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Facies analysis and basin architecture of the Neogene Subandean synorogenic wedge, southern Bolivia

Cornelius Eji Uba *, Christoph Heubeck, Carola Hulka

Institut für Geologische Wissenschaften, Freie Universität Berlin, Malteserstrasse 74-100, 12249 Berlin, Germany

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Abstract

Foreland sedimentation in the Subandean Zone of south-central Bolivia spans from the Upper Oligocene to present. It records sediment dispersal patterns in an initially distal and later proximal retroarc foreland basin, and thereby contains stratigraphic information on the tectonic evolution of the adjacent Andean fold-thrust belt. Within the Neogene orogenic wedge individual siliciclastic-dominated depositional systems formed ahead of an eastward-propagating deformation regime.

We defined, described, and interpreted eight architectural elements and 24 lithofacies from 15 outcrop locations representing the Neogene foreland basin in the Subandean Zone and the Chaco Plain. These are combined to interpret depositional settings. The up to 7.5 km-thick Neogene wedge is subdivided in five stratigraphic units on the basis of facies associations and overall architecture: (1) The basal, Oligocene–Miocene, up to 250 m-thick Petaca Formation consists dominantly of calcrete, reworked conglomeratic pedogenic clasts, and fluvial sandstone and mudstone. This unit is interpreted to represent extensive pedogenesis under an arid to semiarid climate with subordinate braided fluvial processes. (2) The overlying, Upper Miocene, up to 350 m thick Yecua Formation records numerous small-scale transgressive–regressive cycles of marginal marine, tidal, and shoreline facies of sandstone, ooid limestones, and varicoloured mudstone. (3) The Upper Miocene, up to 4500 m-thick Tariquia Formation principally consists of sandstone with interbedded sandstone–mudstone couplets representing frequent crevassing in anastomosing streams with an upsection-increasing degree of connectedness. (4) The up to 1500 m-thick Lower Pliocene Guandacay Formation represents braided streams and consists principally of granule to cobble conglomerate interbedded with sandstone and sandy mudstone. (5) The Upper Pliocene, up to 2000 m-thick Emborozu Formation consists predominantly of alluvial-fan-deposited cobble to boulder conglomerate interbedded with sandstone and sandy mudstone.

The coarsening- and thickening-upward pattern and eastward progradation, coupled with the variable proportions of overbank facies, channel size, and degree of channel abandonment, in the Tariquia, Guandacay, and Emborozu Formations reflect a distal through proximal fluvial megafan environment. This long-lived megafan grew by high sedimentation rates and a northeast-through-southeast radial paleoflow pattern on large, coarse-grained sediment lobes. The marked overall

* Corresponding author. Present address: Institut für Geowissenschaften, Universität Potsdam, Postfach 601553, D-14415 Potsdam, Germany.
E-mail address: ejikeuba@zedat.fu-berlin.de (C.E. Uba).

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upsection change in pattern and depositional styles indicate fluctuations in accommodation space and sediment supply, regulated by basin subsidence, and are attributable to Andean tectonics and climatic controls.

Keywords: Neogene; Fluvial and marine sequence; Architectural analysis; Foreland; Basin history

1. Introduction

Neogene strata of the Subandean Zone (SZ) and the easterly adjacent Chaco Plain (CP) represent dominantly alluvial–fluvial deposits that accumulated within a foreland basin setting on the eastern side of the Andes in response to eastward propagation of the Andean fold-and-thrust belt (Fig. 1). This retroarc foreland basin formed as a result of Mesozoic–Recent subduction of the Nazca and Pacific plates, accompanied by Oligocene–Recent uplift of the Andean Cordillera (Isacks, 1988; Kley et al., 1997; Sempere et al., 1990; Kley et al., 1999). The Upper Oligocene–Recent sedimentary strata representing this rapid eastward Andean growth are particularly well exposed in the Subandean foothills. Although the SZ and the adjacent CP represent one of the classical foreland systems in South America, no detailed sedimentological study has yet been conducted despite the good outcrop quality and the long history of petroleum exploration and production expressed in numerous publications on the petroleum systems and hydrocarbon potential of the SZ (Baby et al., 1995; Dunn et al., 1995; Moretti et al., 1996). In contrast, a wealth of information exists on the structural styles, geometry, and tectonic history of the Subandean belt (Sempere et al., 1990; Baby et al., 1992, 1994; Welsink et al., 1995; Kley, 1996; Colletta et al., 1999; Kley, 1999; Echavarria et al., 2003), including aspects of its subsidence, uplift, and

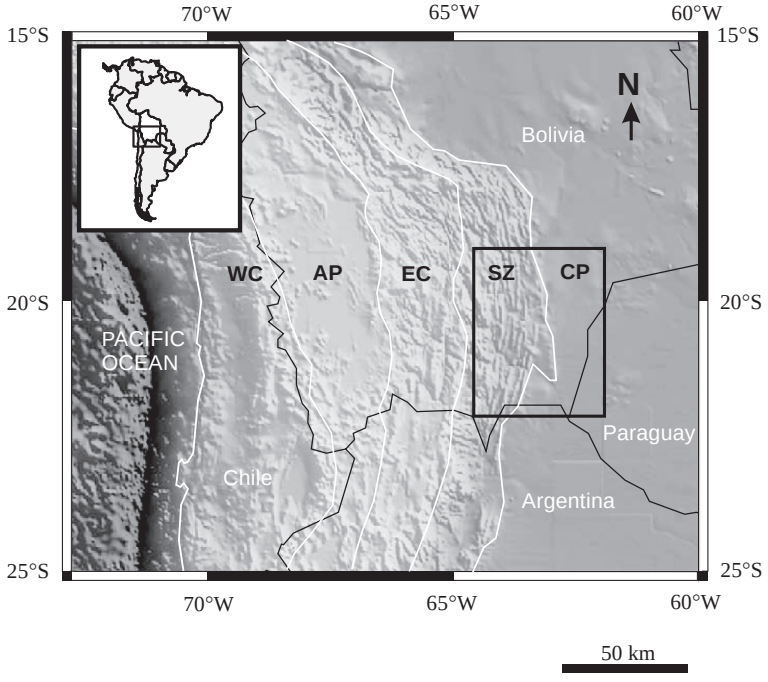

Fig. 1. Topographic map of the Central Andes showing major morphotectonic divisions and location of the study area. WC Western Cordillera, AP Altiplano, EC Eastern Cordillera, SZ Subandean Zone, CP Chaco Plain.