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Looking for the oldest rocks of South America: Paleoarchean orthogneiss of the Sobradinho Block, northernmost foreland of the São Francisco Craton, Petrolina, Pernambuco, Brazil

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INTRODUCTION

Rock fragments older than 3.0 Ga are rare worldwide. They occur generally as small isolated fragments or slivers within large cratons. In South America, the best candidates for the discovery of Paleoarchean rocks are the still poorly studied areas of the São Franscisco Craton. We performed Nd isotopic and U-Pb zircon geochronologic studies on orthogneiss samples collected in several outcrops from Petrolina, Pernambuco and Juazeiro, Bahia, in the northern portion of the São Francisco Craton, in order to better constrain Archean evolution and geological history of the Sobradinho block, foreland to the Neoproterozoic Riacho do Pontal belt.

GENERAL GEOLOGICAL AND TECTONIC FEATURES

The medium São Francisco river valley region, encompassing border areas of Piauí, Bahia and Pernambuco states, represents a very special geotectonic context. It is the northernmost foreland of the former São Francisco plate/paleocontinent. The basement of this domain is exposed in a large tectonic and erosional window, between the frontal thrust sheets of the Brasiliano Riacho do Pontal fold belt northward and several isolated *klippen* southward of the Sobradinho dam, within the stable cratonic domain, largely covered by the Chapada Diamantina Group. In the easternmost part of this window, along BR-122 and BR-428 highways in Pernambuco and Bahia, north and south of the São Francisco River, the largest of these klippen, the Barra Bonita klippe (ca. 1,500 km^2) is exposed.

The northern limit of the São Francisco paleocontinent/plate is rather irregular, displaying a series of bulges and hollows, where pre-Mesoproterozoic basement rocks and metasedimentary piles of the adjacent mobile belt are exposed, respectively (Figure1). In this respect it has not been easy to separate the cratonic domain from the mobile belt, even with the support of geophysical surveys. In this regard it does not help that the basement was deeply reworked below the thrust sheet front and below the metasedimentary klippen.

The domain and its rather complex foreland forms were loosely described in previous regional and tectonic syntheses under the informal Sobradinho block (or massif) designation. It comprises mainly orthogneiss and migmatite, from long ago almost always inferred to be Archean in age, despite the lack of reliable isotopic age data. Associated to these rocks remains of greenstone belt type volcano-sedimentary sequences (Barreiro, Rio Salitre) are observed. A belt of metasedimentary rocks of the Colomi Group of presumed Paleoproterozoic age, including banded iron formations and

carbonate rocks, covers the basement southwestwards. Several granite stocks and batholiths, presently mainly orthogneiss, cut through the basement and display remarkable morphologic expression as inselbergs within the flat-lying São Francisco river plain (the so called Sertaneja surface)(Angelim et al.,2000; Delgado et al.,2003; Figueiroa e Santos, 1993).

The orthogneisses display flat-lying foliation and compositional banding, mostly due to centimetric-decimetric intercalations of mafic and even ultramafic rock,s as well as of calc-silicate rocks. Diorite, gabbro, and sometimes anorthosite may be associated to these rocks. The basement comprises mainly granodiorite and tonalite, with low contents of mafic minerals, usually biotite and less frequently hornblende. Trondhjemite is rare. Preliminary petrographic studies and chemical data (Figueiroa and Santos, 1993), indicate low K/Rb, Rb/Sr and Rb/Ba ratios, typical of TTG associations recorded in many Archean orthogneiss terrains around the world.

The very general geological and geotectonic features of the domain, as well as unpublished preliminary data resulting from reconnaissance surveys carried out previously by CPRM-Serviço Geológico do Brasil and by one of us (BBBN) indicated already the possible occurrence of Archean rocks as basement of the domain, as also stressed by Figueiroa and Santos (1993).

Our study was carried out on orthogneiss and migmatite occurring in the northernmost São Francisco Craton. Five samples were selected for U-Pb zircon dating and 10 samples for Sm-Nd isotopic studies.

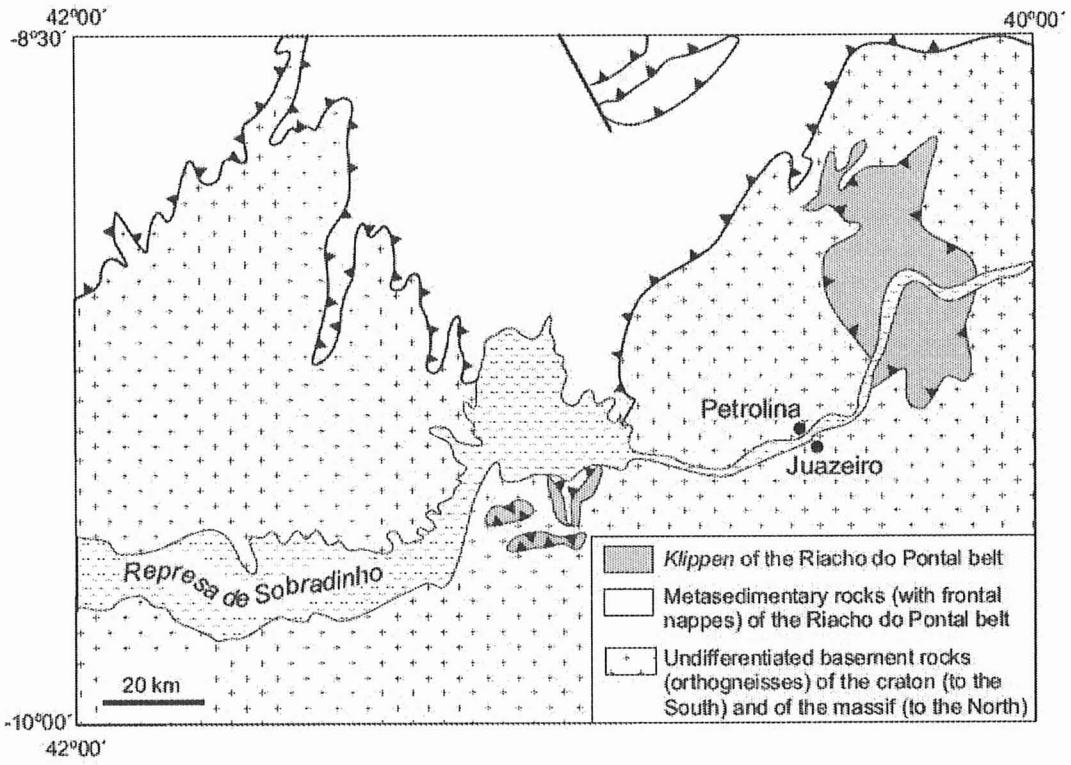

Figure 1. Geologic Map of studied area

RESULTS

U-Pb Geochronology

Sample CSF BROW is a gabbro-diorite xenolith found within grey gneiss collected in the Riacho da Vitória quarry. The analyzed rock shows two different zircon populations. The first is represented by large, prismatic and translucid zircon crystals that yield a concordant age around 3.5 Ga. Another population could be related to intrusive veins cross-cutting the mafic protolith and displays a upper intercept age of 2.56 Ga. Metamict zircon grains show high U content and high common Pb, suggesting that fluids played an important role in the analyzed zircons, defining in some cases a low intercept around 630 Ma (Figure2). Thus, a complex magmatic and deformational evolutionary history is recorded in this rock. More analyses are necessary to better understanding the complex isotopic behavior recorded in this rock.

Another sample comes from Riacho Uruais. The rock is a trondhjemite and displays a discordant age at around 3.2 Ga. Tree other samples collected close to Petrolina, along the BR 428 highway (samples CSF KM 11, 57 and 103) show strong dispersion of isotopic data and do not define well constrained discordia lines, where any age is possible to calculate. We interpreted this as typical behavior of an isotopic open system in zircon grains caused by fluid percolation associated with deformational processes.

Nd Isotopic Signature

T_{DM} model ages range from 3.7 to 3.0 Ga, suggesting dominantly Archean sources for all analyzed samples of the Sobradinho block. Positive and negative End(t) values, calculated for crystallization ages obtained by zircon age determinations, demonstrate that juvenile and reworked crust are present in this Archean segment.

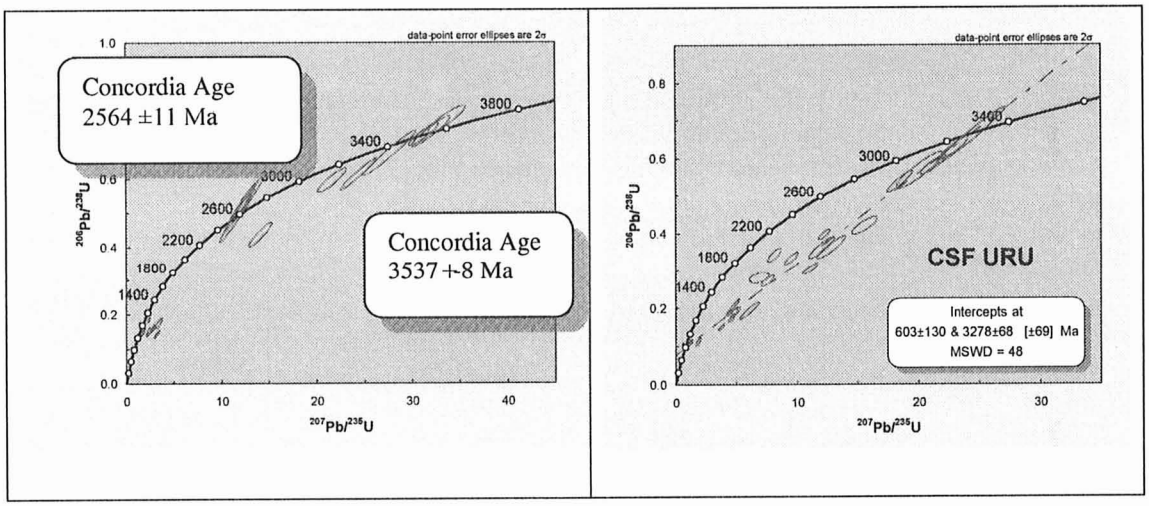

Figure 2 – A) Diorite gneiss from the Riacho da Vitória Quarry; B) Trondhjemite from Riacho Urais.

A few inferences on the Sobradinho block

The portion of the São Francisco Craton immediately to the south of the studied domain is entirely covered by Paleoproterozoic sedimentary rocks of the northern Chapada Diamantina, known as the Mimoso block. These in turn are covered by glacial

and pelite-carbonate deposits of the Neoproterozoic São Francisco Supergroup. It is possible that the Sobradinho block is Just the northernmost exposure of the large orthoplataformal tectonic domain known as Gavião or Gavião–Lençóis block in the specialized literature on the São Francisco craton. The geological context is similar, although reported ages are slightly different. In the Gavião-Lençóis area, the oldest ages are Paleoarchean or Mesoarchean ($\leq$ 3,4 Ga). Alternatively, the Sobradinho block may have been an independent microcontinent, similar to Gaviões-Lençóis, Serrinha, Jequié, Campo Belo, etc., accreted to the São Francisco paleocontinent during Rhyacian orogenies.

The identification of early Paleoarchean rocks is a first in South America and encouraging for new research. In retrospect, the oldest rocks so far recorded in our continent, i. e. 3,4-3,5 Ga old basement of Contendas-Mirante and São José do Campestre massif, were obtained more than 20 years after the first geochronology laboratory started to operate in Brazil, just at the beginning of using U-Pb (TIMS) systematics. With increasing resolution provided by new techniques and a larger number of laboratories (in Brazil and abroad) working on various research fronts, we may expect new findings of rocks with similar ages in the near future.

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