



## Early foreland deformation of the Fuegian Andes (Argentina): Constraints from the strain analysis of Upper Cretaceous–Danian sedimentary rocks

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### ABSTRACT

This contribution addresses new structural data from Upper Cretaceous–Danian sedimentary rocks of the Fuegian Andes orogenic front in Argentina. The structures studied, called *D'*, were formed during the early foreland deformation of the orogen, in the Late Cretaceous–Danian, in times when South America and Antarctica were still connected. The strain analysis of these structures indicates that deformation occurred at upper-crustal depths, and was characterized by flexural folding accompanied by formation of pressure–solution tectonic foliations in zones of higher strain. Deformation intensities increase toward the hinterland and with depth. The history of deformation involved progression from layer-parallel shortening to folding above a detachment, and further formation of a forward-propagating thrust wedge. Layer-parallel shortening and incipient folding recorded in Maastrichtian–Danian rocks indicate the leading edge of *D'* deformation. Non-coaxial finite strain orientations were involved during formation of *D'* structures along the Fuegian Andes front. These finite strain orientations cannot be explained with the SW–NE regional contraction usually assumed to have driven Andean deformation in this region; alternatively, we consider that N–S contraction combined with buttressing against the cratonic foreland comprise a more suitable interpretation for *D'* and younger deformation.

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### 1. Introduction

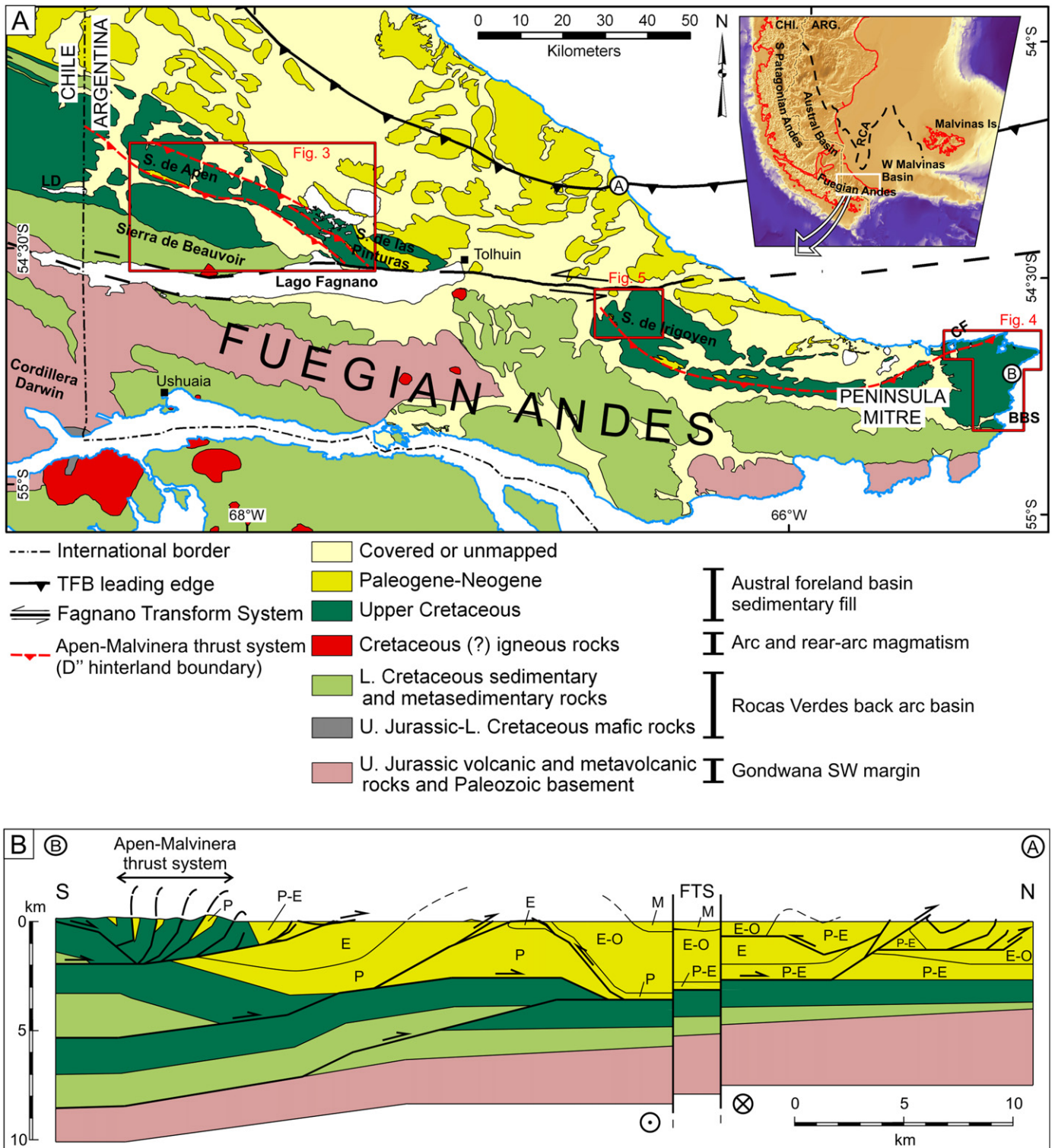
The outer orogenic belt of the Fuegian Andes comprises a foreland thrust-fold belt (Fuegian thrust-fold belt -TFB-) where sedimentary rocks of the Rocas Verdes back arc basin (Lower Cretaceous) and the Austral (Magallanes) foreland basin (Upper Cretaceous–Neogene) were subjected to thin-skinned contractional deformation (Alvarez-Marrón et al., 1993; Klepeis, 1994a; Rojas and Mpodozis, 2006; Torres Carbonell et al., 2011). The TFB can be separated in an external zone, mostly composed of Cenozoic rocks involved in thrust sheets, and an internal zone that comprises deformed Cretaceous–lower Paleogene rocks and bears the connection of the TFB with the inner orogenic belt of the Fuegian Andes (Fig. 1A).

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While several previous studies assessed structural issues in the external zone (Alvarez-Marrón et al., 1993; Ghiglione and Ramos, 2005; Torres Carbonell et al., 2008a, 2011), the internal zone and its transition to the core of the orogenic belt have been less studied, particularly in the eastern segments of the TFB (Argentina). Therefore, the tectonics of the internal zone of the TFB remain poorly known to date, impeding strain estimations of the initial phases of formation of the TFB, and undisclosed the geometric and kinematic relationships between the inner orogenic belt and the foreland TFB.

The purpose of this paper is to address the results of the structural studies carried on in the last years in the internal zone of the TFB, and report for the first time the geometry of tectonic structures in that area. The results of this study give important constraints on the strains and mechanisms of deformation involved in the first stages of formation of the TFB, contributing to understand the structural processes acting during the progressive deformation of clastic successions in thrust-fold belts at moderate to shallow crustal depths. In addition, since the studied structures were formed before separation of the Antarctic Peninsula from southern South America (Barker, 2001; Livermore et al., 2005), our



**Fig. 1.** A. Geologic map of the Fuegian Andes at the area of interest, showing the regional stratigraphy and major tectonic features. The hinterland boundary of D'' structures (red dashed lines) marks the transition between the external (north) and internal (south) zones of the TFB. Main data from Olivero and Malumíán (2008), Klepeis et al. (2010), authors' data, and other references cited in the text. Red boxes indicate location of the Western, Central, and Eastern Areas of this study. LD: Lago Deseado, CF: Caleta Falsa, BBS: Bahía Buen Suceso. Inset shows the regional situation of the study area and the 1 km structural contour of the Austral and Malvinas foreland basin system cratonic border (dashed line). CHI: Chile, ARG: Argentina, RCA: Río Chico Arch. Digital Elevation Model from the GEBCO One Minute Grid, version 2.0 (<http://www.gebco.net>). B. Schematic cross-section of the TFB, which combines several cross-sections between points A and B (in Fig. 1A) (from Torres Carbonell, 2010). P: Paleocene, E: Eocene, O: Oligocene, M: Miocene, FTS: Fagnano Transform System. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

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