

## GEOCHRONOLOGIC CORRELATIONS BETWEEN PALEO AND MESOPROTEROZOIC OROGENS IN BRAZIL AND BOLÍVIA, SW AMAZONIAN CRATON

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### INTRODUCTION

The Amazonian craton is comprised of Archean to Mesoproterozoic provinces bordered by Neoproterozoic belts (Tucavaca in Bolivia, Araguaia, Central Brazil and Tocantins, northeastern Brazil). In this contribution we studied the SW Amazonia craton extension in Bolivian territory comprised of the Paragua craton and its basement and compare with the geologic evolution of the Paleo and Mesoproterozoic terranes in Brazil.

The basement rocks of the Amazonian craton in Bolívia is comprised of gneisses (Lomas Maneches), gneisses (La Chiquitania) and schists (San Ignacio). After the formation of these basements units, occurred two important metamorphic and magmatic events defined as San Ignacio and Sunsás orogens. Based on the literature data and geochronologic reports is possible to suggest the existence of 3 important magmatic events. The first at about 1.68 Ga (Lomas Maneches) responsible for the formation of the basement rocks, 1.34-1.32 Ga (San Ignacio) responsible for the formation of widespread magmatism and metamorphism, and 1.07 Ga (Sunsás) representing the final event prior the cratonization. At the end, the Neoproterozoic belt described as Tucavaca defined the SW boundary of the largest cratonic area of South America.

One of the first tentative to correlate the pré-Cambrian rocks of Bolívia and the rocks observed in Mato Grosso and Rondônia (Brazil) is reported by Litherland *et al.* (1986). In this way, the authors proposed the correlation between the metamorphic basement rocks of Bolívia (Lomas Maneches Granulitic Complex, La Chiquitania gneisses and San Ignacio schists) with the rocks of the Xingu Complex in Brazil. The reported ages of the Xingu Complex during the 1980 decade were in the 1200-1400 Ma interval. These correlations, based mainly in K-Ar and Rb-Sr data, are invalidated actually due knowledge

progress of the SW Amazonian craton geology based on U-Pb and Sm-Nd geochronological studies.

New correlation tentative is now possible as result of recent works in oriental Bolívia based on field work, petrography, geochemistry added to reported U-Pb (Boger *et al.*, 2005) ages and Sm-Nd isotopic studies (Derbyshire, 2000), including also the Rb-Sr and K-Ar data reported by Litherland *et al.* (1986). The main aspects of the correlation between the two areas focussed in this work may be observed in Figure 1.

### OROGENESIS VERSUS OROGENESIS

Whithin Brazilian area, several orogenic events are reported as the Alto Jauru (1.75-1.74 Ga), Cachoerinha (1.58-1.54 Ga) and Santa Helena (1.45- 1.42 Ga) based on U-Pb Sm-Nd ages interpreted as formation ages of the respective rocks. Curious to observe that no events are reported in Bolivian pre-Cambrian at these times. In the same way, the orogenic events defined as Lomas Maneches (1.68-1.66 Ga) and San Ignacio (1.34-1.32 Ga) reported in Bolívia were not observed in Brazilian territory.

The inexistence of coeval orogenic events in Bolívia and Brazilian pré-Cambrian strongly suggests different geologic evolution in the both areas, instead rare units present equivalent ages. The lack of coeval orogenic rocks until the end of the Mesoproterozoic times also may be interpreted as result of a geologic evolution including terrane formation in the Bolivian pré-Cambrian followed by the collage of these terranes to the Amazonian proto-craton. This collision is probably recorded by the Rio Alegre terrane in Brazil comprised of metamorphised oceanic floor rocks. This hypothesis is corroborated by the existence of assymmetric age patterns from both side of this NNW-SSE *strike* terrane.

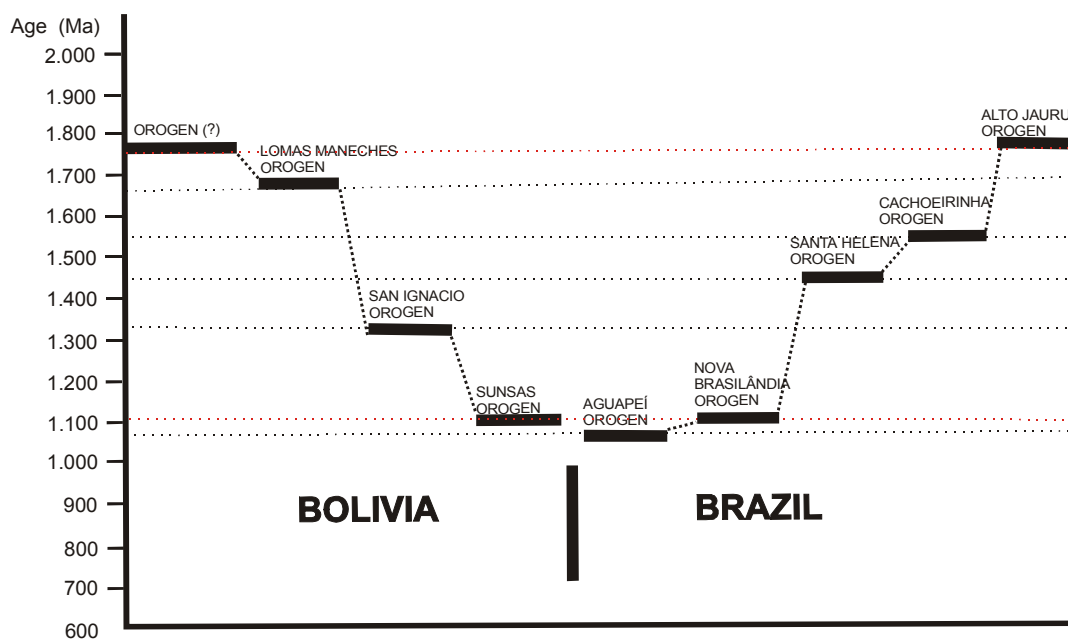


Figure 1. A tentative time-correlation chart showing the orogenic events of the SW Amazonian Craton in Bolívia and Brazil.

### OROGENESIS VERSUS ANOROGENESIS

Coeval Paleoproterozoic ages reported in SW Amazonian craton in Brazil and Bolívia comprise detritic zircon U-Pb ages from San Ignacio schists (c.a. 1.74 Ga) and La Chiquitania paragneisses (1.78-1.76 Ga). In the Brazilian side these ages are observed in magmatic zircons from juvenile rocks of the Alto Jauru magmatic arc (1.79-1.74 Ga). Therefore, it is possible to suggest that the sialic crust represented by the Alto Jauru rocks were the source for the sedimentary rocks deposited in the La Chiquitania/San Ignacio basin. As consequence, if this hypothesis is correct, there was a connection (i.e. proximity) between the Alto Jauru rocks and the La Chiquitania/San Ignacio basin and all the units probably were formed linked to the Amazonian proto-craton.

Later on, geologic and geochronologic data reported both in Brazil and Bolívia suggests that the areas were under different geologic settings at the end of the Paleoproterozoic times. This is due the occurrence of the not coeval Lomas Maneches orogen (1.68-1.66 Ga) in Bolívia and the Cachoeirinha orogen (1.58-1.56 Ga) in Brazil. The lack of geologic evolution correlation occurred also in the beginning of the Mesoproterozoic times, as indicated by the existence of the Santa Helena orogen (1.45-1.44 Ga) in Brazil and the San Ignacio orogen (1.34-1.32 Ga) reported in Bolívia.

By other hand, the units describes as Lomas Maneches enderbites, ortogneisses and migmatites (1663±13 Ma) in Bolívia are coeval to the Serra da Providência Intrusive Suite, which U-Pb ages reported by Bettencourt *et al.* (1996) are about 1.66-1.64 Ga. This suite is interpreted by the cited authors as a bimodal intrusion formed in intracratonic setting. In the Bolivian example, the Lomas Maneches rocks are interpreted as comprised of orogenic rocks originated during a magmatic arc evolution. These

geologic and geochronologic data allow to suggest that the Serra da Providência formation may be related to heat flux originated from the active continental margin represented by the Lomas Maneches magmatic arc.

The rocks formed during the San Ignacio orogen yielded ages c.a. 1.33 Ga (U-Pb zircon age by SHRIMP) and may be time correlated to the Teotônio and Alto Candeias intrusive suites which age is 1346±05 and the São Lorenço-Caripunas intrusive suite which age is 1314±13 (conventional U-Pb zircon ages; Bettencourt *et al.*, 1996). Again the same ages is reported for rocks formed in different tectonic settings. The intrusives suites reported in Brazil by Bettencourt *et al.* (1999) are interpreted as formed in intracratonic environment, and the San Ignacio granitoid rocks are interpreted as being formed in a magmatic arc setting.

### THE FINAL COLLAGE

The Sunsás Orogeny rocks yielded 1005±12 Ma (Casa de Piedra granite) and 993±139 Ma (Rincon del Tigre Complex; Rb-Sr isochrons), obtained by Litherland *et al.* (1986). Recent data reported by Borger *et al.* (2005) for the Taperas granite yielded 1076 ± 18 Ma (U-Pb zircon ages by SHRIMP). Granites of the same ages are represented in Brazil by the Santa Clara suite (1081±50 Ma), Oriente Novo suite (1080±27 Ma, U-Pb zircon ages obtained by conventional method), and by the *Younger granites of Rondônia* (1018±76 Ma; Rb-Sr isochron), according to Bettencourt *et al.* (1996). This is another example where the intracratonic magmatism is coeval to the subduction process occurred in the active margin at the final orogenic event in the Amazonian craton.

Coeval U-Pb zircon ages are again observed in both Brazilian and Bolivian areas only at the end of the Mesoproterozoic times, when occurred the anatectic

magmatism during the Nova Brasilândia orogen (1.1 Ga) in Brazil. In the Bolivian side occurred the Sunsás event which magmatic activity is dated at 1.07 Ga (U-Pb zircon age by SHRIMP). In addition, K-Ar and Ar-Ar cooling ages due the Sunsás orogen, Aguapeí thrust and Nova Brasilândia orogen suggest that the three tectonic units were related to the Rodinia supercontinent assembly.

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## RESUMO

As correlações entre o pré-Cambriano da Bolívia e do Brasil no SW do Craton Amazônico são basadas em trabalhos de campo, estudos petrográficos e geoquímicos, adicionado aos trabalhos de geocronologia U-Pb e Sm-Nd. No Brasil os eventos orogênicos reportados são os eventos Alto Jauru (1,75-1,74 Ga), Cachoerinha (1,58-1,54 Ga) e Santa Helena (1,45- 1,42 Ga) porém não são observados na Bolívia. Da mesma forma, os eventos orogênicos Lomas Maneches (1,68-1,66 Ga) e San Ignacio (1,34-1,32 Ga) observados no pré-Cambriano na Bolívia não são encontrados no Brasil.

A inexistência dos eventos temporalmente equivalentes no pré-Cambriano boliviano e no Brasil (com exceção de suítes anorogênicas contemporâneas) sugerem que a evolução geológica da área boliviana envolve a formação dos terrenos e a sua posterior colagem ao cráton Amazônico.