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Evolution of the Neogene Andean foreland basins of the Southern Pampas and Northern Patagonia (34°–41°S), Argentina

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ABSTRACT

The Pampas plain (30°–41°S) has historically been considered as a sector that evolved independently from the adjacent Andean ranges. Nevertheless, the study of the Pampas showed that it is reasonable to expect an important influence from the Andes into the extraandean area. The Pampas plain can be divided into two sectors: the northern portion, adjacent to the Pampean Ranges, has been studied by Davila (2005, 2007, 2010). The southern sector (34°–41°S) is the objective of the present work. The study of this area allowed to characterize two separate foreland basins: the Southern Pampa basin and the Northern Patagonian basin. The infill is composed of Late Miocene and Pliocene units, interpreted as distal synorogenic sequences associated with the late Cenozoic Andean uplift at this latitudinal range. These foreland basins have been defined based on facies changes, distinct depositional styles, along with the analysis of sedimentary and isopach maps. The basins geometries are proposed following De Celles and Gilles (1996) taking into account the infill geometry, distribution and grain size. In both cases, these depocenters are located remarkably far away from the Andean tectonics loads. Therefore they cannot be explained with short-wave subsidence patterns. Elastic models explain the tectonic subsidence in the proximal depocenters but fail to replicate the complete distal basins. These characteristics show that dynamic subsidence is controlling the subsidence in the Southern Pampas and Northern Patagonian basins.

1. Introduction

The Andean foreland of central Argentina (~30°–41°S) comprises the geomorphological domains of Sierras Pampeanas (Pampean Ranges), the extensive Pampean plain, and the northernmost part of the Patagonian plateau. In the Pampean plain, a vast foreland sedimentary system developed during the Neogene characterized by its relatively reduced and constant thickness (e.g. Dávila et al., 2010; Folguera and Zárate, 2009, 2011; Nivière et al., 2013). Considering the general geological and structural setting, as well as the Neogene stratigraphic record, two main foreland basins here called Southern Pampa basin and Northern Patagonia basin have been identified between 34° and 41°S, a region bounded by Sierras Pampeanas to the north and the Northern Patagonian massif to the south (Fig. 1). The southern Pampa basin (34°–38°S), south of Sierras Pampeanas, is a large area that covers most of La Pampa province and southern Buenos Aires province mainly; it is characterized by a main phase of sedimentation in the late Miocene with up to 200–300 m of thickness widely distributed (Folguera and Zárate, 2009). The Northern Patagonian basin (38°–41°S) extends between the Colorado-Curacó fluvial system and the North Patagonian massif comprising the northern part of Río Negro province, eastern Neuquén province and the southernmost part of La Pampa and Buenos Aires provinces. The sedimentary record is dominantly composed of fluvial conglomerates and sandstones of late Miocene and Pliocene age. The filling of both basins is made up of synorogenic deposits derived from the Andes (Folguera and Zárate, 2009).

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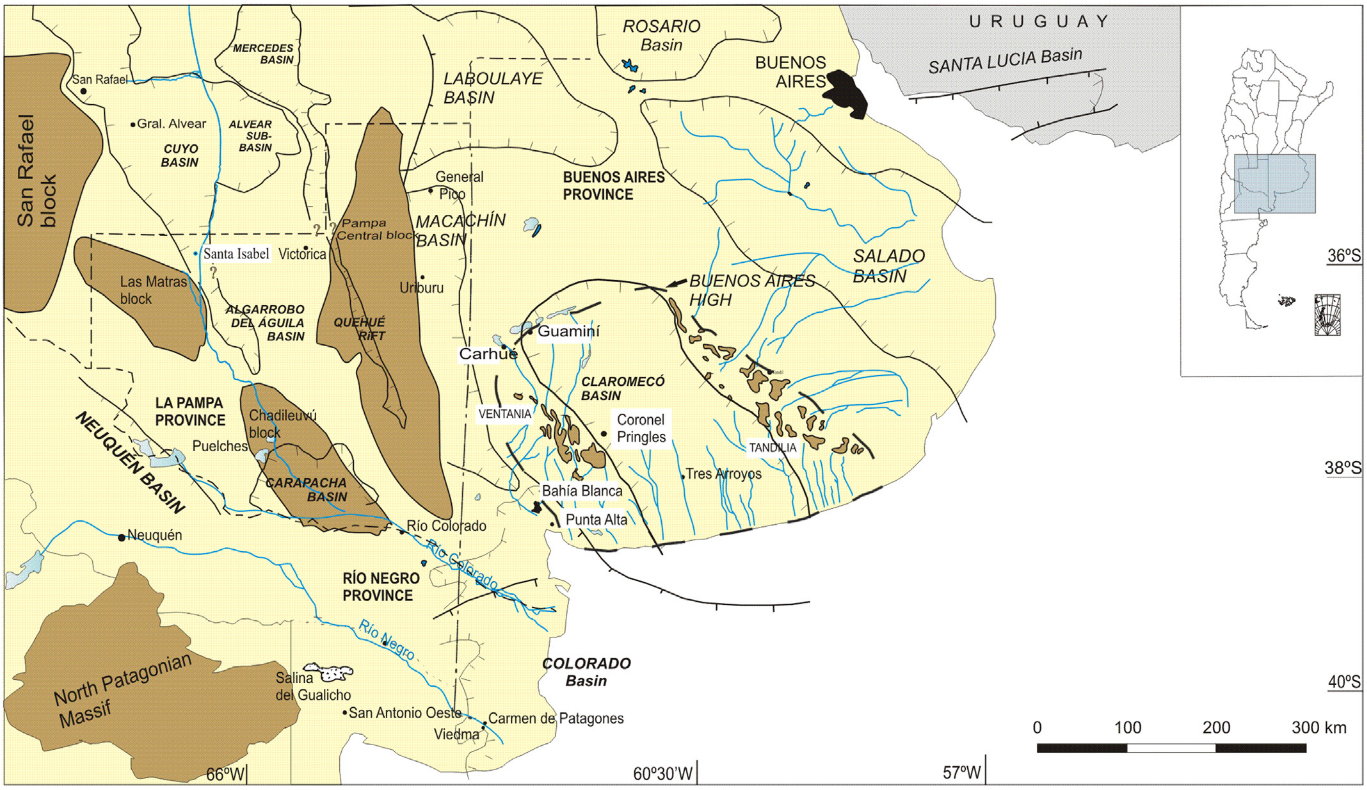

Fig. 1. Pampean region and its surrounding areas. Morphostructural units mapped.

Because of the significant areal extension of the basins, and the distance from the orogenic front, the resulting basin geometry and the maximum thickness of the sedimentary record cannot be only reproduced by topographic loading (see Dávila et al., 2005, 2007; 2010; Dávila and Lithgow-Bertelloni, 2013). In this respect, east of Sierras Pampeanas, subsidence was interpreted as a combination of sub-lithospheric and supra-lithospheric mechanisms driven by both tectonic and dynamic loads (Dávila et al., 2010; Dávila and Lithgow-Bertelloni, 2013); dynamic subsidence was thought to take place at the location of the slab leading edge associated with the flat subduction dynamic; major subsidence may have taken place during the late Miocene, migrating westwards later, during the Pliocene retreating phase of the slab (Dávila et al., 2010). Further south (36°–38°S) at the latitudinal fringe of the Southern Pampa basin, flat slabs occurred during the late Miocene (13–5 Ma, see Ramos and Folguera, 2005), likely followed by rollback and foreland extension since the Pliocene to the present (Folguera et al., 2005a,b).

The main objective of this contribution is to analyze and compare the Neogene evolution of the two foreland basins of central Argentina and the plausible mechanisms involved in the generation of subsidence and the resulting accommodation space. With this purpose in mind, the general infill history is reviewed, including the lithological characteristics of the stratigraphic units, and the description of the basins geometry. Finally, the overall subsidence patterns and the possible relationship of these features to regional tectonic events are discussed.

2. Methods

The analysis of the study region was mainly based on field work that included the reconnaissance, description, and mapping of the Neogene stratigraphic units in the study region. Digital elevation models and Google earth images were also used to map the units and place the stratigraphic sections in the regional geological and geomorphological setting. Sedimentological sections were described based on the identification of lithofacies.

Due to the general lithological homogeneity of the Northern Patagonian Basin deposits, informal allostratigraphic units were defined following the criteria of the North American Commission of Stratigraphic Nomenclature (1983). Morphological features (*i.e.* topographic altitudes, gradient, relative degree of dissection) were qualitatively considered as complementary criteria to attribute relative ages. Isopach maps were made using information from outcrop measurements as well as borehole data recovered by federal institutions of Argentina (YPF, Ministerio de Agricultura, Ministerio de Industria y Comercio de la Nación, Ministerio de Obras Públicas, Secretaría de Industria y Comercio) The information on the areal extension, thickness, lithology, and chronology of the sedimentary units were integrated to analyze the basin geometry, the temporal and spatial thickness of the deposits, and the subsidence history of the basins.

3. Tectonic and geological setting

The western limit of the study region is the Andean orogenic belt, a typical orogen with subduction of oceanic crust, without participation of collisions during the Mesozoic–Cenozoic, absence of Andean age metamorphism, maximum tectonic stacking and crustal shortening (Ramos, 1999). The geometry of the Andean segment west of the study area (34°–41°S) is within the zone of normal subduction characterized by a plate inclination of 30°, that generates a volcanic system in the cordillera (Ramos, 1999). Northwards, between 33° and 34° S is the transition from normal to