely to the mountain front; whereas, towards the West, faults become of higher angle and they curve into parallelism with the mountain belt. Of the folds in the sedimentary sequence, some are flat-lying, whereas others are upright. Flat-lying folds tend to have horizontal axes trending NNW, whereas upright folds tend to have steep axes and axial surfaces trending more nearly N. These features are characteristic of wrenching in a layered sequence (Odonne and Vialon, 1983). Further evidence for wrenching is provided by flat-lying striations with right-lateral senses on steeply-dipping fault planes, especially at the mountain front (Fig. 2). Finally, the mountain front itself is a very sharp topographic feature and deformation decays rapidly away from it.

CONCLUSIONS

In the Lago Viedma area, the Andean foothills form a fold-and-thrust belt. Between Cerro Fitzroy and the Rio de las Vueltas, thick-skinned reverse faults bring Jurassic volcanics, Paleozoic sediments and the Fitzroy granite to the surface. Further East, thin-skinned folds in Cretaceous sandstones detach on flat-lying Early Cretaceous shales.

Growth folds indicate that shortening started in the Middle Cretaceous. It appears to have continued to the Present. Fold geometries and orientations, fault striations, sharp relief and steep gradients of deformation, all provide evidence for a component of right-lateral wrenching along strike.

We suggest that the observed kinematics and the timing of deformation are due to oblique convergence of the Nazca and South American plates during the Late Cretaceous and Tertiary.

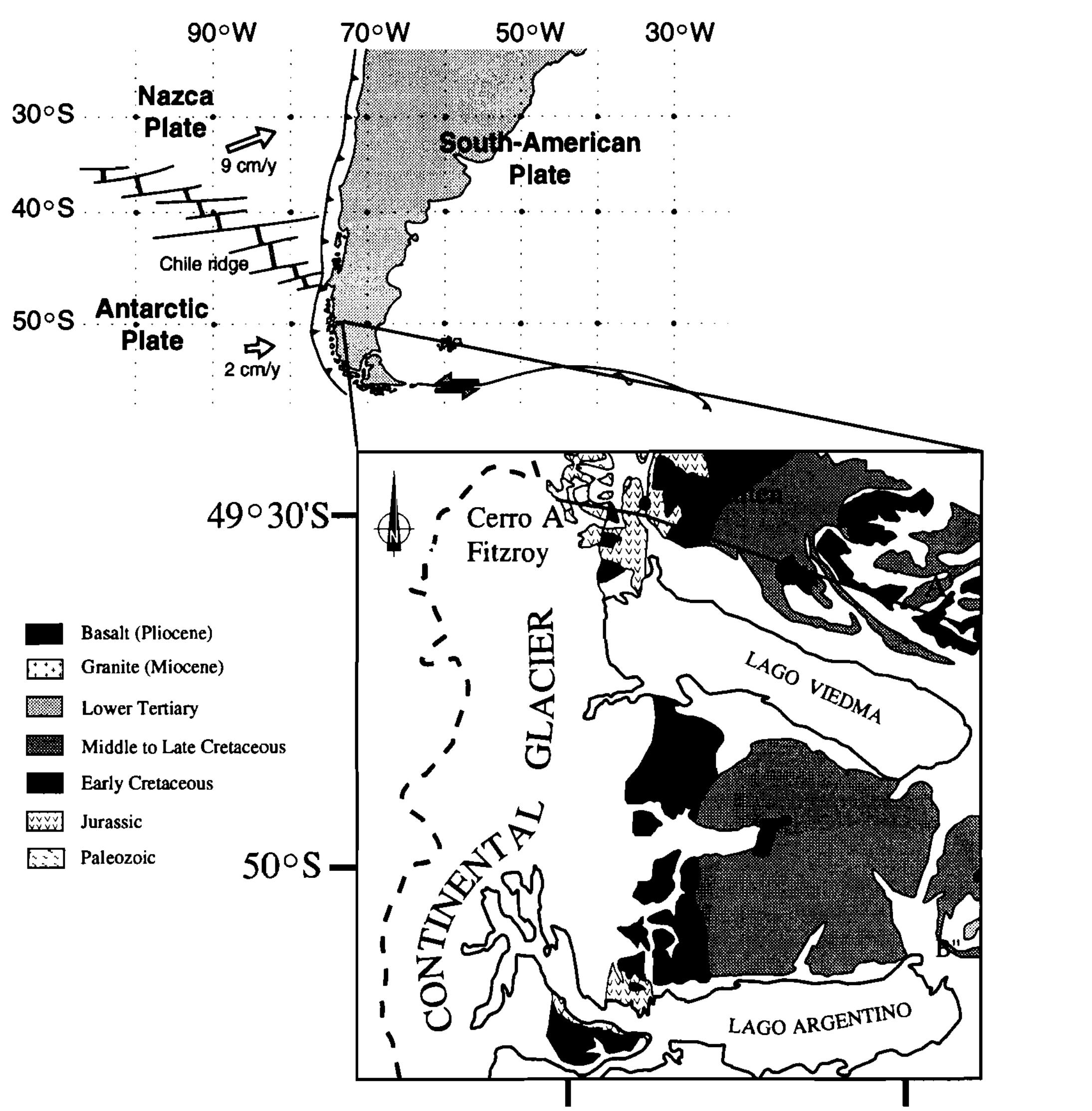

Figure 1.

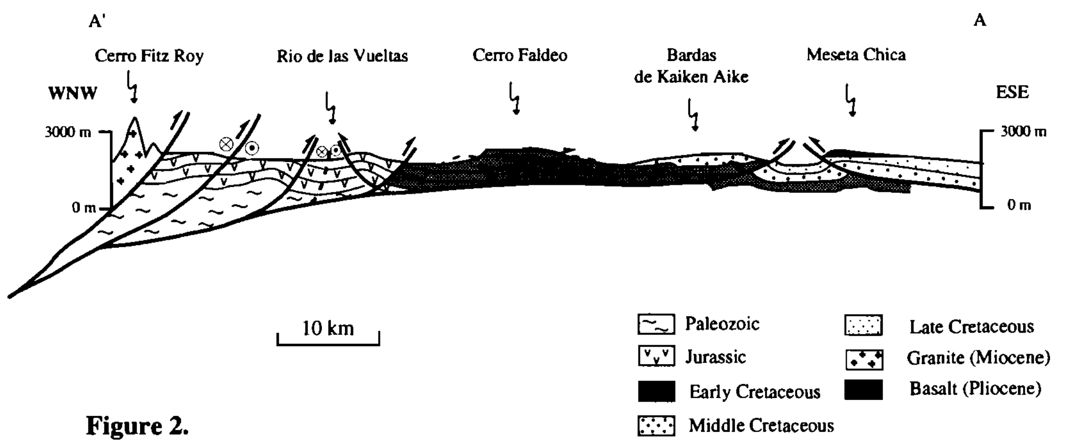

Figure 2.

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