



Carbon-isotope and Hg stratigraphies of the Neoproterozoic Serra do Paraíso (Rio Pardo Basin) and São Desidério (Rio Preto Belt) formations, Bahia, Brazil

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ABSTRACT.

The Rio Preto Basin and Rio Pardo Belt surround, respectively, the southeastern and northwestern portions of the São Francisco Craton. In this study, using carbon isotope and Hg stratigraphies, it is examined the possibility that carbonates of the Serra do Paraíso Fm. (Rio Pardo Basin) that overly diamictite/arkose of Panelinha Fm. or basement, and of the São Desidério Fm. (Rio Preto Belt), represent Neoproterozoic cap carbonates. Composite C-isotope profiles yet to be completed and refined support this hypothesis. Carbonates of the São Desidério Fm. exhibits C-isotope pathway similar to that obtained for the upper portion of the Sete Lagoas and Lagoa do Jacaré formations of the Bambuí Group, Minas Gerais. Hg values from carbonates of the Serra do Paraíso Fm. have been used as a proxy of volcanism intensity and CO₂ buildup during snowball events.

Keywords: C-isotope stratigraphy, mercury, carbonates, Rio Pardo Basin, Rio Preto Belt

RESUMO

A Bacia do Rio Pardo e Cinturão Rio Preto bordejam, respectivamente, as porções sudeste e noroeste do Cráton do São Francisco. Neste trabalho é usado estratigrafia de isótopos de carbono e Hg, para examinar a possibilidade das formações carbonáticas Serra do Paraíso e (Bacia do Rio Pardo) que cobre diamictitos/arcóseos da Formação Panelinha ou embasamento, e a Formação São Desidério (Cinturão Rio Preto), representarem capas carbonáticas Neoproterozóicas. Perfis compostos de isótopos de C ainda a serem refinados apóiam essa hipótese. Carbonatos da Formação São Desidério exibe comportamento isotópico similar aos das formações Sete Lagoas e Lagoa do Jacaré do Grupo Bambuí. Valores de Hg dos carbonatos da Formação Serra do Paraíso tem sido usados como um registro da intensidade do vulcanismo e do acúmulo de CO₂ durante o evento de snowball earth.

Palavras Chave: estratigrafia de isótopos de C, mercúrio, carbonatos, Bacia do Rio Pardo, Cinturão Rio Preto.

1. Introduction

The Rio Pardo Basin, located in the southeastern border of the São Francisco craton in the state of Bahia, eastern Brazil, has been partially affected by the folding of Araçuaí Belt and metamorphosed under greenschist facies. The Rio Pardo Group comprehends, from base to top, the following lithostratigraphic units (Pedreira, 1999): (1) Panelinha Formation consists of breccias, graywackes, immature arkoses and diamictites, perhaps glacial in origin; (2) Itaimbé Sub-group that encompasses the intermediate formations of the Rio Pardo Group, from north to south: (a) Camacan (pelites, siltites and carbonates), (b) Água Preta



(phylites, sandstones, siltites, slates and carbonates); (c) Serra do Paraíso (carbonates, locally with stromatolites, and quartzites), (d) Santa Maria Eterna (quartzites, conglomerates and carbonatic intercalations with tepee structures; and, (3) Salobro (polymitic conglomerates, graywackes and sandstones). The Salobro Formation overlies discordantly the Camacan Formation and are in tectonic contact with the Água Preta Formation.

Dolomitic limestones (~100m thick) in a proximal section of the Serra do Paraíso Formation with planar stromatolites are in contact with the gneissic/granulitic basement, at Serra do Paraíso Farm, and replaced up section by gray/dark limestones (~40m thick) that crop out along the BA-120 highway. Next to Santa Maria Eterna village, in a distal section, gray limestones show breccias and Conophyton bioherms (?) or tepee-like structures similar to what is observed in post-Marinoan cap carbonates in central Brazil. Carbonates of the Serra do Paraíso Formation overlie an immature arkose of the Panelinha Formation near the Pau Brazil locality. This immature arkose overlies, in turn, diamictite that rests on top of the basement and that exhibits carbonate clasts in a clayey matrix.

The Rio Preto Belt, at the northwestern border of the São Francisco Craton, is an example of an intracontinental belt (Trompette, 1994) and is considered to be a marginal belt forming an extension, to the west, of the Riacho do Pontal and Sergipano belts. It is subdivided into: (a) cratonic domain (São Desidério Formation; Egydio-Silva et al., 1989); (b) internal domain, limestones overlain by clastic rocks, marls and limestones (Serra da Mamona Formation); (c) north of Barreiras village, limestones are overlain by arkoses, feldspathic quartzites, graywackes and rare carbonate intercalations (Riachão das Neves Formation). In the central portion of the belt, the Canabrinha diamictites probably was deposited in glacial marine environment. The above formations are, respectively, equivalent to the Sete Lagoas, Serra de Santa Helena (Egydio-Silva et al., 1989), Três Marias (Trompette, 1994) and Jequitaiá formations (Bambuá Group).

2. C-isotope and Hg stratigraphies

In this study, carbonate rocks of the Serra do Paraíso Formation (Rio Pardo Belt) have never been observed in sharp contact with diamictite/arkose of the Panelinha Formation and same with respect to the São Desidério carbonates (Rio Preto Belt) in relation to the Canabrinha diamictites. We hypothesize, however, that in both cases we are dealing with cap carbonates. Carbon isotope stratigraphy of the Serra do Paraíso and São Desidério formations could be useful tool in demonstrating this hypothesis.

Mercury tends to concentrate in sediments deposited right after major glacial events (Santos et al., 2002) as a result from leaching of volcanogenic Hg from land surface and



accumulation along argillaceous sediments. Wherever geological background of Hg is negligible, its concentration in sediments may be useful for investigation of climatic changes.

Volcanism is assumed to be responsible for CO₂ build up in the atmosphere during Snowball Earth event with subsequent greenhouse effect, ice melting and cap carbonate deposition.

Carbon and oxygen isotopes were analyzed in 292 carbonate samples from the Serra do Paraíso and São Desiderio formations aiming at a high-resolution isotope stratigraphy and elucidating the paleoclimatic issue. Hg was analyzed in 8 samples from Serra do Paraíso Formation.

$\delta^{13}\text{C}$ values for carbonates with planar stromatolites at Serra do Paraíso Farm are $\sim -5\text{‰}$ and jump upsection to $+8$ to $+9\text{‰}$ and have Hg values from 4 in the base to 0.9 ng.g^{-1} in the top (Fig. 1a). At the eastern portion of the Agua Branca Range, a section of dolostones displays $\delta^{13}\text{C}$ values $\sim -2\text{‰}$ and Hg values from 2 in the base to 6.4 ng.g^{-1} in the top. Near Santa Maria Eterna, limestones with conophytions (or tepee-like structures) display $\delta^{13}\text{C}$ values $\sim 0\text{‰}$ and Hg values from 10.6 in the base to 1.3 ng.g^{-1} in the top. At Toca da Onça Quarry, dolostones display values from $+1$ to $+3\text{‰}$ and at the western side of the Agua Branca Range, gray limestones from a sequence of rhythmites exhibit values from $+3.5$ to $+6\text{‰}$ and Hg values $\sim 1.9 \text{ ng.g}^{-1}$ (Fig. 1b). Finally, a section to the north of Pau Brasil locality shows values from $+7$ to $+9 \text{‰}$.

In the Rio Preto Belt, representative sections of São Desiderio Formation have the following values: at Derocal, reddish dolomitic argillites display $\delta^{13}\text{C}$ values from $+2.5$ to $+5\text{‰}$, whereas at Mineração do Oeste Quarry limestones show $\delta^{13}\text{C}$ values from $+1.2$ to $+2.2\text{‰}$ in the first 16m changing abruptly upsection to values between $+10$ and $+12\text{‰}$ in organic matter-rich limestones (Fig. 1c). At Sítio Rio Grande, limestones show $\delta^{13}\text{C}$ values from $+13.5$ to $+15\text{‰}$ in the first 30m and from $+14$ to $+16\text{‰}$ in the upper 15 m, organic matter-rich limestones (labeled 5 in Figure 1c).

The composite $\delta^{13}\text{C}$ pathways for the Serra do Paraíso and São Desiderio formations are typical of cap carbonates and the latter approaches that of the Sete Lagoas and Lagoa do Jacaré formations described elsewhere (Santos et al., 2000).

In cap carbonates, Hg values may be over 10 times higher than background ($<1 \text{ ng.g}^{-1}$) values (Sial et al., 2010). In samples from Serra do Paraíso, Hg reached values up to 10 ng.g^{-1} , which supports the hypothesis of mantle-origin for CO₂ in the cap carbonate rocks.

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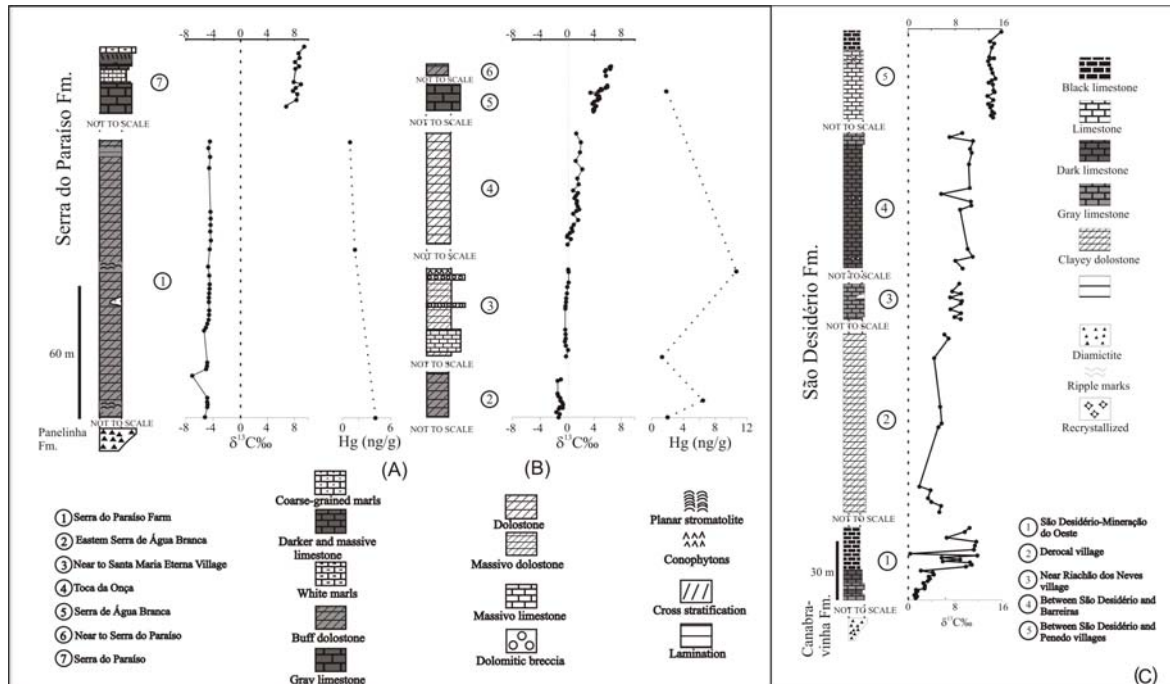


Figure 1. C-isotope stratigraphies for (a) Serra do Paraíso and (b) composite profile (Toca da Onça, Agua Branca and Santa Maria Eterna sections) in the Rio Pardo Basin; (c) São Desiderio Formation carbonates in the Rio Preto Belt.

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