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Buried thrust belt front of the western Central Andes of northern Chile: Style, age, and relationship with basement heterogeneities

F. Martínez [a, *], G. Fuentes [b, c], S. Perroud [b, c], S. Bascuñan [d]

[a] Departamento de Ciencias Geológicas, Facultad de Ingeniería y Geología, Universidad Católica Del Norte, Angamos 0610, Antofagasta, Chile
[b] Escuela de Geología, Facultad de Ingeniería, Universidad Santo Tomás, Ejército 146, Santiago, Chile
[c] Incaic Exploration SpA, Paseo Ahumada 236, Santiago, Chile
[d] Universidad de Chile, Santiago, Chile

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ABSTRACT

We present a regional-scale study combining field, seismic, and limited borehole information to analyze the structural characteristics of the thrust belt front of the western Central Andes at 21 °S. This region, located in northern Chile, consists of the easternmost part of the Coastal Cordillera, the Pampa del Tamarugal, and the western Domeyko Cordillera (or Chilean Precordillera). On the surface, a series of N–S-oriented folds alternating between monoclines and narrow anticline and syncline folds containing Mesozoic, Upper Cretaceous, and Cenozoic rocks form part of the main structural styles, which are frequently bound by west-verging reverse faults that form the basement of the deeper structural levels of the upper crust. The interpretation of a regional seismic grid composed of N–S, NE–SW, and WNW–ESE-oriented 2-D seismic profiles revealed the presence of several blind west-verging inversion anticlines that define the orogenic front of the Central Andes at this latitude. These anticline folds are related to the partial and/or total positive reactivation of ancient east-dipping Jurassic normal basement faults bounding half-graben structures and sub-basins developed within the Tarapacá Basin. Our results suggest that the thrust belt front in this region is preferably located under the Pampa del Tamarugal, and not along the topographic culmination of the western Precordillera as traditionally proposed. New tectonic restorations of 2-D structural models suggest that, during tectonic inversion, between 3 and 4 km of crustal shortening were accommodated by vertical motion along the inverted normal faults. The presence of Upper Cretaceous synorogenic deposits covering the Jurassic syn-rift deposits on the inversion anticlines indicates that both basin inversion and formation of the western thrust belt front began during the Late Cretaceous, and not during the Eocene "Incaic" tectonic phase as previously suggested by regional studies developed in the area.

1. Introduction

Thrust belt fronts are commonly located along the outermost regions of orogens. In these regions, the youngest fold and thrust structures are elevated over areas of the basin, where they may or may not be exposed. Vann et al. (1986) proposed some thrust belt front models including a) flat-lying thrusts underneath semi-consolidated and undeformed synorogenic deposits (Fig. 1a), b) triangle zones (Fig. 1b), c) exposed and buried thrusts (Fig. 1c), and d) a single large fault-propagation fold. Many of these models were inspired by the thin-skinned fold and thrust belt of the Rocky Mountains in North America (Bally et al., 1966) following the conceptual model of the Coulomb wedge. Additionally, the discovery of important oil and gas reserves in several thrust belt fronts has led to their intense exploration, as they are interesting places for the accumulation of economic resources. In those thick-skinned thrust belts preceded by tectonic extension, their outer parts can be characterized by inverted structures that result from the tectonic inversion of previous normal fault systems, thus creating large frontal anticlines (Mouthereau et al., 2002; Pace et al., 2015). Tectonic inversion consists in the slip reversal of pre-existing normal faults, which occurs when subsiding areas initially created from extension are then compressed, shortened, and tectonically uplifted (Bally et al., 1966, Bally, 1984; Butler, 1989; Letouzey et al., 1990; Bonini et al., 2012; Pace et al., 2015, among others).

The Central Andes is a doubly verging and asymmetrical subduction-related orogen. Between 20 and 21°S, it is composed from west to

* Corresponding author.
E-mail address: fernando.martinez@ucn.cl (F. Martínez).

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