

Isotope stratigraphy of the Lapa Formation, São Francisco Basin, Brazil: Implications for Late Neoproterozoic glacial events in South America

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Abstract

The Lapa Formation is a thick carbonate sequence (~900 m) that constitutes the upper part of the Vazante Group on the São Francisco craton, Brazil. It conformably overlies a previously unrecognized glacial diamictite unit of poorly constrained age. The sequence, above the glacial unconformity, consists predominantly of organic-rich shale, subtidal rhythmic dolomicrites and microbialaminites, and intertidal stromatolites. Four boreholes, spanning different depositional settings, were sampled at high-resolution and investigated for their petrographic and chemical criteria to evaluate their degree of preservation.

The $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ values of well preserved Lapa carbonate microsamples range from -8.2‰ to 3.3‰ (VPDB) and from -13.6‰ to -0.9‰ (VPDB), respectively. Each of the $\delta^{13}\text{C}$ profiles of the investigated cores reveals two strong negative excursions of up to 8‰ , an event in post-glacial dolomicrites immediately above the glaciogenic unit and a 10 m interval of organic-rich shale, and a second near the top of the sequence associated with a shale interval. Based on the observation of dropstones and sedimentary iron formation in the underlying diamictite, as well as the distinguishable carbon isotope trends, the Lapa Formation is considered as a cap carbonate lithofacies. The age of the Lapa Formation is presently unknown but the least radiogenic $^{87}\text{Sr}/^{86}\text{Sr}$ value (~ 0.7068), associated with a negative carbon isotope excursion, matches that from the Rasthof Formation in Namibia on the Congo craton, which is radiometrically constrained to be younger than ca. 750 Ma.

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1. Introduction

The successful use of stable isotope signatures encrypted in Phanerozoic marine carbonates (cf. [Veizer et al., 1999](#) and references therein) to understand Earth's

surface evolution encouraged Neoproterozoic (1000–543 Ma) researchers to apply these same techniques to the investigation of changing surface environments and life on Earth. Lacking a biostratigraphic framework and a dearth of radiometric dates in most basins, chemostratigraphy has thus become the hallmark of Proterozoic correlation (e.g., [Knoll et al., 1986](#); [Kaufman and Knoll, 1995](#); [Shields et al., 1998](#); [Jacobsen and Kaufman, 1999](#); [Brasier and Shields, 2000](#); [Azmy](#)

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et al., 2001; Shields and Veizer, 2002; Cozzi et al., 2004). This is especially so in the thick Neoproterozoic successions of Brazil, including the carbonate-dominated Vazante Group (Azmy et al., 2001) and their equivalents on the São Francisco craton. During the Neoproterozoic, this craton was a conjugate to the Congo craton in Africa, which includes the glaciogenic Otavi Group where the ‘Snowball Earth’ hypothesis was resurrected (Kirschvink, 1992; Hoffman et al., 1998a).

Ongoing chemostratigraphic investigations in Brazil aim to refine regional and global correlations of glacial diamictites at the base of the Vazante and Bambuí groups, in order to better understand the evolution of surface environments and climate near the end of the Proterozoic Eon. In this study, we investigate the upper reaches of the Vazante Group, including the Morro do Calcario Formation and the overlying Lapa Formation for evidence of glacial phenomenon and associated stable isotope anomalies. Using these observations, we predict corre-

lations with better dated units on the Congo Craton and thus provide chemostratigraphic constraints on the co-evolution of both successions.

2. Geologic setting

The Lapa Formation is a part of the carbonate-dominated Neoproterozoic platform of the Vazante Group (Dardenne, 2001) that extends along more than 300 km N–S in the external zone of the Brasília Fold Belt in São Francisco Basin (Fig. 1). The stratigraphy of the marginal marine sediments of the Vazante Group (Fig. 2) has been studied in detail and refined by several authors (e.g., Dardenne, 1978; Dardenne and Walde, 1979; Madalosso, 1979; Karfunkel and Hoppe, 1988; Fairchild et al., 1996; Azmy et al., 2001; Dardenne, 2001; Misi, 2001; Misi et al., in press). In the eastern part of the basin, carbonate, diamictite, and shale of the Vazante Group are generally well preserved and little metamorphosed; to the west near the Brasília Fold

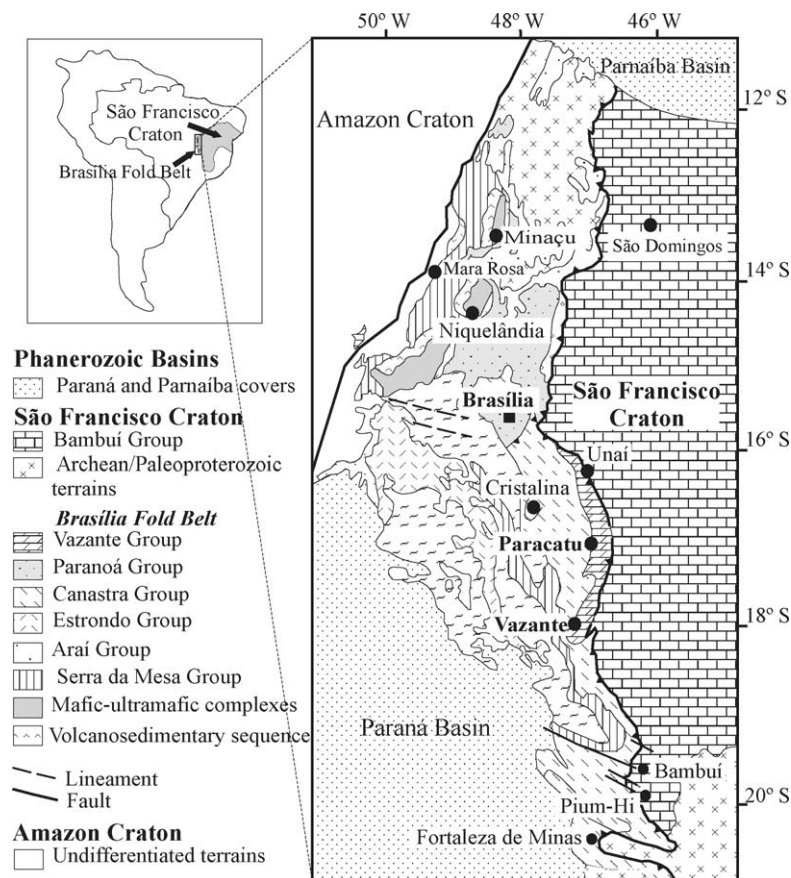


Fig. 1. Location map of São Francisco Basin in Brazil showing the geology of the Brasília Fold Belt including the Vazante Group (modified from Valeriano et al., 2004).

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