PALEOZOIC EVOLUTION OF THE CENTRAL ANDES: A NON-ACCRETIONARY MODEL FOR GONDWANA'S ACTIVE MARGIN

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KEY WORDS: Paleozoic, Central Andes, Gondwana, active margin.

INTRODUCTION

The Paleozoic geologic evolution of South America's western margin is frequently considered to include the complex accretion of exotic terranes. This concept has been widely promoted after the wealth of information recently provided to prove the collision of the Precordillera terrane with southwestern Gondwana (Astini et al., 1995; Rapela et al., 1998, and references therein). However, a review of other evidence present in the Central Andean region indicates that this may not be the norm. In fact, a large part of the Central Andes, in particular that between 5ºS and 27ºS, allows for an alternative overall interpretation. The area here considered covers central and southern Peru, most of Bolivia, northern Chile, and northwestern Argentina, and therefore excludes the Amotapes of northwestern Peru and southern Ecuador, as well as the Precordillera of western Argentina. This abstract attempts to synthesize the paleogeographic and geodynamic evolution of this part of the Central Andes during the Paleozoic, as recently proposed by Díaz-Martínez et al. (2000) and Jaillard et al. (2000). Apart from submitting this conceptual model to the scientific community working on Andean geodynamics for discussion and constructive criticism, the main objective of this abstract is to draw attention to one of the its main implications: that a large part of the Central Andean margin of Gondwana never underwent continental accretion of allochthonous terranes during the Phanerozoic, as opposed to what may be inferred from immediately adjacent regions north of 5ºS (Colombia, Ecuador and NW Peru) and south of 27ºS (Chile and Argentina). Those interested in the details of the model are encouraged to read the original and references therein.

PALEOZOIC GEODYNAMIC EVOLUTION OF THE CENTRAL ANDES

A review of the information published during the last two decades allowed us to establish a conceptual model with a coherent sequence of events for the Paleozoic of the Central Andes (Figure 1; Díaz-Martínez et al., 2000; Jaillard et al., 2000). The model proposed is schematic and considers the lack of evidence for the accretion of allochthonous terranes during the Phanerozoic. In brief, Paleozoic rocks of the Central Andes record the breakup of the Late Proterozoic Protopangea (Rodinia) in the latest Proterozoic-Early Cambrian to form a passive margin along western Gondwana, and its later evolution as an active margin during most of the Paleozoic and until present times (Sempere, 1995). The continuous superposition of magmatic, tectonic and sedimentary events has led to complex lateral variations, both transverse to the orogen and along strike.

The crustal basement in most of the Central Andes formed part of the Grenville orogen, as a result of the collision between Laurentia and Amazonia in the Middle Proterozoic (Wasteneys et al., 1995; Sadowsky and Bettencourt, 1996). The reconstruction of the remains of the Grenville orogen in South America (Sadowski and Bettencourt, 1996) indicates that the Central Andes corresponds to an area intermediate between the magmatic arc (represented by the Sunsas igneous province, in eastern Bolivia and western Brazil) and the thrust belt (SE Canada) of the Grenville orogen (Figures 1a and 1b). This interpretation explains the similar trends identified between the Proterozoic outcrops along the Andes, and those of the Brazilian shield (Litherland et al., 1985, 1989). The geochronology of basement rocks indicates that Paleoproterozoic ages represent the pre-Grenville Laurentian-Amazonian protolith, whereas Mesoproterozoic ages represent the main collisional events of the Grenville orogen (Wasteneys et al., 1995; Sadowski and Bettencourt, 1996). Rifting during break-up of Protopangea (Rodinia) in the Neoproterozoic-Early Cambrian led to separation of Laurentia from Amazonia (Figure 1c), leaving behind the parautochthonous Arequipa-Antofalla craton attached to Amazonia (Central Brazil shield). The boundary zone between the two crustal blocks, located beneath the Altiplano and Eastern Cordillera, constitutes a paleosuture inherited from the Mesoproterozoic evolution of the Grenville orogen (Figure 1b). This crustal weakness zone remained active during the Paleozoic, and ever since, with variable behavior depending on the regional state of stresses (Ramos, 1988; Forsythe et al., 1993).

After the breakup of Rodinia, and opening of the Southern Iapetus Ocean between eastern Laurentia and western Gondwana passive margins, subduction began in the Late Cambrian with the development of an active continental margin lasting most of the Phanerozoic until present times (Figures 1d, 1e, and 1f). Marginal magmatic arcs developed as a result of eastward subduction, with different rates of activity and sense of migration of the arc depending on regional plate stresses and inhomogeneities. Basin development also changed according to these plate interactions. An extensional regime during the early Paleozoic (Late Cambrian-Middle Ordovician) resulted in the development of a backarc basin over a strongly subsiding thinned crust (Figure 1d), with partial rifting and synsedimentary basic volcanism reaching from SE Peru through Bolivia and into N Argentina, and limiting the Arequipa-Antofalla craton to the west (Ramos et al., 1986) and the Amazon craton to the east (Teixeira et al., 1989). The progressive increase of rigidity of the crust, in conjunction with a shift to a compressional regime, resulted in the development of a large retroarc foreland basin during the mid Paleozoic (Middle Ordovician-Early Carboniferous), with progressive onlap of units over the distal cratonic margin of the basin, and episodic development of transpressional uplifts (Figure 1e). The San Nicolás batholith of Peru is interpreted as the roots of the magmatic arc resulting from east-ward subduction of oceanic crust along the active margin of Gondwana during the Ordovician-Devonian (Mukasa and Henry, 1990). An extensional regime during the late Paleozoic (Late Carboniferous-Early Triassic) resulted in the development of forearc, intra-arc and backarc basins, with local transpression and transtension (Figure 1f). A change from an overall accretionary to an overall erosive plate margin took place during the Late Paleozoic, and resulted in the progressive tectonic erosion of the margin during the Mesozoic and Cenozoic. As deduced from the aforementioned sequence of events, this part of western Gondwana (i.e., the Central Andes between 5º and 27ºS) does not show any evidence for allochthonous terrane accretion during the Phanerozoic, and only the Arequipa-Antofalla craton may be considered as para-authochthonous.

ACKNOWLEDGMENTS

Research funded by the Spanish Government, and supported by IRD, SERGEOMIN, and YPFB. G. Laubacher helped with the compilation of data. E. Jaillard and T. Sempere crytically read earlier versions of the manuscript.

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Figure 1: Simplified conceptual model for the pre-Andean geodynamic evolution of the Central Andes (5-27ºS) as proposed in the text. Overall regional stress field: 1, transcurrent; 2, tensional; 3, compressional.