

Pb isotope behavior in carbonate rocks from Bambuí Group, Brazil, during post-depositional events: A study case

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This study was done on more than ninety carbonate samples collected from 10 outcrops (Fig. 1). The samples belong to the Neoproterozoic Sete Lagoas and Lagoa do Jacaré formations, Bambuí Group, from the southern part of the São Francisco basin¹, Minas Gerais State, Brazil. Based on the structural studies^{2,3} the southern part of the basin is divided in three domains (Fig. 1): the central, eastern and western domains. Five outcrops are located in the central part of the basin where the rocks are undeformed, one outcrop is from the domain where the rocks have been deformed by the Brasília fold belt (western domain), and four outcrops are in the domain affected by the Araçuaí fold belt (eastern domain).

Based on Pb isotope analyses and U and Pb concentrations determined on the carbonates, four different types of Pb were identified and they were classified by Babinski⁴ as Pb Type I, II, III and IV. Type I Pb was found in samples with low Pb concentrations (0.10 - 0.88 ppm) and relatively high U concentrations (0.17 - 0.95) with U/Pb ratios greater than 1; it represents *in situ* growth of radiogenic Pb and is able to yield Pb-Pb isochron ages. Type II Pb is present in samples with relatively high Pb concentrations (0.76 - 35.0 ppm) and low U concentrations (0.01 - 3.9 ppm); it is non-radiogenic crustal Pb showing Pb isotopic compositions that could represent either average crustal Pb at the time of deposition or, as interpreted here, the deformation of these rocks. Type III Pb is also found in samples with high Pb concentrations (1.8 - 50.0 ppm) and low U concentrations (0.19 - 1.22 ppm) but it is radiogenic crustal Pb. This Pb can be divided in Type IIIa, IIIb and IIIc according to their Pb isotopic compositions; it is Pb from the Archean/Paleoproterozoic basement that was incorporated into the Neoproterozoic carbonate rocks during the Brasiliano orogeny. Type IV Pb occurs in samples with U/Pb ratios lower than 1 and is intermediate in composition between Type III and Type I Pb; it represents a mixture of those two types. Although most outcrops contain only one type of Pb, three out of four types of Pb were found in rocks of outcrop MF-7 located in the central, undeformed part of the basin (Fig.1).

The Pb-Pb isochron ages obtained from mesoscopically undeformed carbonates containing Type I Pb range from 686 ± 69 Ma to 520 ± 53 Ma. Because the age of 686 ± 69 Ma was determined on the same outcrop (MF-7) where other types of Pb were also detected (Types III and IV, which were incorporated into the carbonates during the Brasiliano orogeny), this age is considered as the minimum depositional age for the carbonate rocks from the Sete Lagoas Formation. The younger age may represent re-homogenization of the U-Pb system during the late stages of the orogeny.

Samples with Type I Pb and displaying deformational features (collected in the western and eastern domains) yielded regressions of 872 ± 290 Ma (MF-9) and 842 ± 240 Ma (MF-3). Although these could represent the approximate time of deposition of the carbonates, the errors are too large to allow precise interpretation.

Isotopic compositions from Type III Pb define a straight line; the Pb isotopic compositions of Type II Pb fall on the lower end of this line, which intercepts the Stacey & Kramers⁵ Pb growth curve at about 520 and 2100 Ma, suggesting that old Pb from the basement was incorporated in the carbonate rocks at about 500 - 550 Ma. This line is interpreted as a S&K third stage 500 - 550 Ma geochron. This old Pb from the basement was probably incorporated into the carbonates through a large scale fluid percolation event that could have begun before 500 - 550 Ma, but it is not possible to define, with the available data, the precise time that the process started. The paths of these fluids may have been along the old basement faults that were reactivated during the Brasiliano orogeny.

According to these data, it is suggested that the carbonate rocks from the Sete Lagoas Formation were deposited before 686 ± 69 Ma. Rocks from Lagoa do Jacaré Formation (MF-6 and MF-5) contained only Type II Pb, which does not permit determination of a Pb-Pb age. During the interval from 690 and 500 Ma, the Pb isotope system of the carbonate rocks from the São Francisco basin was disturbed, and in some areas it was totally reset. The imprecise U-Pb ages of ca. 550 - 600 Ma obtained from some of the carbonates reflect this disturbance. The ages determined in this study are in agreement with most of the published ages of the tectonism from the Brasiliano fold belts marginal to the São Francisco craton, showing that the isotopic system of the carbonate rocks from the São Francisco basin were largely affected by the Brasiliano tectonism, even in areas where no mesoscopic deformation can be observed.

References

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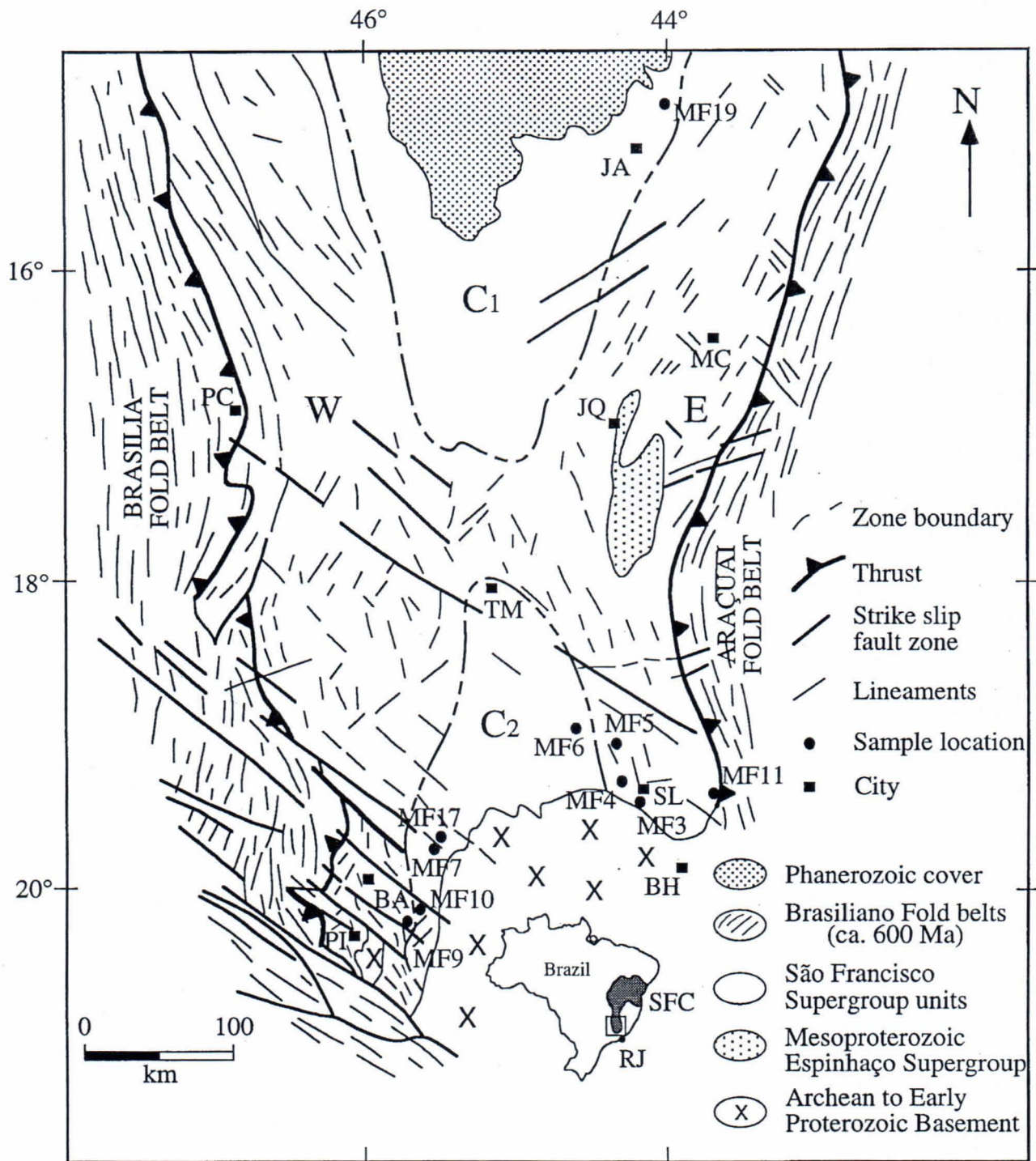


Figure 1. Simplified geologic and structural map of the southern part of the São Francisco basin (after Chemale et al.³), with sample location. SFC = São Francisco craton; C1 and C2 = undeformed domains; E = domain affected by the Araçuaí fold belt; W = domain affected by the Brasília fold belt. BH = Belo Horizonte; BA = Bambuí; PI = Piumhi; TM = Três Marias; PC = Paracatú; JQ = Jequitaiá; JA = Januária; MC = Montes Claros; RJ = Rio de Janeiro.