PALEOMAGNETISM AND GEOCHRONOLOGY OF MAFIC DIKES FROM THE REGIONS OF SALVADOR, OLIVENÇA AND UAUÁ, SÃO FRANCISCO CRATON, BRAZIL: PRESENT STAGE OF THE USP/PRINCETON UNIVERSITY COLLABORATION

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INTRODUCTION

The purpose of the USP/Princeton University collaboration project is a paleomagnetic and geochronological study of Precambrian metamorphic units and anorogenic Proterozoic intrusives from selected areas in Brazil. The Instituto Astronômico e Geofísico of the Universidade de São Paulo has been carrying out the paleomagnetic analyses whereas geochronological determinations using the $^{40}Ar/^{39}Ar$ method are being made at Princeton University with the collaboration of the Instituto de Geociências of USP.

A total of 799 oriented rock samples has been collected from metamorphosed and unmetamorphosed dikes and also from the basement rocks in the regions of Uauá (131 samples), Salvador (200 samples) and Ilhéus-Olivença-Itaju do Colônia (341 samples) in the State of Bahia and west of Belo Horizonte (107 samples), State of Minas Gerais (Fig. 1).

The present status of the paleomagnetic and geochronological studies of these rocks is presented here, including results obtained up to now and an analysis of paleogeographic and geotectonic implications.

Region West of Belo Horizonte - The paleomagnetic analysis of dikes from this region reveals a complex magnetic behaviour when submitted to laboratory treatments. Samples from the same dike often show stable directions which, however, are not coherent. This has probably been caused by the complex thermo-tectonic history of this region in which several thermal events (from Trans-Amazonian to Brasiliano) have been recorded. Samples from the few dikes which present coherent paleomagnetic directions are being prepared for $^{40}Ar/^{39}Ar$ age determinations.

Uauá Region - Samples from 20 dikes (two of them metamorphosed) collected near the town of Uauá presented good magnetic stability to alternating field (AF) and thermal treatment and yielded directions with declination around 13° and positive inclination (Fig. 2a). Some of these samples are being prepared for $^{40}Ar/^{39}Ar$ age determinations.

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Salvador Region - Samples from 24 unmetamorphosed dikes were collected along the coast (18 dikes) and at the Omacil (1 dike) and Valéria (5 dikes) quarries. These samples showed three different groups of magnetization directions (Fig. 2b). The first group (most of the dikes) corresponds to declinations around 110° and negative inclinations or declinations of about 290° and positive inclinations (circles in Fig. 2b). The five dikes at the Valéria quarry presented declinations around 105° but with lower inclination (squares in Fig. 2b). The third group is represented by four dikes with declinations around 170° and positive inclinations (triangles in Fig. 2b).

Biotite grains from the basement rock about 90 cm from the contact with a dike approximately 30 m thick near the Hotel Meridien yielded an $^{40}Ar/^{39}Ar$ age of 1021 ± 8 Ma. Plagioclase from the dike itself yielded 1003 ± 33 Ma by the same method. The magnetization direction of the dated dike belongs to the first group in Figure 2b, with negative inclinations.

Region of Ilhéus-Olivença-Itaju do Colônia - Samples from 65 dikes were collected along the beaches of Olivença (47 dikes) and Ilhéus (18 dikes) and also from 32 dikes along highway BR-101 between Camacã and Itabuna and near the town of Itaju do Colônia (Itaju do Colônia swarm). A detailed description of laboratory and statistical procedures used in the analysis of samples from these dikes can be found in D'AGRELLA FILHO et al. (submitted). For several samples it has been possible to isolate a stable direction after AF and thermal treatments (Fig. 3). The samples from Ilhéus presented only directions with negative inclination, whereas reverse and normal directions were found for samples from Olivença and Itaju do Colônia.

$^{40}Ar/^{39}Ar$ geochronological determinations were carried out using the minerals hornblende, biotite and plagioclase from the basement rock at the contact with a dike in Ilhéus (direction with negative inclination) and from another contact with a dike from Olivença (positive inclination direction). RENNE et al. (submitted) considered the ages on biotite grains as the most representative of the dike intrusions: 1077 ± 25 Ma and 1078 ± 18 Ma for Olivença and 1011 ± 24 Ma for Ilhéus. Plagioclase from an Ilhéus dike yielded an age of 1012 ± 24 Ma.

DISCUSSION

Table 1 presents a summary of paleomagnetic results obtained for the analyzed mafic dikes. The paleomagnetic poles calculated for each direction group (reverse and normal) defined by the paleomagnetic analysis and its associated age are indicated in the table.

A K/Ar determination and two preliminar Rb/Sr diagrams suggest a Trans-Amazonian age for the Uauá basic dikes (Table 1). Taking into account a pre-drift reconstruction, the pole for the Uauá dikes is compared with an apparent polar wander (APW) path constructed for Africa for the interval 2.3-1.9 Ga (McWILLIAMS, 1981). This APW path also suggests a Trans-Amazonian age for the magnetization (around 1.9 Ga) which, however, is slightly lower than existing geochronological determinations (Table 1).

The Salvador paleomagnetic poles (SN, SR - Table 1) corresponding to the directions represented by circles in Figure 2b fall on the APW path defined by the Ilhéus-Olivença-Itaju do Colônia poles presented in Table 1 (Fig. 5, D'AGRELLA FILHO et al., submitted). At least two polarity intervals are defined by the poles of Figure 5.

Two important implications can be inferred from these results: the first concerns the late Precambrian glaciation represented by several formations in central-eastern Brazil (Macaúbas Group, Bebedouro Formation, Ibiá Formation, etc.). An age between 950-1000 Ma has been suggested for these glacial deposits (KARFUNKEL & HOPPE, 1988). Figure 5 shows that the

São Francisco Craton was near the pole during the Ilhéus-Olivença-Itaju do Colônia and Salvador mafic dike intrusions. Paleomagnetic results are consistent with the paleogeographic models for the Macaúbas Group (KARFUNKEL & HOPPE, 1988). It should be remembered, however, that the dikes do not intrude any of the glacial deposits, which suggests that the dikes may be slightly older; Rb/Sr datings of clay fractions from the Bebedouro Formation samples yielded younger ages for the deposition of these sediments. Moreover, many late Precambrian formations of glacial origin present low paleomagnetic inclinations suggesting that glacial deposition also took place at low paleolatitudes.

The second implications is of a tectonic nature (RENNE et al., submitted). Figure 6a shows that poles for the Kalahari Craton in southern Africa (Unkondo dolerites - UD, post-Waterberg dolerites - WD, Kruger Park Gabbro - GK, Koras Group - KG) and the Olivença pole (OR) for positive inclination dikes all present the same age but do not coincide geographically. Also a pole determined for the Namaqua Zone metamorphic rocks (CZ) coincides with the OR pole. However, RENNE et al. (op. cit.) present an age of 1000 $\pm$ 20 Ma ($^{40}Ar/^{39}Ar$) for the cooling-metamorphism of these rocks. The time and space agreement of poles from the São Francisco, Congo and Kalahari Cratons is obtained through a 90° counterclockwise rotation of the Kalahari Craton around an Euler pole at 0° N, 30° E (Fig. 6b).

ACKNOWLEDGEMENTS

The funding for this research was provided by CNPq, FAPESP and FINEP from Brazil and NSF (Grants EAR-8451696 and EAR-8805529) from the USA.

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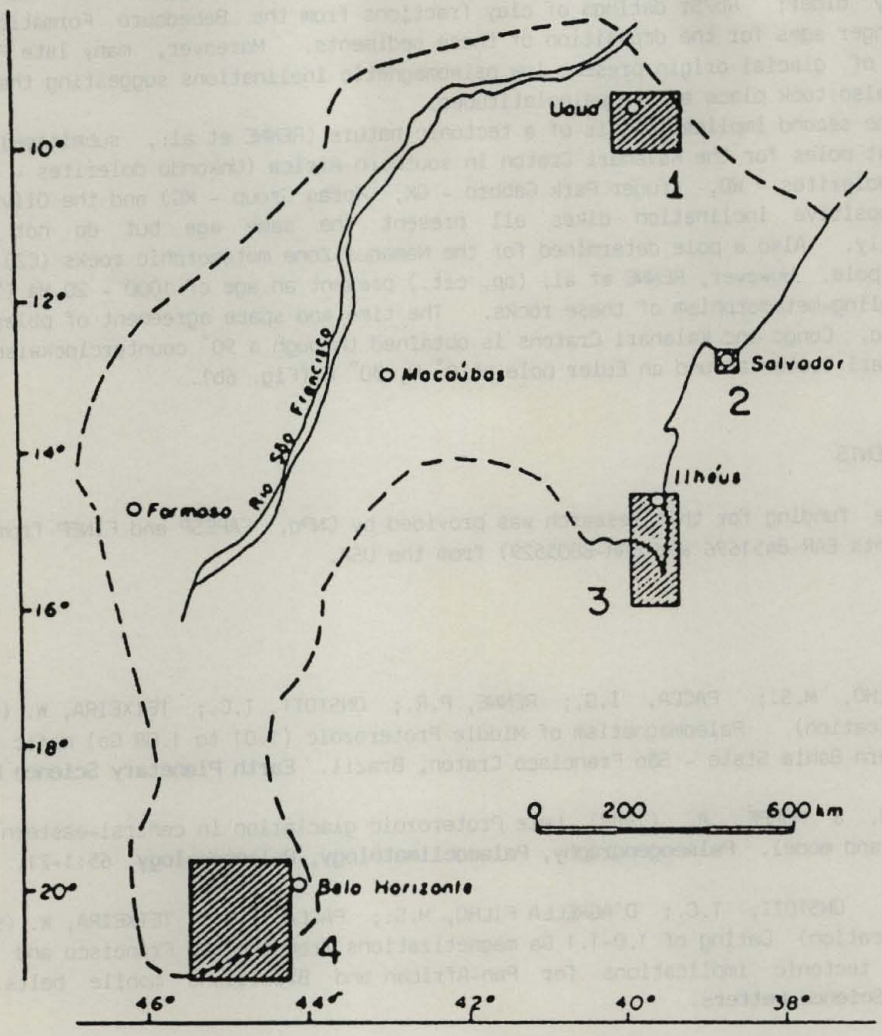

Figure 1 - Sample localities: 1. Uauá region; 2. Salvador region; 3. Ilhéus-Olivença-Itaju do Colônia region; 4. West of Belo Horizonte region. The dashed line delimits the São Francisco Craton.

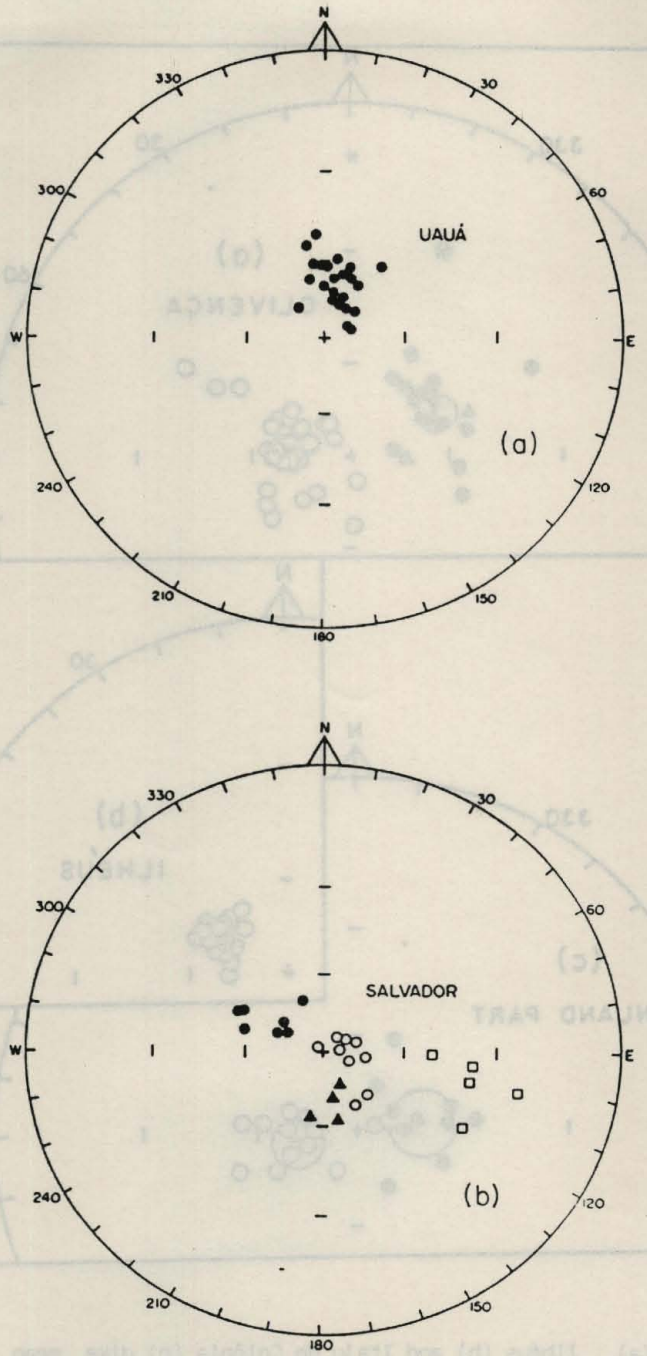

Figure 2 - Uauá (a) and Salvador (b) dike mean directions. Solid symbols represent positive inclinations and open symbols, negative inclinations.

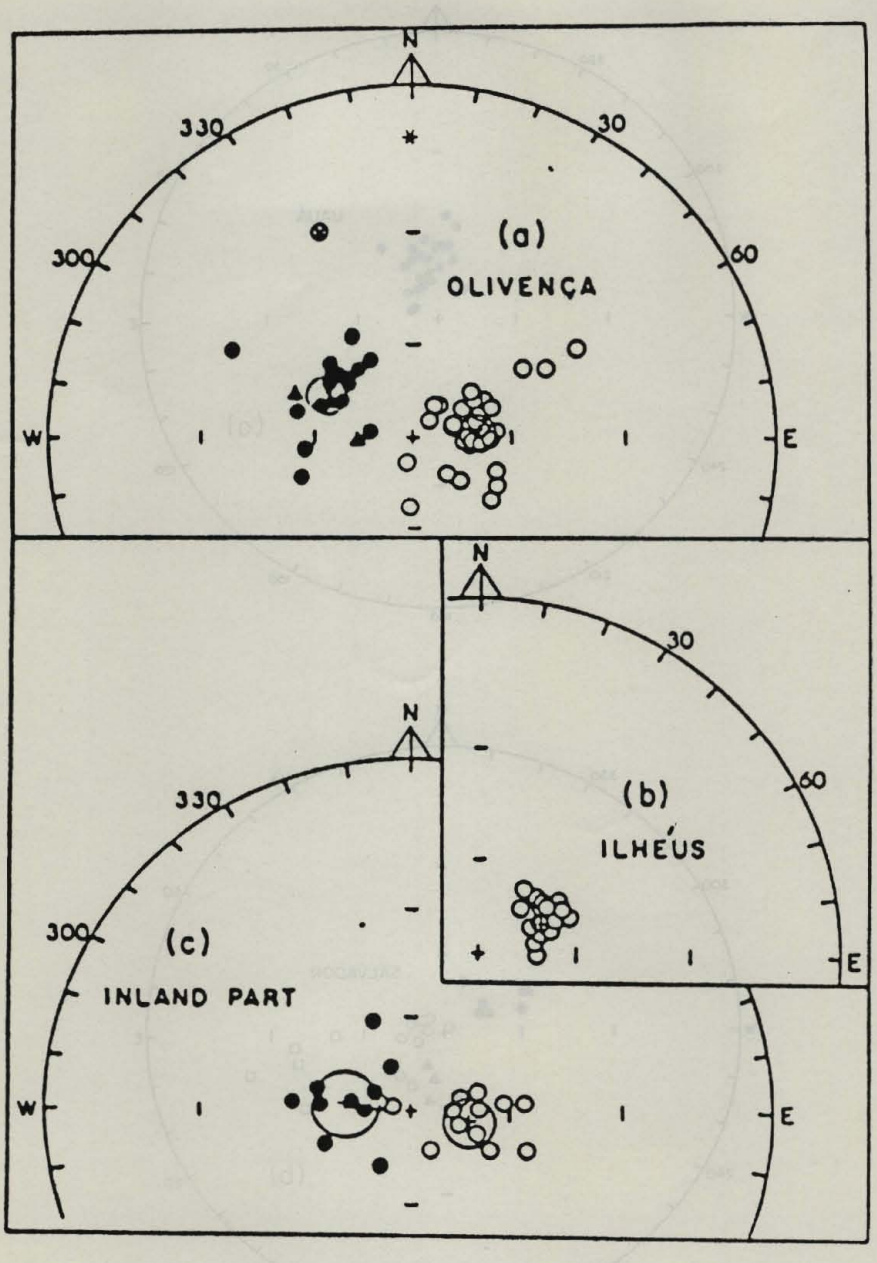

Figure 3 - Olivença (a), Ilhéus (b) and Itaju do Colônia (c) dike mean directions. Solid symbols represent positive inclinations and open symbols, negative inclinations.

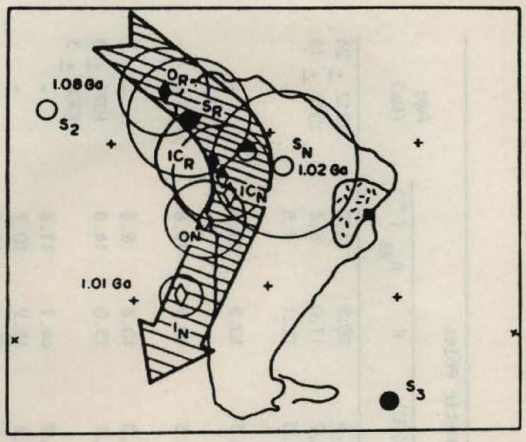

Figure 4 - 1.08-1.01 Ga APW path for the São Franciso Craton defined by the paleomagnetic poles from Ilhéus (IN), Olivença (ON, OR), Itaju do Colônia (ICR, ICN) and Salvador (SR, SN - directions represented by circles in Fig. 2b). Poles S2 and S3 were determined on the basis of the directions represented by squares and triangles in Figure 2b, respectively. Solid symbols represent poles obtained with downward directions and open symbols, upward directions. Half-filled symbols represent poles with both polarities (lozenge - Itaju do Colônia; circle - Salvador). South America is in its present position.

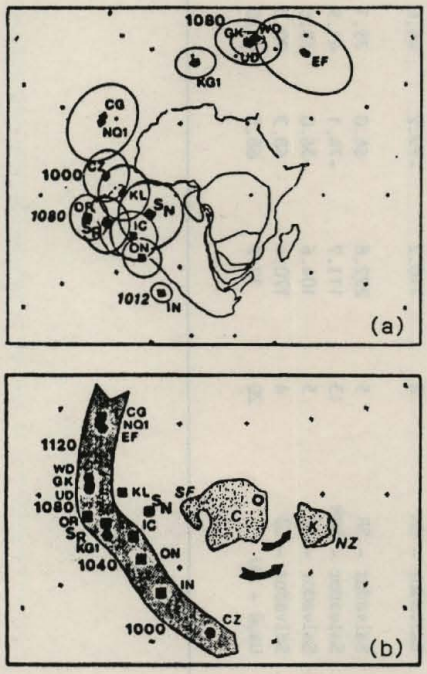

Figure 5 - (a) Comparison between the São Francisco, Congo and Kalahari poles of similar ages (RENNE et al., en prep.), in a pre-drift situation. (b) Hypothetical reconstruction which rotates the Kalahari Craton (K), including the Namaqua Zone (CZ) and corresponding paleomagnetic poles, about a rotation pole located at 0°N, 30°E with the Congo/São Francisco Craton (C and SF) fixed in position of Figure 5a.

Table 1 - Paleomagnetic results.

Locality	Number of sites	Mean Directions				Paleomagnetic Poles				Age (Ma)
		D(°)	I(°)	K	A_{95}(°)	Lat.(°N)	Long.(°E)	K	A_{95} (°)	
Ilhéus - IN	17	60.0	-66.8	189.7	2.6	30.3	100.4	78.9	4.0	1012 ± 24
Olivença - OR	18	298.8	60.7	30.4	6.4	9.5	280.2	17.0	8.6	1078 ± 18
Olivença - ON	31	82.4	-71.0	26.7	5.1	16.1	107.0	12.1	7.8	-
Itaju do Colônia - ICR	10	280.3	70.1	24.9	9.9	-5.4	290.3	10.5	15.6	-
Itaju do Colônia - ICN	13	97.7	-73.4	27.4	8.1	9.5	111.6	10.1	13.8	-
Itaju do Colônia - IC	23	99.0	-71.9	27.2	5.9	7.7	111.0	10.6	9.8	-
Salvador - SN	8	110.2	-79.2	44.9	8.4	6.4	122.4	15.0	14.8	1021 ± 8 1003 ± 3
Salvador - SR	5	292.8	66.0	79.7	8.6	4.5	284.7	44.1	11.6	-
Salvador - SNR	13	111.7	-74.1	41.9	6.5	2.1	115.4	15.9	10.7	-
Salvador - S2	5	104.6	-36.0	35.6	13.0	-8.3	74.9	40.1	12.2	-
Salvador - S3	4	170.4	68.3	90.5	9.7	-50.1	331.3	38.7	15.0	-
Uauá - DU	20	12.9	68.5	49.0	4.7	26.2	329.7	21.0	7.3	K/Ar:2014 ± 77 Rb/Sr: ~2200; ~2180