CHEMOSTRATIGRAPHIC PROFILE OF THE PROTEROZOIC BARROSO LIMESTONE, SOUTHERN MINAS GERAIS, BRAZIL

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INTRODUCTION

The Carandaí Megasequence is exposed in a narrow NE-SW syncline (Fig. 1) at the southern border of the São Francisco Craton, southern Minas Gerais, Brazil. The megasequence includes the Barroso Sequence mainly constituted of limestones and the Prados Sequence constituted of siliciclastic mudstones. Carbon and oxygen stable isotopes were used to clarify paleo-environmental conditions during deposition and possible correlations of the Barroso limestone with carbonates of the Bambui and Paranoá groups.

The Barroso and Prados sequences lie unconformably on a granite-greenstone basement and on Paleoproterozoic quartzites of the São João del Rei Megasequence. All these sequences are also partially covered by Neoproterozoic metasediments of the Andrelandia Megasequence (Trouw et al., 2000) and Cenozoic alluvial deposits (Ribeiro et al., 2003). Detrital zircon ages from metasediments of the São João del Rei and Andrelandia units constrain the depositional age of the Barroso and Prados sequences to the interval 1.3 – 1.0 Ga (Valladares et al., 2004, 2005; Valeriano et al., 2004). The rocks of the Barroso and Prados sequence record metamorphism in the biotite zone, greenschist facies, and contain a well developed slaty cleavage, specially in the mudrocks. Deformation and metamorphism are attributed to the Neoproterozoic Brasiliano Orogeny and related to the evolution of the Ribeira Belt.

BARROSO DEPOSITIONAL SEQUENCE

The Barroso Sequence is composed of a lower diamictite unit, only locally developed, an intermediate gray phyllite unit ca. 10 meters thick and an upper carbonate unit up to 250 meters thick. The three units onlap basement rocks. The diamictite and the gray phyllite are interpreted as the record of transgressive and condensed sections respectively. The carbonate unit represents a highstand system tract of the depositional sequence. A paleokarst surface on top of the carbonates, covered by mudrocks of the Prados Sequence, record a low stand of regional scale.

The highstand carbonate unit is constituted of two main coarsening and thickening upward cycles, each ca. 130 meters thick. The first third of the cycles is constituted of thin (1-10cm) to medium (10-30cm) thick white/gray limestone beds. The other two thirds are formed of thick (30-100cm) to very thick (>100cm)

gray carbonate beds. Marls, now mainly biotite calcite phyllites, appears as thin beds and interlaminations in the first third of the cycles. The carbonate succession is interpreted as a platform deposit in an intracratonic basin.

MATERIALS AND METHODS

Eleven metalimestone or fine marble samples belonging to the first coarsening and thickening upward cycle were colleted in regular intervals of approximately 10-15 meters in a continuous section at the Cimento Tupi quarry near the city of Carandaí. Determinations of minor and major elements by ICP/AES and ICP/MS (trace elements) methods were elaborated at the Acmelab Laboratory, Canada (Table 1 and Fig. 2).

CHEMOSTRATIGRAPHY

The oxygen and carbon isotopic compositions are displayed in Table 1 and Fig. 2. The profile starts with positive values of $\delta^{13}C_{PDB}$ between +7.6‰ $_{PDB}$ and +9.2‰ $_{PDB}$ and then shows a depletion to value –0.4‰ $_{PDB}$. Upward in the profile those values remain positive and then decrease to values as low as +1.4‰ $_{PDB}$ and finally stabilize around +9.3‰ $_{PDB}$.

The result for $\delta^{18}O_{PDB}$ reveals only negative values. The $\delta^{18}O_{PDB}$ starts with values around -5.2‰ $_{PDB}$ and then decreases to -9.9‰ $_{PDB}$. Upward the $\delta^{18}O_{PDB}$ increases, without strong fluctuations, and in the last four samples reaches values around -7.3‰ $_{PDB}$.

In order to determine post-deposicional alteration a petrographic characterization of the samples was perfomed. In general, studied metalimestone present ca. 97% coarse-grained calcite (0.8 to 4 mm) and 3% muscovite, biotite, chlorite and opaques. No dissolution or exsolution textures were found. No relationship was found between presence of silicate minerals and anomalous depleted values.

DISCUSSION AND CONCLUSIONS

The isotopic profile reveals a negative $\delta\ ^{18}O_{PDB}$ and a positive $\delta^{13}C_{PDB}$ excursion at the basal carbonate cycle of the Barroso Sequence. The negative $\delta^{18}O_{PDB}$ values indicate that the carbonate deposition occurred in a warm and shallow marine environment during a non-glacial

period. Although the records were subjected to post depositional processes, including low-grade metamorphism, this does not seem to have altered the $\delta^{18}O_{PDB}$ values in the analyzed profile as no $\delta^{18}O_{PDB}$ fluctuations were detected. The negative values are quite similar to those presented by Santos et al. (2000) for the Paranoá Group and are interpreted as a result of anomalous strontium concentrations during carbonate deposition as stated by Derry et al. (1992).

A negative $\delta^{13}C_{PDB}$ value at the base of the carbonates followed by a positive excursion up in the sequence was obtained in the Bambui Group. In contrast only positive values were obtained for the Paranoá Group carbonate (Santos et al., 2000; Misi 2001). The Bambui carbonate data is interpreted as a pos glacial sequence starting with cap carbonate (negative $\delta^{13}C_{PDB}$ value) related to the Neoproterozoic Sturtian glaciation. The Paranoá data is interpreted as the result of carbonate sedimentation in a non-glacial period predating the Bambui deposition (Misi, 2001).

The absence of negative values and the high posi-tive $\delta\ ^{13}C_{PDB}$ value (mean +8.6‰ $_{PDB}$), obtained for the Barroso carbonates are suggestive of deposition not related to a glacial event. The large amount of ^{13}C present in the system may come from methanogen processes and decarbonation processes during diagenesis. The high positive $\delta^{13}C_{PDB}$ of the Barroso carbonates are almost two times higher as those of ca. + 4.5‰ $_{PDB}$ suggested for most Mesoproterozoic carbo-nates (Santos et al., 2000; Misi, 2001; Juan C. Silva et al., 2005). The data also allow the possible correlation with the Paranoá carbonates, which are considered by Santos el al. (2000) of Mesoproterozoic age.

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RESUMO

A sucessão carbonática que ocorre na região de Carandaí, sudeste de Minas Gerais é parte integrante da Megasseqüência Carandaí. É constituída por sucessões de metacalcários maciços e interlaminações de biotita-filito carbonático (marga) e compõem parte da Seqüência Deposicional Barroso. Análises químicas e petrográficas não revelaram texturas de dissolução ou exsoluçcão, nem uma relação entre a presença de minerais silicáticos e os valores depletados nas razões $\delta^{13}C_{PDB}$. O perfil isotópico mostra valores positivos para as $\delta^{13}C_{PDB}$ (média +8.6‰ $_{PDB}$) e valores negativos para as $\delta^{18}O_{PDB}$ (–5,24 à –9,92‰$_{PDB}$). Os valores positivos para as razões $\delta^{13}C_{PDB}$ indicam que processos metanogênicos e de descarbonatação elevaram a concentração de ^{13}C no sistema. Os valores negativos para as razões $\delta^{18}O_{PDB}$ indicam que a deposição carbonática ocorreu em um ambiente marinho, de águas quentes e rasas, durante um período não-glacial, permitindo assim, uma possível correlação com os carbonatos do Grupo Paranoá.

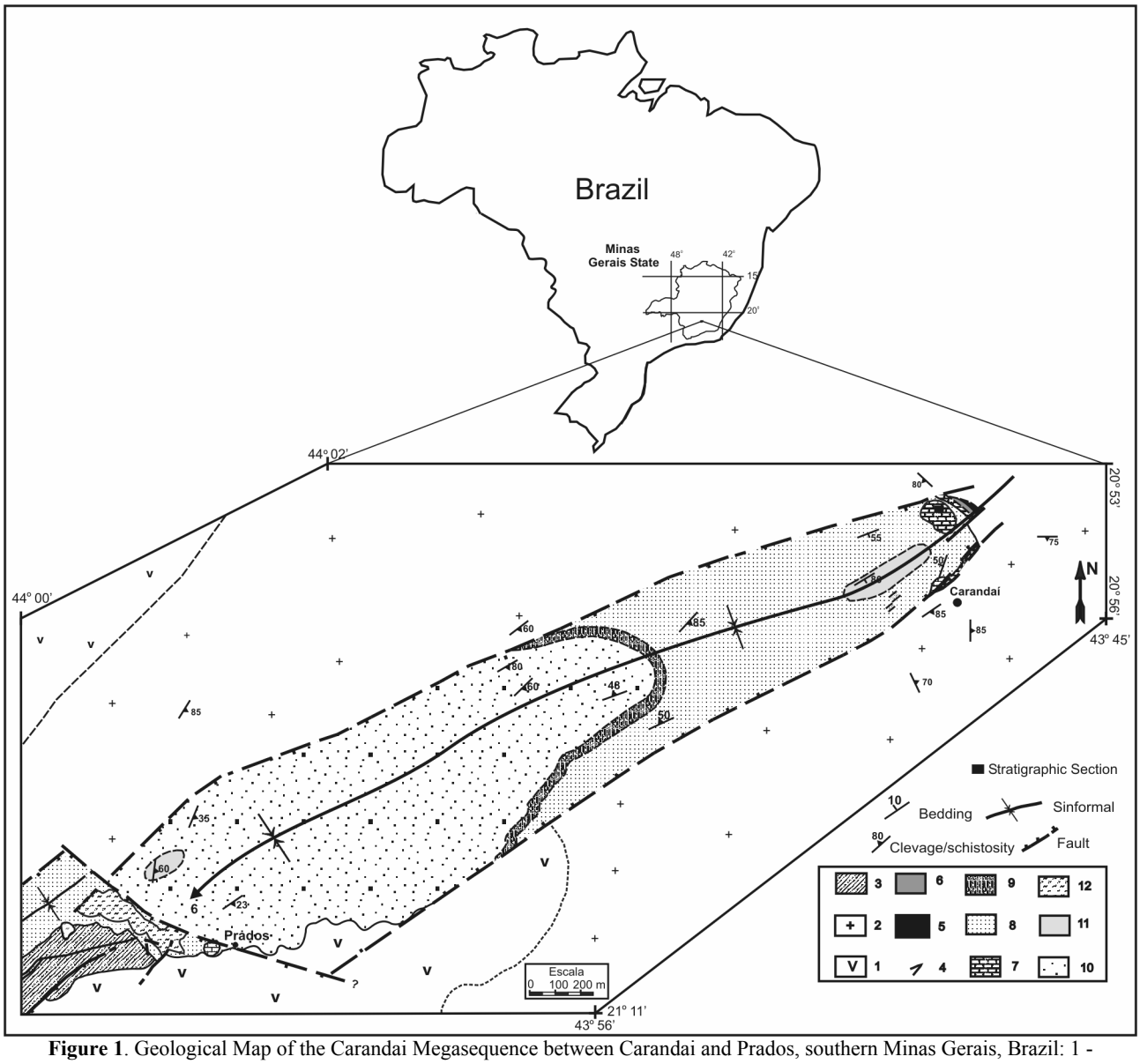

Figure 1. Geological Map of the Carandai Megasequence between Carandai and Prados, southern Minas Gerais, Brazil: 1 - Greenstone Belt and 2 – Paleoproterozoic granitoids. 3 -Quartzites and metapelites of the São João del Rei Megasequence. 4 – Paleoproterozoic mafic dikes. Carandaí Megasequence: 5- Metadiamictite, 6 – Gray phyllites and 7 – metalimestones of the Barroso Sequence; 8 - Metapelites, 9 – Graphyte-phyllite and 10 - Gray phyllites of the Prados Sequence. 11 – Biotite-feldspar-phyllite of the Andrelândia Megasequence. 12 – Cenozoic alluvial deposits.

Table 1. Geochemical analyses of the studied limestones

Samples	Si ppm	Ca ppm	Mn ppm	Mg ppm	Sr ppm	Rb ppm	Fe ppm	$\delta^{13}C‰_{PDB}$	$\delta^{18}O‰_{PDB}$
11(Top)	32.2	377.1	0.23	3.3	2229.3	8.8	1.18	9.2	-7.3
10	273	192.8	0.38	14.2	1588.2	84.8	11.56	9.4	-8.3
9	37.3	380.8	0.15	4.2	2695	8.4	2.49	9.4	-7.9
8	43.4	376.3	0.23	5.1	2566.4	14.9	2.71	8.8	-7.5
7	103.7	369.5	0.07	5.5	510.5	41.5	4.47	1.4	-8.2
6	143.6	292.7	0.31	8	1748.6	59.6	6.78	8.2	-8.5
5	207	301.3	0.46	5.3	368.4	58.3	6.26	2.0	-9.9
4	117.6	359.1	0.38	6.9	434.3	48.1	4.99	-0.4	-8.4
3	325.5	151.7	0.23	13.0	934.1	122.9	15.19	7.9	-8.5
2	55.4	357.1	0.15	5.6	2632.5	25.6	2.67	8.3	-6.7
1 (Base)	18.2	363.1	0.07	3.1	2921.6	8.6	1,79	7.6	-5.2

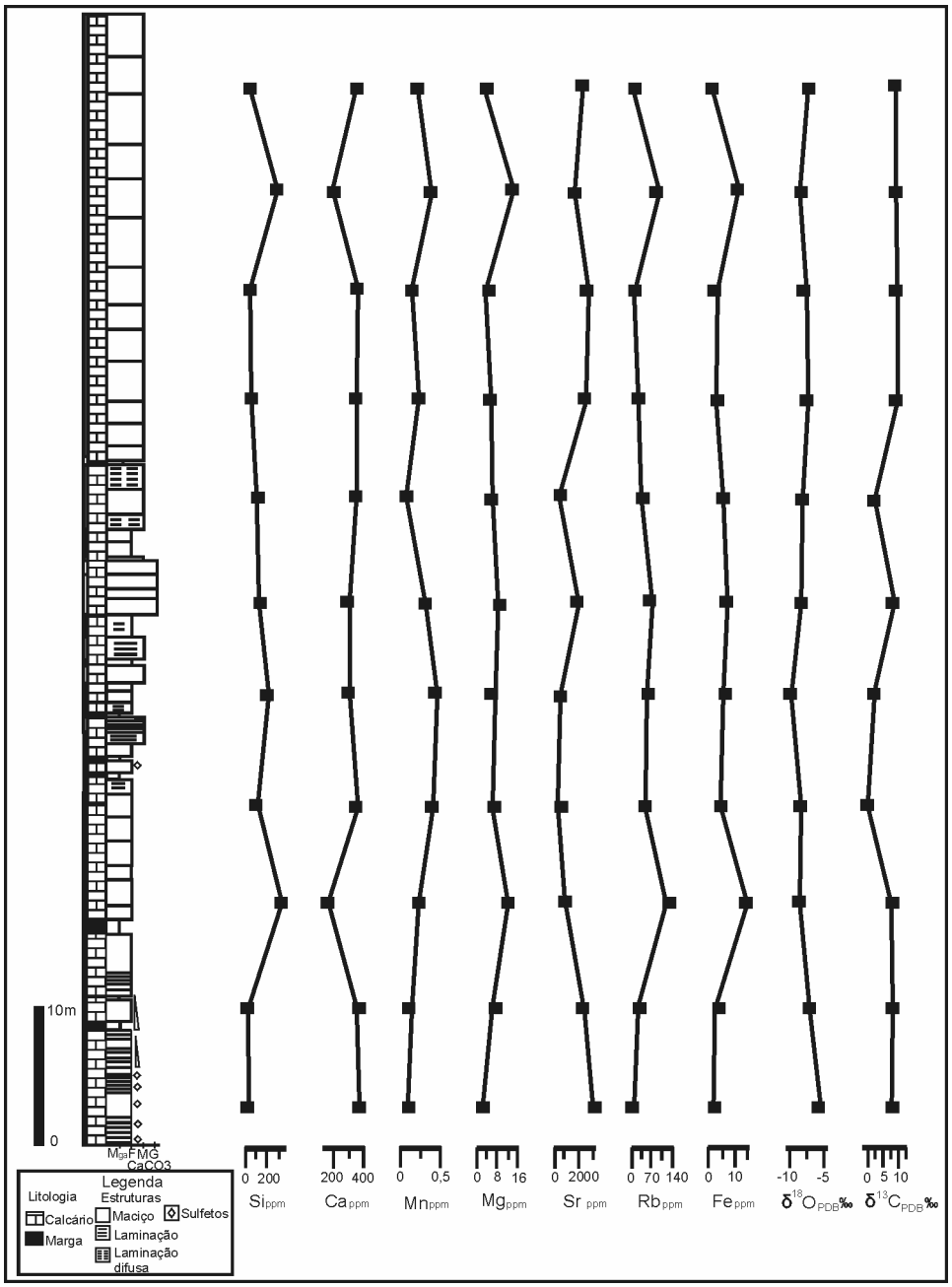

Figure 2. C- and O- isotope chemostratigraphic pathway for the studied sucession.