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Tectonic architecture of the Tarapacá Basin in the northern Central Andes: New constraints from field and 2D seismic data

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ABSTRACT

The Tarapacá Basin is one of the larger basins created on the western margin of South America during the Mesozoic times. Regional studies focused their attention on understanding its Cenozoic surface structures, traditionally interpreted as a west-verging thrust and fold belt. However, its internal and deep architecture and the influence of previously developed Mesozoic extensional structures on its current structure have not been analyzed in detail. We used new field data and 2D seismic data to determine the tectonic architecture of the Tarapacá Basin. We have paid special attention to defining both the deep and superficial structures to understand its tectonic evolution. The seismic data reveal the existence of a series of half-graben structures along which Mesozoic synrift stratigraphic sequences accumulated. We also show that Upper Cretaceous and Cenozoic synorogenic sequences mainly accumulated over contractional folds (anticlines and synclines). The structure is characterized by a thick-skinned structural style dominated by structures inverted during the oblique reactivation of ancient Mesozoic normal faults and also by newly formed reverse faults in the form of short cut and by pass faults. The presence of Upper Cretaceous to Tertiary synorogenic sequences over the contractional structures, separated by angular unconformities, allowed us to show that the basin inversion and its subsequent deformation occurred at least since the Late Cretaceous until Recent times. These results aid in understanding the role of extensional structures in the evolution of orogenic belts and can be compared with similar structures around the world.

INTRODUCTION

The Central Andes is the largest active non-collisional mountain belt worldwide, located along the western margin of South America (Fig. 1). It is related to the subduction of the Nazca plate beneath the westernmost edge of South America, and its major topographic expression is observed along its curved portion in northern Chile and southern Peru and Bolivia (Fig. 1), where it reaches a width of nearly 450 km and a mean elevation of nearly 4 km above sea level (asl) along the so-called Altiplano-Puna plateau (Isacks, 1988). The western flank is mostly located on the Chilean side (Fig. 1). In northern Chile, between 18° and 22°S, this mountain belt is divided into four tectonic provinces: the Coastal Cordillera, the Central Depression, the Precordillera (or Domeyko Cordillera), and the Western Cordillera (Fig. 1).

The present-day tectonic configuration of the Central Andes (Fig. 1) has often been attributed to the almost continuous crustal shortening of the continental margin since at least ca. 90 Ma (Mpodozis and Ramos, 1989; Somoza, 1998; Farías et al., 2005; Mpodozis et al., 2005; Arriagada et al., 2006; Bascuñan et al., 2016, and others), associated with a major plate reorganization and changes in the relative velocity and convergence between Nazca and South America (Pardo-Casas and Molnar, 1987; Somoza, 1998). Nevertheless, its early tectonic history during the Mesozoic (Triassic–Jurassic–Early Cretaceous) was dominated by an extensional tectonic regime, characterized by the creation of different backarc extension related basins, and related to the retreating subduction, coeval with the breakup of the Pangea-Gondwana supercontinent (Coira et al., 1982; Mpodozis and Ramos, 1989, 2008; Franzese and Spalletti, 2001; Vicente, 2006; Ramos, 2010).

The Tarapacá Basin (Figs. 1 and 2) in northern Chile is one of the main basins that resulted from this Mesozoic extensional tectonic regime, which can be extended south toward the Copiapó region in Chile (27°S) and north toward southern Peru (Vicente, 2006). Its structural and stratigraphic relations have been mostly interpreted from field data in some sectors of the Domeyko Cordillera (Muñoz and Charrier, 1996; Ardill et al., 1998; Farías et al., 2005; Amilibia et al., 2008; Herrera et al., 2017), and also from seismic profiles of the Pampa del Tamarugal (Victor et al., 2004; Nester, 2008; Jordan et al., 2010; Nester and Jordan, 2012; Labbé et al., 2015) and the Salar de Atacama Basin (Pananont et al., 2004; Arriagada et al., 2006; Jordan et al., 2007, and others). Based on these studies, different structural styles have been recognized to affect both the infill and the basement of this basin. They are frequently related to thick-skinned thrust systems, strike-slip faults, and/or normal faulting (Mortimer, 1973; Flint et al., 1993; Muñoz and Charrier, 1996; Victor et al., 2004; Farías et al., 2005; Herrera et al., 2017). Despite these attempts, other regions of this basin are still unexplored. One of the main reasons for this gap is the presence